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A futuristic approach towards interface layer modifications for improved efficiency in inverted organic solar cells

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Inverted polymer Solar Cells of the classical poly (3-hexylthiophene) (P3HT):(6,6)-phenyl-C_{61}butyric acid methyl ester ($PC_{61}BM$) blend on indium tin oxide substrates were fabricated, which shows improved device performance, by using a facile solution–processed ZnO-polyelectrolytes [poly (diallyldimethylammonium chloride) (PDADMAC), Poly (acrylic acid sodium salt) (PAS), poly (4-styrenesulfonic acid) (PSS), and Polyvinylpyrrolidone (PVP)] nanocomposite as a cathode interface layer compared to devices using pristine ZnO as cathode buffer layer in ambient conditions. The devices with different combinations of polyelectrolyte with ZnO show different improvements in the device efficiency. The combinations of ZnO with PVP and PDADMAC show highest amount of improvements in the efficiency by a factor of ∼17–19. The improvement of the efficiency may be due to various phenomena, such as the passivation of ZnO surface as well as bulk traps, work function modification, improved energy level alignment, improved electronic coupling of the inorganic/organic interface, improved light harvesting, and decrease of surface as well as bulk charge recombination in the device. The introduction of polyelectrolyte into ZnO inhibits the aggregation of ZnO nanoparticles yielding the large area ZnO nanoclusters; and hence, forming the uniform film of ZnO resulting in the modifications of morphology as well as electronic structure of ZnO-polyelectrolyte nano-composite favouring better electronic coupling between cathode and active layer and hence enhancing the current and, consequently, the efficiency. This simple low temperature ZnO-polyelectrolyte nanocomposite based protocol proposed for cathode interface layer modification may be very much useful for roll to roll industrial manufacturing of organic solar cells. © *2014 AIP Publishing LLC*. [http://dx.doi.org/10.1063/1.4863434]

Organic Solar Cells (OSCs) are expected to be alternative energy resource for future generation and are likely to be commercializing very soon.[1–3] Hence, much attention has been given to OSCs in past few years in view of improvements of their power conversion efficiency (PCE) and life time. The PCE of OSCs has reached in the range of 7–9 in literature;[4–6] however, still improvements are needed in PCE.[7] The factors,[8] which determine the PCE of OSCs, are open circuit voltage (V_{oc}), short circuit current (J_{sc}), and fill factor (FF). The V_{oc} depends on the active layer materials where as J_{sc} depends on the absorption spectrum as well as on the transport of charge carriers through the film. Further, the FF which represents how difficultly or easily the charge carriers can be extracted out of the device, depends on many factors such as series resistance, shunt resistance, and on the quality of diode.

Besides PCE, the stability of OSCs is a major factor which is playing a role against commercialization of OSCs. In general, conventional OSCs comprise an active layer sandwiched between two electrodes, namely, Indium Tin Oxide (ITO) on bottom and metal electrode on the top. The diffusion of air into the active layer through pinholes and grain boundaries causes degradation of the device in air. Moreover, the hygroscopic nature[9,10] of the hole transporting poly (3, 4 ethylene dioxythiophene) doped with polystyrene sulfonate (PEDOT:PSS) layer aids towards degradation of the device.

One approach to resolve the issue of degradation is to adopt the inverted geometry where the charge separation and collection is reversed. In the inverted structure the interface of ITO/PEDOT:PSS can be avoided by using various high band gap n-type of oxides[11,12] such as ZnO, TiO_x, V_2O_5, and NiO instead of PEDOT:PSS. Moreover, the environmental friendly nature, high optical transparency, relatively higher electron mobility, blocking capability for the UV-light induced photodegradation of organic materials, and availability of various techniques of wet synthesis of ZnO makes it most suitable material to be used as an electron transport layer (ETL) in the inverted OSCs.[13–18] However, the major problems in using ZnO nanoparticle films are (i) the presence of defects due to adsorption of oxygen, (ii) back charge transfer from ZnO to electron donating conjugated polymer, and (iii) the spatial distribution of ZnO nanoparticles is also not uniform, which renders large series resistance leading to poor electronic coupling with the active layer. Hence, alternative approaches are needed in view of creating low defect, smooth, and uniform films of the ETL which can create better electronic coupling with the active layer. Self assembled monolayers;[19,20] polyelectrolyte applied on the top[21–25] of ZnO film can eliminate the surface traps up to some extent

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Amine-Functionalized Poly(styrene) Microspheres as Thermoplastic Toughener for Epoxy Resin

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In this article, the potential of amine-functionalized poly(styrene) (PS) microspheres as toughening agent for epoxy resin has been explored. PS microspheres were prepared by suspension polymerization, where the monomer concentration and stirring speed was varied to control the microsphere dimensions (52–183 μm). The obtained microspheres were chemically functionalized with an aim to improve its dispersion within the epoxy matrix. The amine groups generated on the microsphere surface offer a potential site of covalent linkage with the epoxy matrix, thereby resulting in increased compatibility and improved properties. Epoxy composites containing varying amounts of microspheres (1–7% w/w) were prepared and their mechanical properties were evaluated under both quasi-static as well as dynamic conditions. The amination of poly(styrene) (APS) led to improved dispersion of the rigid microspheres in the epoxy matrix, which was evident from higher impact strength and fracture energies (G_{IC}) as compared to its neat analogs. The izod impact strength and G_{IC} increased by 33% and 150%, respectively, on introduction of 3% APS. This was accompanied with an increase in the tensile modulus and strength of the epoxy resin. Further increase in loading led to agglomeration of the microspheres, which in turn resulted in lowering of impact strength and toughness. Excellent agreement was found between the experimentally measured modulae and the predictions made on the basis of Halpin–Tsai and Lewis–Neilson models. Fracture surface morphology was studied to arrive at the principal toughening mechanisms behind the experimental findings. POLYM. COMPOS., 00:000–000, 2014. © 2014 Society of Plastics Engineers

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INTRODUCTION

Physical blending and curing are fundamental tools, which can be employed to alter the structure–property relationship of polymeric materials. This technique has been used to improve the fracture properties of epoxies by shifting its mechanical response from "brittle" manner toward "ductile" mode. Most of the conventional epoxies are extremely vulnerable to impact-induced damage because of their inherently brittle nature, which limits their usage in more demanding applications. Physical toughening techniques include blending of epoxy–resin with elastomers [1–3], thermoplastics [4–6], rigid particulates [7–10], and nanomaterials [11]. In this context, the oldest approach being practiced involves blending with liquid reactive rubbers [12]; however, the resultant blends suffer from specific disadvantages including reduced elastic modulus, low glass transition temperatures and high water absorption. To address these issues, it has lately become more common to use thermoplastics as toughening agents [13–15]. However, these thermoplastic modifiers are rather difficult to process [16], and many a times require the use of solvents [17], which warrant a separate removal step, as the presence of even residual amounts can adversely affect the final properties of the blends.

It is to be noted that irrespective of the type of polymer used for epoxy toughening, it is the thermodynamically (location of the phase diagram) and kinetically controlled process (competition between phase separation and polymerization kinetics), which governs the morphology of the resultant blend, thereby determining its final properties and applications [18]. The curing phenomenon, in the presence of another polymer results in the formation of phase separated blends, a phenomenon more commonly known as "polymerization-induced phase separation" (PIPS). It becomes increasingly difficult to control this process in fast curing compositions, leading to minimal improvement in the properties. In view of the above, developing ways and means of controlling the morphology has attracted the attention of

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Anisotropically Functionalized Carbon Nanotube Array Based Hygroscopic Scaffolds

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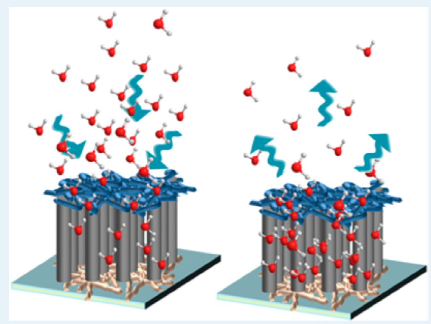
Supporting Information

ABSTRACT: Creating ordered microstructures with hydrophobic and hydrophilic moieties that enable the collection and storage of small water droplets from the atmosphere, mimicking structures that exist in insects, such as the Stenocara beetle, which live in environments with limited amounts of water. Inspired by this approach, vertically aligned multiwalled carbon nanotube forests (NTFs) are asymmetrically end-functionalized to create hygroscopic scaffolds for water harvesting and storage from atmospheric air. One side of the NTF is made hydrophilic, which captures water from the atmosphere, and the other side is made superhydrophobic, which prevents water from escaping and the forest from collapsing. To understand how water penetrates into the NTF, the fundamentals of water/NTF surface interaction are discussed.



KEYWORDS: *carbon nanotubes, water harvesting, asymmetric functionalization, hydrophobic, hydrophilic*

INTRODUCTION

Fresh water is an ever-decreasing resource that can be found in small amounts in almost every environment. In nature, there are many organisms, such as the Stenocara beetle, which lives in the Namib Desert and survives by drinking fogwater that collects on its wing case.[1] The unique design of the Stenocara beetle's back involves randomly spaced bumps with hydrophilic peaks surrounded by hydrophobic areas that guide water into its mouth. The Stenocara beetle stands on a sand dune, facing into the morning wind at a 45° angle. With its head facing downward and its bottom upward, the minute water droplets from the fog collect on the superhydrophilic peak of each bump. When the water droplets grow big enough, they detach from the bump peaks, fall onto the superhydrophobic areas between the bump peaks, and are guided downward to the beetle's mouth.[1] Additionally, Stipagrostis Sabulicola[2] and Cotula Fallax[3] are some other organisms that are able to effectively capture water droplets from the fog of the morning desert by using hydrophilic/hydrophobic combinations. In the recent past, a few efforts have been done using these and other hydrophilic/hydrophobic biomimetic mechanisms to capture and harvest atmospheric water[4−13] that do not require significant amounts of energy. Up to now, several approaches have been reported to create hydrophilic/hydrophobic surfaces for water harvesting. In these reports, polymers have been extensively used. For example, Zhai et al. mimicked the Stenocara beetle by creating hydrophilic patterns on superhydrophobic surfaces using hydrophilic and hydrophobic polymers.[14]

Another material that can be used for water harvesting is carbon nanotubes (CNTs). Known for their small size and mechanical and physical strength, CNTs can be easily made hydrophilic or superhydrophobic by chemical functionalization.[15,16] Several kinds of CNT functionalizations, such as covalent[17] and noncovalent functionalization,[18] have been reported extensively. Another type of CNT functionalization is asymmetric end functinalization, which attaches two different functionals at their opposite ends.[19] Even though some work has been reported, it is still a big challenge to functionalize two end tips with different functional groups.[19,20] For example, Lee et al. have used UV irradiation to attach different functional groups to opposite ends of individual CNTs.[19]

In order to harvest water, the material must consist of both hydrophilic and hydrophobic surfaces. For example, Kinoshita and co-workers used micropatterning on CNT films to create superhydrophobic−hydrophilic heterogeneous surfaces using plasma-type hydrothermal atom beams.[15] Here we report a new approach for anisotrophically functionalized carbon nanotube forest (NTF) as superhydrophilic/superhydrophobic. Because of the combination of hydrophilic and hydrophobic surfaces, we were able to utilize the material for water collection from dry air and high-humidity air. By this approach, the water microparticles in air can be captured and stored in comparatively large amounts.

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Ball End Magnetorheological Finishing Using Bidisperse Magnetorheological Polishing Fluid

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A scheme to finish workpiece surface in nanometer range and obtain defect free surface using bidisperse magnetorheological polishing fluid (MRPF) by ball end magnetorheological finishing (BEMRF) tool is presented. Bidisperse MRPF consist of micron size CS and HS grade of carbonyl iron powder (CIP) with different volume fraction combinations within 20 vol.% magnetic solid contents, 25 vol.% SiC abrasives and 55 vol.% base fluid. Vibration sample magnetometer (VSM) has been used to study the magnetization of magnetic abrasives. Maximum magnetization has been found for CIP of 16 vol.% CS grade, 4 vol.% HS grade and 25 vol.% SiC abrasives. Magnetorheological behavior of bidisperse MRPF was evaluated using magnetorheometer. Performance of MRPF was evaluated by steady state rheograms in magnetic field strength. The yield strength of MRPF was found maximum at CIP of 16 vol.% CS grade, 4 vol.% HS grade, 25 vol.% abrasives and 55 vol.% base fluid. After characterization, experiments were performed with BEMRF tool on mild steel workpiece material for 30 min with given machining conditions. Percentage reduction in surface roughness (%ΔR_a) was calculated and compared with %ΔR_a obtained by finishing the workpiece with existing monodispersed MRPF and superior results as compared to existing one was found.

Keywords Abrasives; Bidisperse; Magnetorheological; MRPF; MRR; Nanofinishing; Rheology; Viscosity.

Introduction

Magnetorheological (MR) fluids are smart fluids that changed reversibly from fluid to solid like in a very short time in magnetic field and show changed magnetorheology [1–3]. The MR fluids composed ferro/ferri magnetic contents and base fluid. Magnetorheology for extremely bidisperse magnetic fluids has been studied with same magnetic solid contents and found enhanced relative viscosity with addition of nanoparticles as compared to available MR fluid [1]. The carbonyl iron powder (CIP) is produced by thermal decomposition of iron pentacarbonyl $Fe(Co)_5$ and grains in spherical shape are obtained. It has outstanding magnetization behavior which is relevant for the applications such as inductive electronic components and MR fluids. CIP of nanometer size was considered as an additive for conventional MR fluids. The flow behavior has been seen with/without nanomagnetic contents in the magnetic field. Introduction of magnetic nano-CIP contents in MR fluids improved yield behaviors with strengthened structure [2]. The microcavities were formed by association with large magnetic contents. These structural microcavities were filled with nanomagnetic contents in presence of magnetic field [3]. By inclusion of nanomagnetic contents along large magnetic contents, the aggregation of large contents restricts and causes field induced phase separation in MR fluid. Hence it became important to study the stability against sedimentation and redispersibility of MR fluid for its potential application. It was observed that 3% volume fraction nanomagnetic content is sufficient for stability of MR fluids having iron more than 30%. Performance of MR fluids was evaluated by steady state rheograms with various combinations of magnetic contents under applied magnetic field. Yield shear stress was observed to be high with improved stability and redispersibility [4].

The magnetorheological polishing fluids (MRPFs) have potential application in ultrafine finishing of workpiece surfaces. The existing conventional as well as unconventional machining processes are not capable to provide the required surface roughness on complex geometrical shapes. The processes are not controlled during machining the workpiece. Abrasive flow finishing is used to finish complex geometrical shapes by passing prepared medium through workpiece but rheolocial properties of medium are not controlled by external means [5]. Magnetic abrasive finishing is another nanolevel finishing method used for internal and external surfaces. Surface roughness has been modeled and then simulation is done for the study of non-uniform surface profiles [6, 7]. Surface roughness is a key parameter for mating the parts, dimensional tolerances, product quality, finishing the brittle materials and high-strength alloys [8]. MR finishing is smart finishing technique applied on variety of geometries with changing the MR fluid's yield shear stress in externally applied magnetic field. In this process, the surfaces are selectively finished and nanolevel surface finish is

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MECHANICAL ENGINEERING

Development of reliability index for combined cycle power plant using graph theoretic approach

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KEYWORDS

CCPP;
Systems;
Graph theory;
Digraph;
Permanent function;
Matrix

Abstract A systematic approach based on graph theory and matrix method is developed ingeniously for the evaluation of reliability index for a Combined Cycle Power Plant (CCPP). In present work CCPP system is divided into six subsystems. Consideration of all these subsystems and their interrelations are rudiment in evaluating the index. Reliability of CCPP is modeled in terms of a Reliability Attributes Digraph. Nodes in digraph represent system reliability and reliability of interrelations is represented by edges. The digraph is converted into one-to-one matrix called as Variable System Reliability Permanent Matrix (VPM-r). A procedure is defined to develop variable permanent function for reliability (VPF-r) from VPM-r. Reliability index of CCPP system is obtained from the permanent of the matrix by substituting numerical values of the attributes and their interrelations. A higher value of index implies better reliability of the system. The proposed methodology is illustrated step-by-step with the help of two examples.

1. Introduction

Reliability analysis is an innate aspect of combined cycle power plant design and plays considerable role throughout the plant operation in terms of expenses (operating and maintenance) and optimal maintenance scheduling of its equipments. Reliability may be defined as the ability of an equipment, component, product, system, etc., to function under designated operating state of affairs for a specified period of time or number of cycles [1]. For a large and complex electricity generating system such as CCPP, reliability is the probability of generating electricity under operational conditions for a definite period of time. Reliability of a CCPP is function of maintenance (scheduled or forced) cost, which in turns depends upon the Mean Time Between Failures (MTBF) and Mean Time To Repair (MTTR) of equipments or systems, and which are further dependent on complexity in design, state, age of the equipment or system and to some extent on the availability of spare parts.

Recurring failures that lead to complete power plant outage need repair and proactive maintenance to invigorate power

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Electrochemically Assembled Gold Nanostructures Platform: Electrochemistry, Kinetic Analysis, and Biomedical Application

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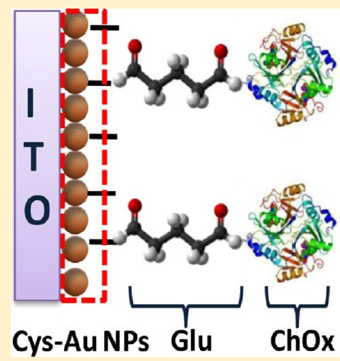
S *Supporting Information*

ABSTRACT: A novel one-step electrochemical method for controlled synthesis of electroactive gold nanoparticles (Au NPs) in an organic medium using an organometallic precursor $Au(PPh_3)Cl$ [Ph = phenyl] has been proposed. The hierarchical assembly of Au nanostructures has been tuned on indium tin oxide (ITO) surface during electrochemical reduction of $Au(PPh_3)Cl$ using cysteamine. The Au NPs act as building blocks to form secondary structures of Au that has been confirmed using transmission electron microscopic studies. The presence of triphenylphosphine in Au film enhances the electrocatalytic activity, resulting in higher charge transfer kinetics. The cholesterol oxidase (ChOx) as a model enzyme has been immobilized on various fabricated nanostructured Au films. Direct electron transfer properties of nanostructured Au films result in third-generation cholesterol biosensor. We have investigated the biosensing performance of different Au nanostructures toward cholesterol estimation at low operating potential (+0.3 V). The high sensitivity of 4.22 AM^{-1} cm^{-2} and low detection limit of 5.49 μM of this biosensor (ChOx-Glu/Cys-Au/ITO) is due to higher current resulting from monodisperse Au NPs. In addition, this bioelectrode shows charge transfer rate constant as 247.27 s^{-1} and low K_m^{app} value as 0.57 mM. The biosensor shows good reproducibility, stability, and selectivity and thus can be utilized for health care diagnostics application.



1. INTRODUCTION

The application of noble metal nanostructures such as gold (Au) in the development of biomedical diagnostic devices has remarkably increased.[1,2] The unique properties of Au nanostructures like high quantum yield of Rayleigh scattering, photostability, plasmonic properties, etc., enable them to serve as molecular probes for biosensors and *in vivo* imaging of single live cells.[3−5] The potential use of bioconjugated Au nanostructures as a novel contrast agent for cancer cells imaging and photothermal therapy has been investigated.[6] Chen et al. have reported the use of anti-EGFR functionalized gold nanocages as contrast agent for optical diagnostics of breast cancer and as potential thermal therapeutic agent for cancer treatment.[7] In addition, the Au nanostructures are utilized in photovoltaics,[8] optical sensing,[9] drug delivery and discovery,[10] electrocatalysis, and electrochemical biosensing applications.[11,12] The building blocks of gold nanoparticles (Au NPs) to construct the electrochemical biosensor are promising platform owing to their extraordinary electrocatalytic activity. The electrochemical properties of Au can be tuned by controlling the size and shape of Au nanostructures in order to improve the efficacy of biosensor.[13] The Au nanostructures provide unprecedented electron transfer between biomolecules and electrode surface resulting in higher sensitivity, excellent detection limit, and fast response.[14] The low redox potential of Au nanostructures may result in higher selectivity and reproducibility. It is known that most enzyme molecules are unable to directly exchange electrons with electrode surface due to the inaccessibility of the electroactive redox centers embedded in protein shells.[15] This limits the performance of a biosensor. However, Au nanostructures have been found to possess excellent electrocatalytic activity and may thus result in efficient direct electron transfer between enzyme and electrode surface. Haruta et al. have demonstrated the high catalytic activity of Au nanoparticles (<10 nm) for the electrochemical oxidation of carbon monoxide.[16] Wang et al. have developed an electrochemical DNA biosensor based on Au nanoflowers and investigated the hybridization of target DNA using $[Ru(NH_3)_6]^{3+}$ as an indicator.[17] Xiao et al. have reported the electrical wiring of redox sites of glucose oxidase with Au NPs and the fabrication of glucose biosensor based on direct electrochemistry.[14]

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Energetic and exergetic analyses of a hydrogen-fuelled HCCI engine for environmentally benign operation

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In this paper, combined first and second law approach is applied to investigate the effects of percent excess air and ambient temperature on the energy and exergy efficiency of the hydrogen-fuelled homogeneous charge compression ignition engine. A maximum energy efficiency of 45% and an exergy efficiency of 37% are obtained at the excess air of 25%. A narrow range of 42–40% energy efficiency and a wide range of 25–45% exergy efficiency were achieved between the 20–40% excess air and an ambient temperature of 300 K. Close range of variation for energy efficiency (48–44%) and exergy efficiency (32–36%) were achieved between the ambient temperatures of 13°C and 41°C. Exergy analysis indicates that 52% of the fuel hydrogen exergy is destroyed due to various irreversible processes of the engine, around 40% is available as a useful work output, and 7.83% is lost via engine exhaust.

Keywords: hydrogen; HCCI; energy; exergy; efficiency; irreversibility

1. Introduction

Depletion of fossil fuel reserves and increased fuel prices together with increased awareness of the environmental impacts of burning hydrocarbon fuels led to an interest in alternatives to fossil-fuel-based combustion engines. One of such alternatives is to use hydrogen as an energy carrier and to extract energy using a modified internal combustion engines on account of its renewability, clean burning characteristics, high calorific value etc. (Das 1990). Its high self-ignition temperature and flame speed make hydrogen an ideal fuel for spark ignition (SI) engines (Verhelst and Wallner 2009). It is also shown that compared to hydrocarbon fuels, hydrogen has higher exegetic efficiency of combustion indicating greater effectiveness of transformation of the chemical exergy of the fuel into useful work (Rakopolous *et al*. 2009).

Emissions of carbon monoxide and unburnt hydrocarbons are practically eliminated with a conventional hydrogen-fuelled SI engine as the only source of carbon will be the lubricating oil. For the same reason, the engine does not emit carbon dioxide. The only non-trivial exhaust gas emissions will be nitrogen oxides which result from the oxidation of atmospheric nitrogen under

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Enhanced Field Emission Properties from CNT Arrays Synthesized on Inconel Superalloy

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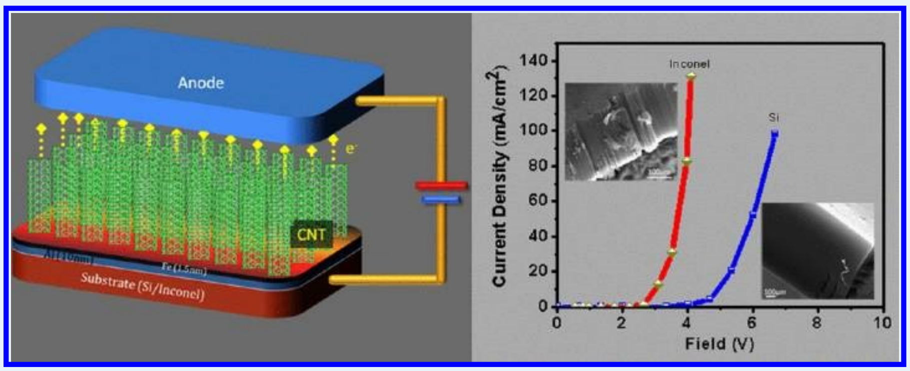

ABSTRACT: One of the most promising materials for fabricating cold cathodes for next generation high-performance flat panel devices is carbon nanotubes (CNTs). For this purpose, CNTs grown on metallic substrates are used to minimize contact resistance. In this report, we compare properties and field emission performance of CNTs grown via water assisted chemical vapor deposition using Inconel vs silicon (Si) substrates. Carbon nanotube forests grown on Inconel substrates are superior to the ones grown on silicon; low turn-on fields (~1.5 V/μm), high current operation (~100 mA/cm^2) and very high local field amplification factors (up to ~7300) were demonstrated, and these parameters are most beneficial for use in vacuum microelectronic applications.

KEYWORDS: *carbon nanotube, water assisted CVD, adhesion, field emission, ohmic contact*

■ INTRODUCTION

Since the reports made by Heer et al.[1] and Rinzer et al.,[2] on the field emission from films and individual multiwalled carbon nanotubes (MWCNTs), respectively, various experimental studies on the field emission of MWCNTs grown using various techniques on different substrates have been pursued.[3−15] Reliability and reproducibility are the biggest aspects needing improvement when using CNTs in field emission devices; electrical breakdown and current degradation are the two major limiting factors of the reliability of CNT based field emitters. The electrical breakdown is a sudden discharge caused by an avalanche of charged particles above a certain threshold field. The process is associated by the evaporation of electrode materials and/or surface adsorbed impurities as a consequence of electron bombardment of the anode, resistive heating of the sharp cathode or simple desorption of surface impurities so that a low pressure vapor forms in the proximity of the electrodes.[16] Above the threshold field, the vapor undergoes ionization and sparking, similar to that in ordinary low pressure gases, takes place.[17] On the other hand, the emission current degradation is a slow process that occurs below the threshold field. Heating by the emission current and subsequent evaporation of the electrode materials results in a gradual loss, structural collapse and deterioration of the cathode. Apart from thermal and electrical stability of the electrode materials, high quality robust electrical contacts that are interfacing the emitter back side are also vital for multiple reasons. First, the contact must be uniform along the entire interface to allow optimal, uniform

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Fuzzy logic based modeling and estimation of global solar energy using meteorological parameters

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A B S T R A C T

Global solar energy data is considered as the most important parameter in smart grid applications, particularly for sizing the photovoltaic system and demand driven supply. However the data of global solar energy is rarely available on hourly basis, even for those stations where measurement has already been done. Due to lack of such measured data, the estimation of global solar energy at the earth's surface is an important study in the present scenario to meet the energy requirement from green energy sources.

This paper is based on fuzzy logic approach for modeling and estimating the global solar energy using mean duration sunshine per hour, temperature, latitude, longitude, altitude and months of the year as input parameters. Fortunately, these important for accurate parameters estimation of solar energy are commonly available. Results obtained from fuzzy logic approach are used for the prediction of SPV system output for smart grid application.

1. Introduction

The rapid depletion of fossil fuel reserves and large greenhouse emissions are becoming the major challenge for the today's power sector. Due to increasing population and urbanization, the demand of electricity is increasing exponentially. Under such circumstances it is highly desirable to adopt the environment friendly energy sources for power generation. In order to achieve the target, renewable energy sources particularly solar and wind sources can play the important role. In addition, solar energy is one of the most promising and more predictable than other renewable energy sources. Therefore, high penetration of solar technologies into electric power system can meet the desired goals. It is well known fact that, India is located on the equatorial sun belt of the earth has great potential of solar energy with an average of about 300 solar days per year. Further, the government is also providing the incentives and other benefits for installing the power plants based on solar energy. Hence, to exploit the environment friendly source of energy, analysis and estimation of solar energy at different stations of the country is utmost important [1–3]. Keeping in view of the aforesaid, a thorough literature review is carried out and it is found that number of mathematical models for the estimation of global solar energy under cloudless skies is available in the literature [4–5]. Regression models and stochastic models for estimating the solar energy are also presented by researchers [6–11]. The results obtained using these models were satisfactory, but applicable only for clear sky weather condition. In India around 300 days in a year are clear sky and remaining days are cloudy, so it is very difficult to estimate the accurately using mathematical/regression/stochastic models. Therefore, due to uncertainty in weather conditions, fuzzy logic based models are proposed by researchers to estimate the solar energy at a given location using different meteorological parameters [12–18]. The uncertainty in atmosphere may occur due to the existence of the following: dust, moisture, aerosols, clouds, or temperature differences in the lower atmosphere. Among these factors, clouds can cause the maximum losses in the extraterrestrial solar energy reaching at earth's surface. The atmosphere causes a reduction of the extraterrestrial solar input by about 30% on a very clear day to nearly 100% on a very cloudy day [13]. Further, the use of solar energy estimation in smart grid application is rarely available in the literature. Keeping in view of aforesaid fuzzy logic based model for the estimation of global solar energy has been developed considering latitude, longitude, altitude of the location, months of the year, mean duration sunshine per hour (it is the ratio

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Guided-Mode Analysis of Tamm-Plasmon Polariton at Metal–Heterostructure Dielectric Interface

Ritwick Das, Awanish Pandey, Triranjita Srivastava, and Rajan Jha

***Abstract*—We present a comprehensive analysis for transverse electric (TE) and transverse magnetic (TM) polarized guided Tamm-plasmon polariton (TPP) mode at metal–heterostructure media interface. We explicitly show that the quarter-wavelength stack condition will not be satisfied for TE or TM polarized TPP mode due to the existence of null-point at metal–heterostructure media boundary. Therefore, we propose an alternate route to design TPP waveguide by solving the mode-dispersion relation for different geometrical parameters in a TiO_2/SiO_2 bilayer system. The guided TPP-modes (TE and TM) exhibit interesting dispersion characteristics which can be tailored as per the desired application. The group index of TM polarized TPP mode remains constant over a significant wavelength range which results into zero group-velocity dispersion (GVD) at $\lambda \approx 630$ nm wavelength. Also, the propagation length for TM-polarized TPP modes vary between $25\,\mu$m to $50\,\mu$m in a 630–650 nm wavelength range. However, the variation of GVD for TE-modes exhibit a monotonic variation with an exceptionally large GVD $\approx -3 \times 10^4$ ps/km · nm around $\lambda = 632.8$ nm.**

***Index Terms*—Bragg reflection, dispersion, optical waveguides, plasmons.**

I. Introduction

The possibility of guiding electromagnetic (em) waves at the interface of a metal–dielectric has given rise to the field of plasmonics which has received considerable experimental and theoretical investigation in recent years due to their application in fabrication of devices used in integrated optics [1]. In the case of a metal–dielectric interface at optical frequencies, these waves are commonly termed as surface plasmon-polariton (SPP) modes and propagate as transverse-magnetic (TM) polarized em fields coupled to the surface plasma (electron gas) oscillations [2], [3]. The possibility of strong field-confinement close to the interface makes such modes an attractive candidate for microscopy and biochemical sensing [4]. An additional consequence of this coupling to the electron gas is that the modal phase-velocity of non-radiating SPP mode reduces with respect to the plane-wave propagating in the dielectric (ϵ_d) or in the metal (ϵ_m). Therefore, we need to deploy high refractive-index prisms for achieving the matching of phase-velocities between SPP mode and the incident-wave so as to excite SPP modes [5]. The existence of bulky prisms unavoidably renders the experimental configuration unsuitable for monolithic-integration and miniaturization of photonic circuits. In order to carry out an efficient excitation of SPP modes, a few alternate schemes have been proposed which essentially utilize coupling of dielectric waveguide modes to SPP modes [6]. Though, miniaturization is achieved by this approach, the phase-matching between conventional dielectric waveguide mode and SPP mode still remains a challenge, owing to high refractive index of typical waveguide core (~ 1.45) at optical frequencies. Another interesting route is to employ the bandgap guided modes in photonic crystal based waveguides [7], [8]. Due to the inherent nature of bandgap guidance mechanism, the effective mode indices of guided modes is appreciably smaller than the core indices and could be substantially tuned using suitable photonic crystal geometries, thus facilitating flexibility in the realization of phase-matching.

A crucial requirement in conventional integrated optics is the possibility to tailor the dispersion characteristics of waveguiding geometries depending on the application. Although, the SPP modes exhibit strong dispersion in the optical frequency range owing to significant presence of mode-field in highly dispersive metal, the dispersion characteristics cannot be tailored significantly once the metal and the dielectric is chosen. A few hybrid geometries supporting long-range and short-range SPP modes have been proposed where the dispersion could be tailored in a limited range by judiciously altering the coupling between interacting SPP modes at different surfaces [2], [9].

In order to simultaneously address the concern related to excitation as well as dispersion tailoring of SPP modes, the Tamm-plasmon polariton (TPP) modes provide a promising alternate route [10]–[15]. The existence of TPP modes have been proposed by M. Kaliteevski *et al.* [10] and very recent studies have shown their importance in slow-light devices, magneto-optic effects and nonlinear optical effects [12], [16]–[18]. The TPP modes are formed at the interface of a metal and a periodically stratified medium having alternate layers of high and low index material or distributed Bragg-reflectors (DBR) [19]–[21]. The transverse mode-field profile of TPP-modes is characterized by a decaying field in the metal and an oscillatory field in the periodically-stratified region with a decaying envelope. In other words, the normal component of the wavevector of propagating wave in the periodic region (Bloch wavevector) falls within the photonic stop-band of DBR structure which results into guidance of em wave along the interface. As such, the guided TPP-modes will have effective indices lower than

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ORIGINAL PAPER

High seasonal variation of atmospheric C and particle concentrations in Delhi, India

Papiya Mandal · T. Saud · R. Sarkar · A. Mandal · S. K. Sharma · T. K. Mandal · J. K. Bassin

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Abstract The highly populated Indian regions are currently in a phase of rapid economic growth resulting in high emissions of carbonaceous aerosols. This leads to poor air quality and impact on climate. The chemical composition of carbonaceous aerosols has rarely been studied in industrial areas of India. Here, we investigated carbonaceous aerosols in particulate matter (PM) monthly in the industrial area of Delhi in 2011. The concentrations of organic C and elemental C in PM_{10} fraction were analyzed. Results show a clear seasonal variability of organic and elemental C. PM_{10} ranged 95.9–453.5 μg m^{-3}, organic C ranged 28.8–159.4 μg m^{-3}, and elemental C ranged 7.5–44.0 μg m^{-3}; those values were higher than reported values. Organic and elemental C were correlated with each other in pre-monsoon and winter seasons, implying the existence of similar emission sources such as coal combustion, biomass burning and vehicular exhaust. The annual average contribution of total carbonaceous aerosols in PM_{10} was estimated as 62 %.

Keywords Particulate matter · Organic carbon · Elemental carbon · Total carbonaceous aerosols · Seasons · Monthly variation

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Introduction

Atmospheric particulate matter, a very complex matrix, originating from natural and anthropogenic sources having different physical and chemical characteristics (Perrino et al. 2011) is increasing rapidly due to energy-intensive activities associated with urbanization and industrialization. Carbonaceous aerosols are the major dominant contributors to aerosol components (Yu et al. 2003, 2005). In recent years, scientific research has focused on carbonaceous particles due to their impact on climate and human health (Ramana et al. 2010). Carbonaceous aerosol may be classified into two categories, i.e., organic carbon and elemental carbon, which are the important constituents of PM_{10}, especially in highly industrialized and urbanized areas (Nunes and Pio 1993). The organic carbon represents a large variety of organic compounds and classified as aliphatic, aromatic compounds, acids, etc. Elemental carbon emits directly from primary sources, whereas organic carbon is emitted by either direct sources or volatile organic compounds condensed in the atmosphere to form secondary organic carbon. The rapid industrialization and urbanization in Asian country require more energy consumption that leads to enhanced emission levels of carbonaceous aerosols (Cooke et al. 1999). The environmental impacts are severe in megacities with a population of 10 million or more (Gurjar and Lelieveld 2005) in China and India due to industrial expansion and strip rise of vehicular registration. Delhi, the capital of India, is located in North India (28°12′–28°63′N, 75°50′–77°23′E) at an altitude between 213 and 305 m above sea level. The climate of the city is varied from arid to semi-arid. Wind speeds are normally high during pre-monsoon and monsoon seasons. Wind direction is predominant in west and northwest directions. The monitoring was carried out at CSIR R&D Centre, Naraina

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In-flight gas phase growth of metal/multi layer graphene core shell nanoparticles with controllable sizes

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In this report, we present a general method for a continuous gas-phase synthesis of size-selected metal/multi layer graphene (MLG) core shell nanoparticles having a narrow size distribution of metal core and MLG shell for direct deposition onto any desired substrate kept under clean vacuum conditions. Evolution of MLG signature is clearly observed as the metal-carbon agglomerates get transformed to well defined metal/MLG core shell nanoparticles during their flight through the sintering zone. The growth takes place via an intermediate state of alloy nanoparticle (Pd-carbon) or composite nanoparticle (Cu-carbon), depending upon the carbon solubility in the metal and relative surface energy values. It has been also shown that metal/MLG nanoparticles can be converted to graphene shells. This study will have a large impact on how graphene or graphene based composite nanostructures can be grown and deposited in applications requiring controllable dimensions, varied substrate choice, large area and large scale depositions.

The observation of unique combination of properties, such as, mechanical strength, good thermal and electronic conductivity, zero band gap and ballistic electron transport in the 'ideal two dimensional' graphene structure have resulted in an unprecedented research interest[1–6]. In the last few years, graphene-metal nanoparticle composites have got attention due to possibility of tailoring the above mentioned properties resulting in improved, new and novel applications[7–18]. State of the art chemical vapor deposition allows the growth of graphene sheets on metal foils[19]. The restrictions of graphene growth only on few selected metal substrates and the requirement of transfer are the main nagging issues for using the graphene-metal nanostructures prepared by the above method in applications requiring large scale and large area deposition such as catalysis, Li ion batteries and solar cells[7–9,14,20]. The multistep chemical processes, used for growing graphene-metal composites involve simultaneous or separate reduction of graphene oxide with metal precursors yielding undefined configurations, high dispersibility and wide distribution of nanoparticle sizes and graphene thickness[21]. Chemical contamination incorporated into metal nanoparticles and graphene layers during reduction process is known to affect optical, electronic and catalytic properties[22–24]. The average nanoparticle size and distribution of Au nanoparticles grown by physical vapor deposition methods is linked to the number of graphene layers[25,26]. In physical methods of metal nanoparticles deposition, both particle density and particle size depend upon deposition time, and thus, nanoparticle size cannot be controlled independently. Further, in earlier reports on metal- carbon core shell nanoparticles prepared by arc discharge, metal carbide (in place of metal) core was found to be encapsulated in polyhedron carbon shells[27]. In another report, the graphite layer surrounding the metal nanoparticle was found to appear throughout the sample[28]. Broad size distribution and phase inhomogeneity are the other issues in these metal/graphite core shell nanoparticle prepared by arc discharge method[27,28]. Metal/graphite nanoparticles prepared by chemical methods have been reported to have low crystallinity, chemical contamination, and broad size distribution[29,30]. Therefore, these methods are not suitable for applications requiring controllable size, narrow size distribution and well defined graphene-metal interface such as biomedical and opto-electronic applications. In this report, a gas phase synthesis methodology for growing size selected metal/multilayer graphene (M/MLG) core shell nanoparticles with controllable size, narrow size distribution, well defined metal core and graphene shell is described.

Results

M/MLG core shell nanoparticles were fabricated using an integrated gas phase synthesis setup of which schematic diagram is shown in Fig. 1. The structural properties of the nanoparticles sintered at different temperatures during

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Kinetic study on enzymatic esterification of tuna fish oil fatty acids with butanol

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ABSTRACT

Docosahexaenoic acid (DHA) is an important polyunsatured fatty acid (PUFA) which can be purified from tuna fish oil fatty acids by selective enzymatic esterification. The present paper investigates the kinetic study for selective esterification of tuna fish oil fatty acids with butanol catalyzed by *Rhizopus oryzae* lipase (ROL) in biphasic solvent system. Under the most suitable reaction conditions, 76.2% esterification was achieved in 24 h. Different kinetic models for esterification given by Segel [1], Oliveira et al. [2], Gogoi et al. [3], and Kraai et al. [4] were tested for fitting the esterification data and the model given by Oliveira et al. [2] was found to be most suitable. The model given by Prazeres et al. [5] for hydrolysis was also tested for esterification and the model with second order product inhibition was found to provide better match between the predicted and experimental values than that of model by Oliveira et al. [2]. The kinetic model was fitted using MATLAB® to determine the best kinetic parameters. The average value of kinetic constants using the model given by Prazeres et al. were estimated as $K_m = 23.6$ μmoles FFA/ml, $K_{i1} = 4.6 \times 10^{-5}$ μmoles FFA/mg enzyme h, $K_{i2} = 0.0062$ μmoles FFA/mg enzyme h and $K_2 = 149.5$ μmoles FFA/mg enzyme h.

1. Introduction

DHA is one of the most useful PUFA with pharmaceutical potential and important for the prevention and control of various human diseases and disorders such as cardiovascular disease, inflammation, allergy, cancer, immune response, diabetes, hypertension and renal disorders. DHA comprises of 40% of the PUFAs in the brain and 60% of the PUFAs in the retina, and is highly concentrated in the membranes of brain cells and retinal cells of eye [6–8].

Tuna fish oil is one of the richest source of DHA with 25–30 (wt%) approximately. Fatty acids from fish oil can be separated by enzymatic hydrolysis and then DHA rich mixture of fatty acids can be obtained by selective esterification. These reactions are catalyzed by enzymes commonly known as lipases. Lipases show high selectivity for esterified product with improved purity and quality [9]. The use of enzymes in biphasic systems instead of aqueous media offers several important advantages such as reduction in enzyme substrate and/or product inhibition, the solubilization of hydrophobic compounds, and the possibility of shifting thermodynamic equilibrium towards the desired product [2].

Several mechanisms have been proposed for lipase catalyzed esterification reactions. Most of these mechanisms have been developed for soluble lipases acting on insoluble substrates (e.g. fatty acid dispersed in water). In general, based on initial reaction velocity studies many researchers have shown that lipase catalyzed esterification reactions follow Michaelis–Menten kinetics. Various mechanisms related to different types of kinetic models and consequent modifications of Michaelis–Menten equation during esterification have been proposed by researchers to incorporate factors affecting the reaction rate. Segel [1] proposed a model incorporating substrate inhibition by alcohol. Janssen et al. [10] indicated that the Ping-Pong model (including alcohol inhibition) is not suitable to describe the kinetics of a lipase-catalyzed esterification reaction. The first product, water, which inhibits the reaction, is always present at the start of the reaction that leads to an equation with one extra parameter. Chowdary et al. [11] observed twin inhibition for esterification between ethanol and isovaleric acid using immobilized lipase from *Rhizomucor miehei* in hexane and in mixed solvent system. They observed bi-substrate inhibition pattern with a Ping Pong bi–bi mechanism and inhibition of enzyme by both substrates. Al-Zuhair et al. [12] determined the kinetics of the esterification of butyric acid with methanol catalyzed by a free *R. miehei* lipase in a micro aqueous system containing enzyme in hexane suspension and a biphasic system (*n*-hexane and water). Ping-Pong model with competitive alcohol inhibition has been

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Lipase catalyzed esterification of Docosahexaenoic acid rich fatty acids with glycerol

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Abstract

Docosahexaenoic acid (DHA) is an important polyunsaturated fatty acid (PUFA) having pharmaceutical potential. It has gained much scientific attention due to its beneficial use in prevention of many diseases such as dyslexia, alzheimer, schizophrenia and dysprexia etc. The present paper deals with the esterification of DHA rich fatty acids with glycerol. The reaction has been carried out in biphasic solvent system using immobilized *Candida antarctica* lipase B (CAL-B) to synthesize glyceride mixture enriched with DHA. The most suitable reaction conditions for esterification of DHA rich fatty acids with glycerol using immobilized CAL-B were found to be 0.49 g fatty acid mixture with 46 mg glycerol, 3mL solvent, 26µL buffer, 200 mg molecular sieves, 7.0 pH, 50 ºC temperature, 300 rpm agitation speed and 50 mg enzyme amount. In 120 h, esterification of 75.4% was obtained with 30% triglyceride (TG), 16.1% diglyceride (DG) and 29.3% monoglyceride (MG) in the glyceride mixture. DHA could be concentrated in glyceride mixture upto 87%.

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Microstructure and mechanical properties of thermoelectric nanostructured n-type silicon-germanium alloys synthesized employing spark plasma sintering

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Owing to their high thermoelectric (TE) figure-of-merit, nanostructured $Si_{80}Ge_{20}$ alloys are evolving as a potential replacement for their bulk counterparts in designing efficient radio-isotope TE generators. However, as the mechanical properties of these alloys are equally important in order to avoid in-service catastrophic failure of their TE modules, we report the strength, hardness, fracture toughness, and thermal shock resistance of nanostructured n-type $Si_{80}Ge_{20}$ alloys synthesized employing spark plasma sintering of mechanically alloyed nanopowders of its constituent elements. These mechanical properties show a significant enhancement, which has been correlated with the microstructural features at nano-scale, delineated by transmission electron microscopy. © *2014 AIP Publishing LLC*. [http://dx.doi.org/10.1063/1.4892879]

Among the several available thermoelectric (TE) materials, SiGe alloys have been identified as one of the most important material for TE power generation, due to their high TE figure-of-merit (ZT), coupled with excellent thermal stability at high temperatures $\sim$1000 °C.[1–3] For about the past four decades, SiGe based thermoelectrics have been used as TE devices for power generation in Radio-isotope TE Generators (RTG) for deep space missions.[4] In the recent past "nanostructuring" has resulted in significantly increasing the ZT of both n-type[5] and p-type[6] $Si_{80}Ge_{20}$ and thus nanostructured $Si_{80}Ge_{20}$ are evolving as a potential replacement for their conventional bulk counterparts in designing efficient RTGs.

A vast majority of the research done[1,5–8] on SiGe TE materials has been focused on their thermal and electrical transport properties primarily aimed towards enhancing their ZT. However, their mechanical properties are equally important for the long term reliability of their TE modules, as these materials are known to be brittle with low fracture toughness. In RTGs, the individual TE elements are subjected to significant stresses under in-service conditions, due to thermal cycling as well as thermal expansion mismatch and externally applied mechanical stresses. Thus, in order to ensure the structural reliability of SiGe TE modules, it becomes important that the material must withstand numerous mechanical vibrations and thermal stresses while in-service. Thus, apart from ZT, the mechanical properties of SiGe are equally vital in order to avoid catastrophic failure of their TE modules.

In the recent past, a high ZT in both n- and p-type nanostructured $Si_{80}Ge_{20}$ alloys has been reported by several researchers,[5,6,8,9] which is far higher than their bulk counterpart,[4] currently used for RTG applications. Owing to their enhanced TE performance, these nanostructured SiGe alloys are being seriously explored for their application in RTGs, replacing the conventional SiGe bulk alloys. However, in the literature there is no comprehensive reported data on a complete set of mechanical properties of these nanostructured alloys, although there have been some sporadic reports[3,10,11] about their hardness and fracture toughness.

With this premise, we report the detailed mechanical properties of nanostructured n-type $Si_{80}Ge_{20}$ alloys, synthesized employing the Spark Plasma Sintering (SPS) of mechanically alloyed $Si_{80}Ge_{20}$ nanopowders. The results suggest that these alloys exhibited superior mechanical properties compared to state-of-the-art TE materials in terms of toughness, and more importantly, thermal shock resistance. This increase in the fracture toughness has been explained on the basis of grain boundary sliding mechanism aided by the presence of soft amorphous phase at the grain boundaries,[12,13] which has been corroborated by High Resolution Transmission Electron Microscopy (HRTEM) results. Although the hardness and elastic modulus of the SiGe nanostructured alloy, synthesized in the present study, are comparable to those reported earlier,[10] but the fracture toughness was found to be significantly higher. Further, the thermal shock resistance of the nanostructured SiGe alloys, which has not been reported earlier, exhibited a very high value compared to other TE material.

Experimental procedure for synthesis and technique used for microstructural characterization of nanostructured n-type $Si_{80}Ge_{20}$ alloys has already been described in our earlier paper.[8] It may be noted that p-type nanostructured SiGe alloys can also be synthesized by similar method[8] employing SPS of mechanically milled elemental powders of Si and Ge doped with 1.2 at. % of Boron. The Fracture toughness measurements were carried out employing the indentation-crack technique using Vickers micro-hardness tester (FM-e7) with a load of 4.9 N for 10 s of indentation time. Elastic modulus and hardness were determined using nano-indentation

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Novel hybrid fuzzy-Bees algorithm for optimal feeder multi-objective reconfiguration by considering multiple-distributed generation

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ABSTRACT

This paper presents a hybrid optimal multi-objective reconfiguration method to determine an optimal size and location of multiple-distributed generation (DG) in a distribution feeder. The purposes of this research are to mitigate losses, improve voltage profile and equalize the feeder load balancing in power distribution systems. To reduce the search space, the Improved Analytical (IA) method is employed to select the optimum candidate locations for multiple-DG, while the Bees algorithm (BA) approach as a population based algorithm is used to simultaneously reconfigure and identify the optimal capacity for installation of DG units in the distribution network. In order for the algorithm to facilitate ability for multi-objective search the optimization problem is formulated to minimize fuzzy performance indices. The proposed method is validated using the IEEE 33 bus test system at nominal load. The obtained results revealed that this proposed hybrid method has superior accuracy and efficient convergence property over the other intelligent search algorithms. It is also can be concluded that the multi-objective simultaneous placement of DGs along with multi-objective reconfiguration can be more beneficial than separate single-objective optimization.

1. Introduction

Distribution system is an interface between end-users and transmission network. In distribution system, radial configuration is generally used due to the various advantages like lower short circuit current, better protection coordination, etc. On the other hand, the radial structure reduces the reliability of end user because of large power losses and voltage drops at the load points. Electrical power distribution systems have two types of switches, i.e. tie and sectionalizing [1]. These switches are used to determine the configuration of distribution network. By changing the switches statue and transition of sections between feeders during operation, the construction of network distribution will change. This change is known as reconfiguration and it is performed time to time. The main objectives of reconfiguration of any distribution systems are loss reduction, increase stability, improving voltage profile, increase reliability of network, and relieve overload in the network. However, due to dynamic nature of loads, total system load is more than its capacity, which makes feeders unable to relieve loads hence voltage profile of the system will not increase to the required level. In order to meet the required level of demand, DG units are integrated in distribution network to improve voltage profile, to provide reliable and uninterrupted power supply and also achieve economic benefits such as minimum power loss, energy efficiency and load leveling. Network reconfiguration is a complex combinatorial and non-differentiable constrained optimization problem. To solve it, an algorithm is required vitally.

Reconfiguration of distribution network for loss reduction was first proposed by Merlin and Back [2] in 1975. They have used a branch and bound optimization method to determine the configuration that has the minimum total loss. In this method, all the switches are first closed to establish a meshed configuration and then opened successively to achieve the radial configuration. In addition, many algorithms have been developed for reconfiguration of distribution system. Goswami and Basu [3] present a heuristic algorithm for reconfiguration in which, power flow program is

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One-Step Continuous Coating of Silver Nanoparticles on Well Aligned Fibers of PAI/PTACM

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Abstract: Highly aligned ultrafine fibers of Poly (amide-co-imide) PAI (torlon)/Poly (trimellitic anhydride chloride-co-4, 4'-methylene dianiline) (PTACM) blends have been prepared by using mechano-electrospinning. Employing a mixed solvent system of DMSO and THF alongwith water coagulation bath as a medium, continuous fibers with improved mechanical properties have been obtained. The continuity of the fibers is strongly dependent on the solvent mixing ratio of DMSO and THF (6:4). Continuous fibers with the most uniform diameter are obtained when a 30 % of PAI and PTACM (1:1) resins by weight is used in the blending solution. The aligned fibers are further coated with silver nanoparticles using a one-step process by passing the electrospunned fibers through PEG solution and a silver precursor solution followed by reduction in a continuous process. The advantage of our method lies in a uniform silver coating on a single fiber that can be coated continuously on a larger length scale (~Km). The mechanical properties of these fibers are dramatically improved after their alignment. Better electrical conductivity is obtained for these fibers after they are coated with silver nanoparticles. The highly aligned silver decorated fibers utilizes a novel electroless continuous process using Polyethylene glycol (PEG), which shows good binding properties and can be used for various bio and electronic applications.

Keywords: Poly (amide-imide), Poly (trimellitic anhydride chloride-co-4, 4'-methylene dianiline), Mechano-electrospinning, Electroless silver plating, Polyethylene glycol, Silver nanoparticles

Introduction

Electrospun fibers, owing to their diverse physical, chemical and biological behavior, find use in different applications e.g., in filtration, antibacterial coatings, drug release formulations, tissue engineering, living membranes, sensors [1]. Electrospinning is an enabling technique which can produce nanoscale fibers from more than 100 different polymers [2]. Due to initial instability of the jet, the electrospun fibers are often collected as non-woven mats in the form of randomly oriented structures, which are acceptable only for some applications such as filters, wound dressings and tissue scaffolds. However, obtaining continuous aligned ultrafine fibers and high-volume production is very important for many areas such as fiber reinforcement and device manufacturing. Several techniques have been developed to align electrospun fibers and some breakthroughs have been obtained [3,4]. The results are promising, but these methods need to be further improved for practical applications. In the technique of using a rotating drum as the collector [4] only partial fiber alignments have been achieved. Few recently developed techniques can produce well-aligned fibers, but only of limited length, [5,6] area [7,8] and thickness [9,10]. Uniaxially aligned arrays of fibers have been obtained under certain conditions such as use of an airgap collector or a mandrel rotating at a high speeds but limited length is the limitation of these processes [11,12].

PAI thermoplastics emerge as the preferred material for the fabrication of fibers and large, load bearing composites due to their high strength, superior stiffness, excellent thermal resistance and high performance [13,14]. PAI has been extensively used in filtration media, wire enamels and for reinforcement by virtue of its superior chemical resistance and physical properties at higher temperature [15,16]. On the other hand, chemical or physical surface modification of electrospun fibers is needed in order to get functional materials for various applications like heterogeneous catalysis, device functionality and enhanced biological compatibility [17]. In particular, metallization of silver on PI and PAI substrates is very important process for industrial applications as the ultrafine PAI fibers possess high strength and high specific area while silver nanoparticles are used as antibacterial agents and are promising material in catalysis and sensors [17,20].

Generally, silver nanoparticles were deposited by chemical, electrochemical, physical adsorption and vapor deposition techniques [21]. The adhesion of silver nanoparticles on the polyimide surface of the fibers plays an important role in getting the homogenous silver coating. However, the direct adhesion of metals to the polyimide is usually poor due to the inertness of polyimide surfaces. Failure to activate a polyimide surface will normally cause the subsequent coatings to adhere poorly, crack easily, blister and consecutive metal coatings will eventually deteriorate [22-24].

However, employing other surface treatment techniques, such as ion beams, photografting, plasma, or sputtering, can

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Optical studies of Sm^{3+} ions doped Zinc Alumino Bismuth Borate glasses

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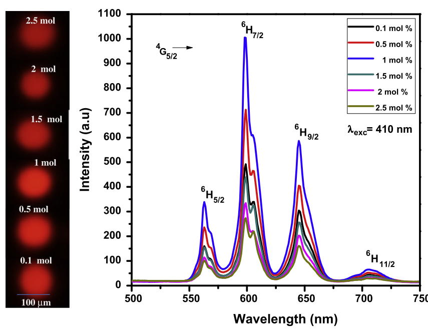
HIGHLIGHTS

- ZnAlBiB glasses were prepared by conventional melt quenching technique.
- Emission data coupled with JO analysis were used to measure radiative properties.
- Quantum efficiency of ZnAlBiB glasses were measured from decay curves.

GRAPHICAL ABSTRACT



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ABSTRACT

Zinc Alumino Bismuth Borate (ZnAlBiB) glasses doped with different concentrations of samarium (Sm^{3+}) ions were prepared by using melt quenching technique and characterized for their lasing potentialities in visible region by using the techniques such as optical absorption, emission and emission decay measurements. Radiative properties for various fluorescent levels of Sm^{3+} ions were estimated from absorption spectral information using Judd–Ofelt (JO) analysis. The emission spectra and con-focal photoluminescence images obtained by 410 nm laser excitation demonstrates very distinct and intense orange–red emission for all the doped glasses. The suitable concentration of Sm^{3+} ions in these glasses to act as an efficient lasing material has been discussed by measuring the emission cross-section and branching ratios for the emission transitions. The quantum efficiencies were also been estimated from emission decay measurements recorded for the $^4G_{5/2}$ level of Sm^{3+} ions. From the measured emission cross-sections, branching ratios, strong photoluminescence features and CIE chromaticity coordinates, it was found that 1 mol% of Sm^{3+} ions doped ZnAlBiB glasses are most suitable for the development of visible orange–red lasers.

Introduction

In recent years, there has been an increasing interest to the lanthanide ions doped in different hosts to achieve favorable optical devices such as lasers, fiber amplifiers, light converters, sensors

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Review Article

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Phytochemical importance of medicinal plants as potential sources of anticancer agents

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Abstract: The diverse and magnificent plant kingdom of the world is widely known for its medicinal importance. The potential medicinal properties of plant species have contributed significantly in the development of various herbal therapies for a number of diseases across the globe. The benefits of herbal medicine over allopathic medicine have helped medicinal plants to regain their importance in the field of health and medicine. Cancer is one of the major health problems that have widely affected the world's population. There is a great need to combat this disease with better and more effective medication as compared to existing therapies. A vast number of medicinal plants are known to have biochemical constituents with anticancer properties. The chemical metabolites of natural origin that possess anticancer properties can serve as potential lead compounds in drug designing. This association of medicinal plants and cancer needs further research and experimentation in order to develop and design anticancer drugs. The present review is an effort to compile information on some of the geographically diverse and important medicinal plants that possess anticancer activity.

Key words: Biochemical constituent, anticancer properties, medicinal plants, drug designing, antiinflammatory, antiviral, antitumor, antimalarial, analgesic

1. Introduction

Medicinal plants are considered a repository of numerous types of bioactive compounds possessing varied therapeutic properties. The therapeutic potential of plants has been well explored over a very long time period. The vast array of therapeutic effects associated with medicinal plants includes antiinflammatory, antiviral, antitumor, antimalarial, and analgesic. Cancer is one of the major obstacles to human health around the world. Among all epidemic diseases, cancer holds the first place as a death-causing disease. The main reason behind the growing number of cancer cases is the changing lifestyle of the population across the globe. Keeping in view the statistical data, the most prevalent cancer among females is breast cancer, accounting for about 23% of total cancer cases; in males, the most prevalent is lung cancer, which accounts for 17% of total cancer cases (Jemal et al., 2011). Poor survival rate of cancer patients in developing countries is attributed to the lack of timely diagnosis and limited treatment facilities. There is a great need to address this epidemic disease with more effective therapeutic and preventive strategies, which could be possible with the use of natural compounds.

Recently the scientific world has experienced an upsurge of interest in the therapeutic potential of medicinal plants as a source of promising anticancer agents. However, the application of plant-based compounds for the treatment of cancer can be traced back to 1950s. Some of the very first anticancer agents derived from plants are vinca alkaloids, vinblastine, vincristine, and cytotoxic podophyllotoxins. Statistical data suggest that 16 plant-derived anticancer drugs have been subjected to clinical trials thus far (Belayachi et al., 2013). Landmarks of these clinical trials are flavopiridol, isolated from the Indian tree *Dysoxylum binectariferum*, and meisoindigo, isolated from the Chinese plant *Indigofera tinctoria*, which have been documented to have less toxicity than conventional chemotherapeutic anticancer drugs (Saklani and Kutty, 2008). These discoveries have propelled the scientific interest of various research groups in the discovery of new anticancer agents from all-natural product sources, inclusive of plant secondary metabolites. The emerging importance of natural anticancer agents demands more research and experimentation in order to develop successful natural therapeutic options for this disease. This review focuses on the phytochemical aspect of some of the potential anticancer medicinal plants with data gathered from the scientific literature of the PubMed database. Thus, the present review aims to assemble information on some of the medicinal plants that possess anticancer properties and thus great potential for cancer treatment.

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Poly(ethyleneterephthalate) Glycolysates as Effective Toughening Agents for Epoxy Resin

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ABSTRACT: The potential of poly(ethyleneterephthalate) glycolysates toward improving the energy absorption characteristics of cycloaliphatic epoxy resins has been explored. Microwave-assisted glycolytic depolymerization of PET was performed in the presence of polyether diols of different molecular weights. The obtained glycolysates were blended with epoxy, and their mechanical properties were studied under both quasi-static and dynamic conditions. Significant improvements were observed, which were found to depend both on the amount as well as nature of glycolysate. Amine functionalities were introduced at the terminal positions of glycolysates to improve the compatibility between the two phases. The amine derivatives exhibited superior performance and the Mode I fracture toughness (K_{IC}) of epoxy increased by $\sim$18% in optimized compositions, which is indicative of its improved notch sensitivity. Neat epoxy specimens fractured in a brittle fashion, but all the blends exhibited ductile failure, as evidenced by surface morphological investigations. The mechanical properties of epoxy blends prepared with analogous aliphatic polyols, both before and after amine functionalization, were also studied which clearly reveal the beneficial role of aromatic groups toward improving the toughness of the base cycloaliphatic epoxy resin without compromising on the material stiffness. © 2013 Wiley Periodicals, Inc. J. Appl. Polym. Sci. **2014**, *131*, 39941.

KEYWORDS: thermosets; blends; functionalization of polymers

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INTRODUCTION

Poly(ethyleneterephthalate) (PET) is one of the most important commodity thermoplastic, which has been extensively used in the last few decades for packaging beverages; particularly, mineral water and carbonated soft drinks. In addition, PET finds extensive usage in the textile industry, which consumes more than 60% of worldwide PET production.[1] The primary reasons behind its widespread use include its excellent barrier properties against oxygen and carbon dioxide,[2] mechanical properties, chemical and biological inertness, low cost, and high energy effectiveness. However, this widespread usage of PET, in combination with irresponsible methods of handling and disposal has led to its littering, which in turn has resulted in its undesired ubiquitous presence.[3,4]

Several strategies have evolved for managing PET wastes, the most common being primary and secondary recycling techniques.[5] Although, the fruition of "bottle to fiber and bottle to bottle" recycling[6] has gained popularity in the last few years, but practically, only a small fraction of PET is recycled, the reason being the higher cost of the recycled product.[7] It is thus highly desirous to adopt technically and economically feasible routes toward recycling of PET into industrially important products. In this context, tertiary recycling of PET offers interesting possibilities.[8–10] This process basically refers to the chemical depolymerization of PET, leading to the production of fuels or basic chemicals. In fact, products of tertiary recycling have found interesting applications including their usage as plasticizers,[11,12] raw materials for preparation of metal organic frameworks,[13] polyurethanes,[14,15] unsaturated polyesters,[16,17] and UV curable films.[17]

An interesting area where the potential of glycolysed PET remains unexplored concerns its prospect toward impact modification of epoxy resins. The considerably lower viscosity of the PET glycolysates is expected to improve the resin wetting action which can permit higher filler loadings, without compromising the rate of curing and thermal stability. In fact, polyether polyol-based reactive diluents have been employed for improving the resistance of epoxy toward brittle fracture[18–20]; however, PET glycolysates have not been employed for this purpose. Blending of epoxy with aliphatic polyols is generally associated with a reduction in the material stiffness,[18] a feature that can be

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Pr^{3+} doped lead tungsten tellurite glasses for visible red lasers

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Abstract

Lead tungsten tellurite (LTT) glasses doped with Pr^{3+} (0.01, 0.1, 0.5, 1.0 and 1.5 mol%) ions were prepared by the conventional melt quenching technique. The glasses were characterized by X-ray diffraction, optical absorption and photoluminescence spectra. The glassy nature of LTT host glass has been confirmed through XRD measurements. From the measured intensities of various absorption bands of these glasses, the three phenomenological Judd–Ofelt (J–O) intensity parameters (Ω_2, Ω_4 and Ω_6) have been evaluated by using the standard as well as modified J–O theory. The J–O parameters measured from the modified J–O theory were used to characterize the absorption and luminescence spectra of these glasses. From this theory, various radiative properties like radiative transition probability (A_R), total transition probability (A_T), branching ratio (β_R) and radiative lifetime (τ_R) have been evaluated for the fluorescent levels of Pr^{3+} in these glasses. The emission spectra show five emission bands in visible region for which the effective band widths ($\Delta\lambda_P$) and emission cross-sections (σ_{se}) have been evaluated. Among all the five emission transitions, a transition $^3P_0 \rightarrow {}^3F_2$ is more intense and falls in red region. The visible emission spectra, stimulated emission cross-sections and branching ratios observed for all these glasses suggest the feasibility of using these glasses as lasers in red region. The CIE chromaticity co-ordinates were also evaluated from the emission spectra to understand the suitability of these materials for red emission. From the absorption, emission and CIE chromaticity measurements, it was found that 1 mol% of Pr^{3+} ion concentration is quite suitable for LTT glasses to develop bright red lasers from these glasses.

Keywords: Glasses; Optical absorption; JO parameters; Photoluminescence

1. Introduction

In recent years rare-earth doped glasses have fascinated several researchers because of their potential applications in the development of several optical devices like optical amplifiers, solid state lasers, laser wave guides, light converters, sensors, three dimensional displays, color display devices, biomedical diagnostics and up conversion lasers [1–9]. The spectral characteristics of rare-earth ions are reliant on host glass composition, concentration of dopant ion and ambient temperatures [10]. Heavy metal oxide glasses are suitable candidates for the development of non-linear optical devices, electro-optic modulators, electro-optic switches, solid state laser materials and IR technologies because of their high density, refractive index and low phonon energy [11–14]. Tellurium oxide being a conditional glass former can form a stable glass in presence of certain glass modifiers like tungsten trioxide (WO_3). Tellurium based glasses can be prepared at relatively low temperatures with phonon energies as low as $\sim 800\ cm^{-1}$ in comparison to phosphate, borate and silicate glasses. Glasses with low phonon energies offer less non-radiative relaxation rates and high fluorescence quantum efficiencies. Tellurium based glasses have slow crystallization rate, owing to good transparency in a wide spectral region from visible to NIR region. Relatively good mechanical strength, chemical stability and high refractive indices make them as the best host materials for obtaining efficient luminescence from trivalent rare-earth ions [15,16].

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Preparation and characterization of self-assembled layer by layer $NiCo_2O_4$–reduced graphene oxide nanocomposite with improved electrocatalytic properties

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ABSTRACT

$NiCo_2O_4$ nanoparticles dispersed on reduced graphene oxide (RGO) are prepared by simultaneously reducing graphene oxide (GO), nickel and cobalt nitrate via a hydrothermal method assisted by post annealing at low temperature. The method involves formation of hydroxides on GO using ammonia under hydrothermal conditions. Subsequent thermal treatment at 300 °C led to the conversion of hydroxides into single-phase $NiCo_2O_4$ atop the RGO. The synthesized products are characterized through several techniques including X-ray diffraction (XRD), ultraviolet–visible spectroscopy (UV–Vis), Fourier transform infrared spectroscopy (FT-IR), Raman spectroscopy (RS), field emission scanning electron microscopy (FE-SEM), transmission electron microscopy (TEM) and X-ray photoelectron spectroscopy (XPS). The FE-SEM investigations reveal the growth of a layer by layer assembly of $NiCo_2O_4$–RGO (2:1) nanocomposite, where the $NiCo_2O_4$ nanoparticles are tightly packed between the layers of RGO. Further, the catalytic properties of the $NiCo_2O_4$–RGO nanocomposite are investigated for the oxygen evolution reaction (OER) through cyclic voltammetry (CV) measurements. It is observed that the special structural features of the $NiCo_2O_4$–RGO (2:1) nanocomposite, including layer by layer assembly, integrity and excellent dispersion of the $NiCo_2O_4$ nanoparticles atop the RGO, produced a synergistic effect and therefore significantly improved the electrochemical performance. The oxidation potential (0.135 V) of $NiCo_2O_4$–RGO (2:1) nanocomposite was observed to be lower than that of bare $NiCo_2O_4$ nanoparticles (0.33 V), whereas the corresponding current densities were measured to be 4.1 mA/cm^2 and 3.11 mA/cm^2, respectively.

1. Introduction

Graphene, a carbon allotrope consisting of a single layer of carbon atoms with a hexagonal packed lattice structure, has aroused great interest within the scientific community. Graphene exhibits several unique properties such as excellent optical and mechanical properties, good thermal conductivity, high surface area and high carrier mobility [1]. Owing to these attractive properties, graphene and its composites have shown potential for applications in different research fields including environmental pollution remediation and energy storage/conversion devices such as supercapacitors, lithium ion batteries and fuel cells [2,3].

Usually, nanoparticles are combined with graphene to produce different types of composite materials for catalytic applications. However, poor dispersion of nanoparticles over the graphene and aggregation of graphene may reduce the catalytic activity [4]. On the other hand, though GO may exhibit better dispersibility and anchoring of the nanoparticles, GO is insulating, making it unsuitable for fabrication of catalyst [5]. In contrast, reduction of GO to fabricate reduced graphene oxide (RGO)/nanoparticle composites has stimulated intense research as RGO can combine the advantages of graphene and GO in terms of both conductivity and dispersibility. Therefore, various types of RGO/nanoparticle composites have been widely studied for potential applications including in supercapacitors, lithium ion batteries, catalyst, biosensors, reinforced composites, photocatalysts and semiconductor devices [6–12].

Among the various types of metal oxides, nickel–cobaltite ($NiCo_2O_4$) is a low cost environmentally-friendly transition metal oxide that has been used as an electrocatalyst for water splitting

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Purification of Free DHA by Selective Esterification of Fatty Acids from Tuna Oil Catalyzed by *Rhizopus oryzae* Lipase

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Original Paper
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Abstract

Tuna fish oil contains 25–30 % docosahexaenoic acid (DHA) and is one of the richest sources of DHA. The present paper investigates the enrichment of DHA by selective esterification of fatty acids obtained from hydrolysis of tuna fish oil catalyzed by *Rhizopus oryzae* lipase (ROL). The fatty acid mixture obtained after hydrolysis of tuna fish oil, referred to as tuna-FFA contained 26 % DHA. For purification/concentration of DHA in free fatty acids, selective esterification of the fatty acid mixtures with butanol was carried out using ROL in a water-organic solvent system. The best reaction parameters found in this study were pH 7, temperature 35 °C, agitation speed 800 rpm and a fatty acid to solvent (iso-octane) ratio of 1:1.32 (w/v). Also, the effects of other parameters such as type of alcohol, type of enzyme, alcohol to fatty acid ratio, enzyme to fatty acid ratio were studied to determine the most suitable reaction conditions. Exactly 76.2 % of tuna-FFA was esterified in 24 h, under the most suitable reaction conditions and the DHA content in the fatty acid fraction rose from 26 to 86.9 % with 80 % recovery of DHA, after selective esterification. The DHA content of fatty acids in butyl esters was found to be 13.6 %.

Keywords

Journal

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Review Article

Radiation-induced autophagy: mechanisms and consequences

Madhuri Chaurasia, Anant Narayan Bhatt, Asmita Das, **Bilikere S. Dwarakanath** & **Kulbhushan Sharma**

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ABSTRACT

Autophagy is an evolutionary conserved, indispensable, lysosome-mediated degradation process, which helps in maintaining homeostasis during various cellular traumas. During stress, a context-dependent role of autophagy has been observed which drives the cell towards survival or death depending upon the type, time, and extent of the damage. The process of autophagy is stimulated during various cellular insults, e.g. oxidative stress, endoplasmic reticulum stress, imbalances in calcium homeostasis, and altered mitochondrial potential. Ionizing radiation causes ROS-dependent as well as ROS-independent damage in cells that involve macromolecular (mainly DNA) damage, as well as ER stress induction, both

capable of inducing autophagy. This review summarizes the current understanding on the roles of oxidative stress, ER stress, DNA damage, altered mitochondrial

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Radius of Starlikeness for Analytic Functions with Fixed Second Coefficient

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Abstract. Sharp radius constants for certain classes of normalized analytic functions with fixed second coefficient, to be in the classes of starlike functions of positive order, parabolic starlike functions, and Sokół-Stankiewicz starlike functions are obtained. Our results extend several earlier works.

1. Introduction

Let $\mathcal{A}$ denote the class of analytic functions f defined on $\mathbb{D} := \{z \in \mathbb{C} : |z| < 1\}$, which are normalized by the conditions $f(0) = 0$, and $f'(0) = 1$ and let $\mathcal{S}$ denote its subclass consisting of univalent functions. The well-known Bieberbach theorem states that the second coefficient in the Maclaurin series of functions in $\mathcal{S}$ is bounded by two. This estimate for the second coefficient plays an important role in the study

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Supercooling transition in phase separated manganite thin films: An electrical transport study

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The impact of variation in the relative fractions of the ferromagnetic metallic and antiferromagnetic/charge ordered insulator phases on the supercooling/superheating transition in strongly phase separated system, $La_{5/8-y}Pr_yCa_{3/8}MnO_3$ ($y \approx 0.4$), has been studied employing magnetotransport measurements. Our study clearly shows that the supercooling transition temperature is non-unique and strongly depends on the magneto-thermodynamic path through which the low temperature state is accessed. In contrast, the superheating transition temperature remains constant. The thermo-magnetic hysteresis, the separation of the two transitions and the associated resistivity, all are functions of the relative fraction of the coexisting phases. © *2014 AIP Publishing LLC*. [http://dx.doi.org/10.1063/1.4880725]

Phase separation (PS) is believed to be the key ingredient of the physics of doped rare earth manganites.[1–3] It dominates the composition-temperature (x-T) diagram of intermediate and low bandwidth manganites like $Nd_{1-x}Sr_xMnO_3$,[3,4] $Sm_{1-x}Sr_xMnO_3$,[5,6] and $La_{1-x-y}Pr_yCa_xMnO_3$.[7–10] Amongst these materials, $La_{1-x-y}Pr_yCa_xMnO_3$ has emerged as the prototypical phase separated system and its different variants like bulk single crystal, polycrystals, and thin films have been investigated.[7–16] The strong nature of the phase separation has been established by the observation of (i) strong divergence of the zero filed cooled (ZFC) and field cooled warming (FCW) magnetization, (ii) pronounced hysteresis between the field cooled cool (FCC) and FCW magnetization, and (iii) prominent thermomagnetic hysteresis in the temperature and magnetic field (H) dependent resistivity (ρ) measured in cooling-warming cycles.[7–16] A study by Uehara *et al.*[7] has shown the coexistence of sub-micrometer scale ferromagnetic metallic (FMM) and antiferromagnetic/charge ordered insulator (AFM/COI) clusters and that the latter is explicit in magnetotransport measurements only at $y \geq 0.3$. Consequently, the electrical transport becomes percolative, which is evidenced by huge residual resistivity (ρ_0) for $y \approx 0.4$ in the metallic regime.[7] The study of Ghivelder and Parisi[8] on bulk $La_{5/8-y}Pr_yCa_{3/8}MnO_3$ ($y \approx 0.4$) has shown that COI phase appears at $T_{CO} \sim 230$ K and subsequently acquires AFM and FM spin order $T_N \sim 180$ and $T_C \sim 80$ K, respectively. Due to the rapid spatial and temporal variations in the relative fraction of the FMM and AFM/COI phases, large relaxation effects are also observed.[8] Further, the theoretical study by Ghivelder and Parisi[8] has predicted that interplay between temperature and separation of the system from equilibrium could create multiple blocked states. Sharma *et al.*[9] studied the same material and have established the existence of a liquid like magnetic phase in the phase separated regime, which transforms cooperatively to a randomly frozen glass like phase at low temperature. The frozen glass like phase (termed as strain glass) is believed to arise from the presence of martensitic accommodation strain.[9] Wu *et al.*[10] have demonstrated that in $La_{5/8-y}Pr_yCa_{3/8}MnO_3$ ($y \approx 0.4$) thin films the magnetic liquid like phase exhibits a supercooled glass transition. This glass transition is believed to arise due to the presence of the accommodation strain caused by distinct structural symmetries of FMM and AFM/COI phases. Their study has also provided evidence in favour of the non-ergodic nature of the magnetic liquid. Wu *et al.*[10] have shown that non-ergodicity appears when the long range cooperative strain interactions hinder the cooperative dynamic freezing of the first-order AFM/COI–FMM transition.[9,10]

The FCC-FCW and thermoresistive hysteresis are regarded as signatures of supercooling and superheating transition of the magnetic liquid formed by competing FMM and AFM phases in the presence of martensitic of accommodation strain and long range cooperative strain interactions.[8–10] Despite the exhaustive investigations on different variants of the $La_{1-x-y}Pr_yCa_xMnO_3$, the nature of the supercooling/superheating transitions, e.g., their dependence on relative fractions of FMM and AFM phases has not been probed through electrical transport measurements. The different relative fractions of the FM/AFM phases at the beginning of the magneto-thermodynamic process are expected to lead to different thermodynamic paths and yield different supercooling transition temperatures. Hence, it is important to investigate the signature of different magneto-thermodynamic paths in electrical transport. In this Letter, we report the electrical transport studies on $La_{5/8-y}Pr_yCa_{3/8}MnO_3$ ($y \approx 0.4$) epitaxial thin films. Our results demonstrate that of the two observed insulator-metal transitions (IMTs), the lower one caused by the supercooling of a magnetic liquid is non-unique, while the upper on remains constant.

The $La_{5/8-y}Pr_yCa_{3/8}MnO_3$($y \approx 0.4$) thin films were grown by RF magnetron sputtering of a stoichiometric (2 in.)

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Synthesis, Magnetic and Mössbauer Spectroscopic Studies of Cr Doped Lithium Ferrite Nanoparticles

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TDDFT study of the polarity controlled ion-pair separation in an excited-state proton transfer reaction

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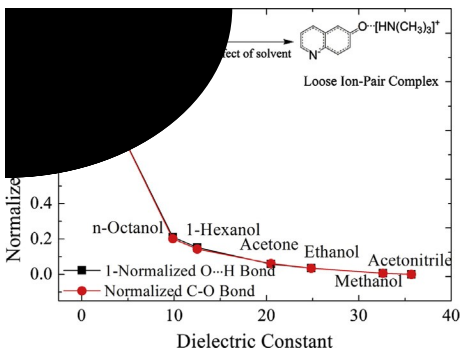
HIGHLIGHTS

- The excited-state nature of the ion-pair formed between 6-hydroxyquinoline and trimethylamine in polar solvents has been studied.
- Both of the contact ion-pair and solvent separated ion-pair exist following the ESPT reaction.
- The polarity of solvents could effectively facilitate the formation of the solvent separated ion-pair.

GRAPHICAL ABSTRACT



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ABSTRACT

6-Hydroxyquinoline (6HQ) is an ideal photoacid system for exploring excited-state proton transfer (ESPT) reactions. We have previously (Mahata et al. (2002) [40]) shown that the ESPT reaction between 6HQ and trimethylamine (TMA) leads to an "unusual" emission in the 440–450 nm range, containing two decay components (~5 ns and ~12 ns). The observed results suggest the presence of a contact ion-pair and a solvent separated ion-pair. In this work, density functional theory (DFT) and time-dependent density functional theory (TD-DFT) have been employed to study the nature of the contact ion-pair formed between 6HQ and TMA and to determine why the decay component ~12 ns is absent in a non-polar solvent. Calculations of the hydrogen-bonded complexes formed between 6HQ and TMA and its ESPT reaction product, namely 6HQ–TMA and 6HQ–TMA-PT, respectively, have been carried out, both in the electronic ground and excited states. Moreover, by using the CPCM model, different dielectric constants have been introduced into the calculations. On increasing the dielectric constant, the hydrogen bond in 6HQ–TMA-PT becomes weaker and the hydrogen bond length becomes larger; this effectively facilitates the proton transfer reaction and formation of separated ion-pair. Thus, the separation and diffusion of the contact ion-pair can be controlled by changing the polarity of the surroundings.

Introduction

Proton transfer (PT), a fundamental class of photochemistry, is ubiquitous as an elementary process throughout nature [1–3]. A photoinduced solute–solvent PT reaction can be considered to be a series of elementary steps, as described by the Eigen–Weller mechanism [4,5], namely electronic redistribution upon photoexcitation, hydrogen bond rearrangement, proton transfer and ion-pair formation and diffusion (ion-pair separation) processes. Photoacids, whose acidity can be switched by optical excitation, have proved to be one of the most convenient sources for

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Review

The implications of recent advances in carboxymethyl chitosan based targeted drug delivery and tissue engineering applications

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ABSTRACT

Over the last decade carboxymethyl chitosan (CMCS) has emerged as a promising biopolymer for the development of new drug delivery systems and improved scaffolds along with other tissue engineering devices for regenerative medicine that is currently one of the most rapidly growing fields in the life sciences. CMCS is amphiprotic ether, derived from chitosan, exhibiting enhanced aqueous solubility, excellent biocompatibility, controllable biodegradability, osteogenesis ability and numerous other outstanding physicochemical and biological properties. More strikingly, it can load hydrophobic drugs and displays strong bioactivity which highlight its suitability and extensive usage for preparing different drug delivery and tissue engineering formulations respectively. This review provides a comprehensive introduction to various types of CMCS based formulations for delivery of therapeutic agents and tissue regeneration and further describes their preparation procedures and applications in different tissues/organs. Detailed information of CMCS based nano/micro systems for targeted delivery of drugs with emphasis on cancer specific and organ specific drug delivery have been described. Further, we have discussed various CMCS based tissue engineering biomaterials along with their preparation procedures and applications in different tissues/organs. The article then, gives a brief account of therapy combining drug delivery and tissue engineering. Finally, identification of major challenges and opportunities for current and ongoing application of CMCS based systems in the field are summarised.

Contents

Abbreviations: ADR, adriamycin; AQCOM, alginate-Q-CMCS-organic montmorillonite; bFGF, basic fibroblast growth gactor; BSA, bovine serum albumin; BMSCs, bone marrow stromal cells; CPT, camptothecin; CMC, critical micelle concentration; CMCS, carboxymethyl chitosan; O-CMCS, O-carboxymethyl chitosans; N-CMCS, N-carboxymethyl chitosans; N,O-CMCS, N,O-carboxymethyl chitosans; N,N-di-CMCS, N,N-di-carboxymethyl chitosans; CMHC, carboxymethylhexanoyl chitosan; CMCPEG, methoxy poly(ethylene glycol)-grafted carboxymethyl chitosan; CMCS-g-D-GA, CMCS-graft-D-glucuronic acid; CD, cyclodextrin; DD, degree of deacetylation; DS, degree of substitution; DA, deoxycholic acid; DOX, doxorubicin; EPR, enhanced permeability and retention; EDC, 1-ethyl-3(3-dimethylaminopropyl) carbodiimide hydrochloride; FA, folic acid; 5-FU, 5-fluorouracil; GA, glutaraldehyde; GL, glycyrrhizin; GFLX, gatifloxacin; HAP, hydroxyapatite; IPN, interpenetrating; iPSCs, induced pluripotent stem cells; LA, linoleic acid; mPEG-g-CMC, methoxy poly (ethylene glycol) grafted carboxymethyl chitosan; MW, molecular weight; MTA, mineral trioxide aggregate; MIC, minimum inhibitory concentration; MMA, methyl methacrylate; N-CECS/nano-HAP, N-carboxyethyl chitosan/nanohydroxyapatite; OCT, octreotide; OCC, N-octyl-O,N-carboxymethyl chitosan; OD, ornidazole; OMMT, organic montmorillonite; PTA, Cis-3-(9H-purin-6-ylthio)-acrylic acid; PTX, paclitaxel; PNIPAM, poly(N-isopropylmethacrylamide); PBS, phosphate buffer saline; PEG, polyethylene glycol; PAMAM, poly(amidoamine); PVA, poly-vinyl alcohol; QCMCS, quaternised carboxymethyl chitosan; SA, stearic acid; SMCs, smooth muscle cells; TLAC, thiolated lactosaminated; VEGF, vascular endothelial growth factor.

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Tunable negative refractive index metamaterial from V-shaped SRR structure: fabrication and characterization

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In this paper, we report the fabrication and characterization of a V-shaped split ring resonator (SRR) metamaterial and have shown that it is possible to tune a negative refractive index by changing the angular gap of V-shaped SRR. Our experimental characterization results are well supported by simulation results using the FDTD method. The reported design of a V-shaped SRR structure has the distinctive advantage of having its capacitance varied by changing the angular gap between its arms. It is also observed that the electromagnetic parameters (such as permittivity and permeability) of metamaterials can be tuned as per our requirement by varying the angular gap. © 2014 Optical Society of America

OCIS codes: (160.3918) Metamaterials; (350.3618) Left-handed materials; (220.4241) Nanostructure fabrication.

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1. INTRODUCTION

Metamaterials have been in prime focus for the past few years with the number of publications and patents increasing exponentially due to their highly uncommon electromagnetic properties and applications such as negative refraction, reverse Doppler effect, flat lens, cloaking, etc. [1–17]. It is possible to design metamaterials due to the dispersive nature of materials, i.e., electric permittivity and magnetic permeability are functions of the radiation frequency [1–3,10]. Metamaterials provide precise control over the flow of electromagnetic waves [9]. The main challenge in the design of metamaterials is to design a structure that shows electric permittivity and magnetic permeability simultaneously negative for the desired frequency range within its characteristic size [1–3,8].

Due to this challenge and uncommon electromagnetic properties, it took a long 30 years after Veselago in 1968 [1] for the practical realization of metamaterials by Smith *et al.* 2000 [7], who used metallic split ring resonators (SRRs) of dimension smaller than the wavelength of light as basic building block (basic units) of a metamaterial. After Smith *et al.*, scientists proposed various different metamaterial unit structures such as Ω-shaped, circular, U-shaped, S-shaped, I-shaped, H-shaped, asymmetric-type split ring structures, to name a few, for various applications such as antenna and optical sensing [18–24].

In almost all cases, SRRs are fabricated as periodic arrays of metallic structures whose dimensions are smaller than the wavelength of radiation. The collective oscillations of conducting electrons in these metallic structures (known as localized surface plasmon) determine the overall electromagnetic response of the entire material [25–31]. By adjusting the dimensions and geometries of these SRRs, a customized electromagnetic response can be obtained. The C-shaped SRR is arguably the most common element used in forming the basic microstructure of metamaterials resonating in the infrared regime [26–30]. SRRs, in their fundamental resonance, behave as LC oscillatory circuits containing a single-turn magnetic coil of inductance in series with a capacitance produced by the gap between the arms. For normal incidence with TE polarization mode, with an incident electric field across its gap, the electric field couples with the capacitance of the SRR and generates a circulating current across it. This circulating current induces a magnetic field at the bottom of the SRR that interacts with the external field to generate the magnetic resonance identified as an LC resonance by Linden *et al.* [32]. The LC resonance of the SRR is given as $\omega_{\mathrm{LC}} = 1/\sqrt{\mathrm{LC}}$ and is inversely proportional to the size (dimension) of SRRs. For the TM polarization mode, where the electric field is perpendicular across the SRR gap, no circulating current could be produced and therefore results in no LC resonance only with the plasmon resonance being present.

In this paper, we report on the fabrication and characterizations of a V-shaped SRR metamaterial and have shown its angular-gap-dependent tunable negative refractive index (NRI) characteristics. The reported V-shaped SRR structure and angular-gap-dependent NRI, to the best of our knowledge is so far not studied. The unique property of this structure is that by varying the angular gap between its arms, we can change the capacitance (C) for the structure, and hence we can tune and control the NRI. We experimentally and computationally investigated the interdependence of the capacitance (C) and inductance (L) of the structure, and we observed that

A novel intelligent water drops optimization approach for estimating global solar radiation

Bagheri Tolabi, Hajar and Hosseini, Reza and Shakarami, Mahmoud Reza and Md. Ayob, Shahrin and Rizwan, Mohammed Ashif (2015) *A novel intelligent water drops optimization approach for estimating global solar radiation.* International Journal of Engineering, Transactions B: Applications, 28 (5). pp. 701-708. ISSN 1728-144X

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Abstract

Measurement of the solar radiance requires utilization of expensive devices. To address this issue, estimator models are used to facilitate the measurement process. In this paper, a new method based on the empirical equations is introduced to estimate the monthly average of daily global solar radiation on a horizontal surface. The proposed method takes advantages of an intelligent water drops algorithm as a swarm-based nature-inspired optimization technique. This algorithm has been implemented in the MATLAB software. The best obtained coefficients of linear and nonlinear empirical models and global solar radiation are employed for the measurement of the six different climate regions of Iran. Performance of this approach has been compared to the other existing techniques. The result reveals the superiority of the proposed method in term of accuracy for estimating the monthly average daily global solar radiation.

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A Secure and Efficient Authentication Protocol in Wireless Sensor Network

Kakali Chatterjee · Asok De · Daya Gupta

Abstract With increasing popularity of wireless sensor networks (WSN), the security issues related to such networks have become crucial. Most of the networks use shared key among all the nodes to make communicational overhead minimal. But it is vulnerable to many attacks like replay attack, node-compromise attack, impersonation attack etc. Further many traditional security mechanisms cannot be suitably implemented in WSN as resources are constrained in terms of power, energy and speed. In this paper, we propose a mutual authentication protocol based on timestamp in WSN which generates a new session key for each session. The proposed authentication approach requires light computational and communicational load and resist the major vulnerable attacks in WSN.

Keywords Mutual authentication · Wireless sensor networks (WSN) · Elliptic curve Diffie–Hellman (ECDH) · Timestamp

1 Introduction

As wireless sensor networks (WSN) are now extensively used to transmit critical data relating to area monitoring (e.g. military), infrastructure monitoring (e.g. airport) etc, the security mechanisms are essential to ensure integrity, confidentiality and authenticity of the data. These networks consist of many tiny and smart devices, referred to as nodes, which typically combine an 8-bit processor with memory (program + data) between 128 and 1,024 KB RAM. The data gathered by these sensor nodes relay to a central server which processes the data according to the application. Implementation of suitable authentication protocol in this environment is challenging as these devices are constrained in terms of memory, computing

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Automated guided vehicle configurations in flexible manufacturing systems: a comparative study

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Abstract: In the present competitive environment, manufacturing organisations have changed the trend from mass production to mass customisation. Flexible manufacturing system (FMS) has evolved as a solution to the requirement of modern manufacturing industries. Automated guided vehicle (AGV) system is the most widely used material handling system in FMS which enhances the flexibility in material transfer between the workstations (WSs). The pattern of AGV guide path layout also called as AGV configuration has become the main issue in the AGV system. This paper compares the three commonly used AGV configurations, i.e., single loop, tandem, and tandem loop in terms of AGV load/unload time, machine failure, processing time distribution and AGV speed. Simulation method is used to perform the study while Taguchi method is used for statistical analysis of results. It has been concluded that no single AGV configuration perform better in all the manufacturing environments.

Keywords: automated guided vehicle configuration; flexible manufacturing system; FMS; mass customisation; material handling system; AGV guide path; simulation; Taguchi method.

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Big Data Analysis Using Hadoop Cluster

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***Abstract*— Industries keep a check on all statistics of their business and process this data using various data mining techniques to measure profit trends, revenue, growing markets and interesting opportunities to invest. These statistical records keep on increasing and increase very fast. Unfortunately, as the data grows it becomes a tedious task to process such a large data set and extract meaningful information. Also if the data generated is in various formats, its processing possesses new challenges. Owing to its size, big data is stored in Hadoop Distributed File System (HDFS). In this standard architecture, all the DataNodes function parallel but functioning of a single Data Node is still in sequential fashion.**

This paper proposes to execute tasks assigned to a single Data Node in parallel instead of executing them sequentially. We propose to use a bunch of streaming multi-processors (SMs) for each single Data Node. An SM can have various processors and memory and all SMs run in parallel and independently. We process big data which may be coming from different sources in different formats to run parallelly on a Hadoop cluster, use the proposed technique and yield desired results efficiently. We have applied proposed methodology to the raw data of an industrial firm, for doing intelligent business, with a final objective of finding profit generated for the firm and its trends throughout a year. We have done analysis over a yearlong data as trends generally repeat after a year.

Keywords— Big data, Hadoop, distributed data processing, data mining, Mappers, Reducers

I. INTRODUCTION

Big data consists of a heterogeneous mixture of data-structured and unstructured data. Big data refers to datasets whose size is beyond the ability of typical database software tools to capture, store, manage, process and analyze. An issue with big data is that it uses NoSQL and has no Data Description Language. Also, web-scale data is not universal and is heterogeneous. For analysis of big data, database integration and cleaning is much harder than the traditional mining approaches. Manipulation of large datasets possesses problems of computational speed and error recovery. In this paper, the issue of speed has been addressed by distributing the computation over several nodes each of which works in parallel on a subset of the complete dataset and maintains coherence for producing appropriate result. Also the whole system is able to handle data coming from different sources which can be in different formats. Data size grows with the number of computational units present on the system. In a distributed data system, resources and cost of maintenance can scale up as per need and the proposed system is flexible enough to handle this. Also the framework used is intelligent enough to handle errors on its own. When coupled with the advantages of parallel processing, we are able to get a faster system.

All firms keep a record of their raw data like sale-purchase statistics and process it for finding various parameters which play a major role in governing their strategies. This paper has chosen 'profit generation and its trends throughout a year on various products of the company' as one such parameter. Profit on various products may be different during different periods of time throughout the year and the associated firm can line up production and storage etc. of various products accordingly. Various technologies play a major role to accomplish this task of processing big data such as Spring Hadoop Data Framework [8] for the purpose of basic foundations and running of the Map-Reduce jobs, REST Web services [9] for communication, Apache Maven [10] for distributed building of code, and Apache Hadoop [11] for distributed processing of huge sets of data. We have used Apache Hadoop for this purpose.

Apache Hadoop is designed to scale up from single server to lots of machines each offering local computation as well as storage. It is a framework which allows distributed processing

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Biofunctionalized Nanostructured Zirconia for Biomedical Application: A Smart Approach for Oral Cancer Detection

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Results of the studies are reported relating to application of the silanized nanostructured zirconia, electrophoretically deposited onto indium tin oxide (ITO) coated glass for covalent immobilization of the monoclonal antibodies (anti-CYFRA-21-1). This biosensing platform has been utilized for a simple, efficient, noninvasive, and label-free detection of oral cancer via cyclic voltammetry technique. The results of electrochemical response studies conducted on bovine serum albumin (BSA)/anti-CYFRA-21-1/3-aminopropyl triethoxy silane (APTES)/ZrO_2/ITO immunoelectrode reveal that this immunoelectrode can be used to measure CYFRA-21-1 (oral cancer biomarker) concentration in saliva samples, with a high sensitivity of 2.2 mA mL ng^{-1}, a linear detection range of 2–16 ng mL^{-1}, and stability of six weeks. The results of these studies have been validated via enzyme-linked immunosorbent assay.

1. Introduction

Oral cancer (OC) is presently one of the most prevalent cancers known till date, and it occurs more often in men than women. OC occurs as a sore in the mouth that does not easily heal. This cancer can be life threatening if not detected and treated early. It includes cancers of the floor of the mouth, tongue, cheeks, lips, sinuses, throat, etc. Smoking, chewing tobacco, alcohol consumption, diet (red and processed meat, fried foods), gastro-esophageal reflux disease, human papillomavirus, and exposure to certain chemicals (e.g. asbestos, sulfuric acid, and formaldehyde) are some of the common causes behind the onset of OC.[1,2] These high risk factors are known to alter the expression of p16, APC, and p53 genes and account for the origin of OC.[3] Most patients do not show any symptoms at the early stage. However, with passage of time, symptoms like mouth ulcer, loosening of teeth, and hoarse voice are known to develop.[1]

Many techniques, including laser capture microdissection, visualization adjuncts, cytopathology, and biopsy, are being used for detection and monitoring of OC.[4–6] These methods are invasive, time-consuming, expensive, and labor-intensive. In this context, biosensors offer a reliable, user-friendly, increased assay speed, high sensitivity and require low sample volumes.[7,8]

Among the various nanomaterials, the nanostructured metal oxides have recently aroused much interest since these interesting materials provide high surface area for effective immobilization of desired biomolecules with desired orientation.[9] In this context, nanostructured zirconium oxide (ZrO_2) has been found to have interesting characteristics for biosensing applications. These characteristics include biocompatibility, excellent electrical, and surface charge properties that can be beneficial for integration of the immobilized biomolecules. Furthermore, oxygen moieties in ZrO_2 may facilitate covalent attachment of both silane compound and indium tin oxide coated glass (ITO) surface.[10–12]

The detection of cancer via biomarkers has been recently proposed.[13] In this context, the biomarkers, such as interleukin-8 (IL-8), interleukin-6 (IL-6), vascular endothelial growth factor (VEGF) and epidermal growth factor receptor (EGFR) are currently being used for detection of oral cancer.[14–17] The OC detection via these biomarkers is currently a challenge since these are secreted at very low concentration (≈pg mL^{-1}) and the biosensors proposed for the detection of these biomarkers require serum samples and are thus invasive.[14–17] Thus,

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Characterizing relatedness of web and requirements engineering

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Abstract

Web and Requirements Engineering have been well- recognized as two individual active areas of research in the past. Convergence between these two notable areas has been a point-of-discussion in recent years and offers new avenues of research. This paper explores this alliance from two perspectives; firstly, where Requirement Engineering can be viewed as a process for Web application development as it primarily concerns with adapting the Requirement Engineering process to the Web applications which are special in characteristics as compared to traditional software applications and secondly, where Web can be viewed as a supporting technology for improving the requirements engineering process and enabling new capabilities. The basics of this two-way relationship are examined along with state-of-art and potential opportunities to equip a better understanding.

Keywords

Web application; Requirements engineering; Web 2.0; Web 3.0

Computational design of novel flavonoid analogues as potential AChE inhibitors: analysis using group-based QSAR, molecular docking and molecular dynamics simulations

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Original Research
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Abstract

Acetyl cholinesterase (AChE) is an enzyme associated with the loss of cholinergic neurones in Alzheimer's disease. Acetylcholine is an important neurotransmitter found in the brain and the levels of which decrease significantly in Alzheimer's patients due to increased expression of AChE. In this study, a novel fragment-based QSAR model has been developed using twenty-seven flavonoid-derived compounds exhibiting inhibitory activity against AChE. This fragment-based method gives the advantage of studying the effect of individual fragments on the biological activity of the compound by evaluating the descriptors. The compounds were divided into training and test sets, where the test set was used for cross-validation of the model. The QSAR model exhibited good statistical values for the training set (r^2 = 0.8070, q^2 = 0.7088, *F*-ratio = 31.3616) and test set (pred_r^2 = 0.8131). The regression equation obtained had three descriptors describing effect of substitutions in terms of quantitative values. Evaluation of the model implied that electronegative substitution at R1 position lowers the inhibitory activity, while the presence of hydroxyl group improves the same. The presence of rings increased the activity of the compounds. The model thus generated

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Controlled synthesis and magnetic properties of monodispersed ceria nanoparticles

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In the present study, monodispersed CeO_2 nanoparticles (NPs) of size 8.5 ± 1.0, 11.4 ± 1.0 and 15.4 ± 1.0 nm were synthesized using the sol-gel method. Size-dependent structural, optical and magnetic properties of as-prepared samples were investigated by X-ray diffraction (XRD), field emission scanning electron microscope (FE-SEM), high resolution transmission electron microscopy (HR-TEM), ultra-violet visible (UV-VIS) spectroscopy, Raman spectroscopy and vibrating sample magnetometer (VSM) measurements. The value of optical band gap is calculated for each particle size. The decrease in the value of optical band gap with increase of particle size may be attributed to the quantum confinement, which causes to produce localized states created by the oxygen vacancies due to the conversion of Ce^{4+} into Ce^{3+} at higher calcination temperature. The Raman spectra showed a peak at ~461 cm^{-1} for the particle size 8.5 nm, which is attributed to the 1LO phonon mode. The shift in the Raman peak could be due to lattice strain developed due to variation in particle size. Weak ferromagnetism at room temperature is observed for each particle size. The values of saturation magnetization (Ms), coercivity (Hc) and retentivity (Mr) are increased with increase of particle size. The increase of Ms and Mr for larger particle size may be explained by increase of density of oxygen vacancies at higher calcination temperature. The latter causes high concentrations of Ce^{3+} ions activate more coupling between the individual magnetic moments of the Ce ions, leading to an increase of Ms value with the particle size. Moreover, the oxygen vacancies may also produce magnetic moment by polarizing spins of f electrons of cerium (Ce) ions located around oxygen vacancies, which causes ferromagnetism in pure CeO_2 samples. [http://dx.doi.org/10.1063/1.4908003]

I. INTRODUCTION

Nanostructured materials having a size of less than 100 nm, at least in one dimension, exhibit extraordinary optical, magnetic, electrical, thermal, and mechanical properties compared to the bulk material. Due to the unique size and shape dependent physical and chemical properties, nanostructured materials have attracted considerable attention to the scientific community. The band gap

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Crystal structure and mechanical properties of spark plasma sintered Cu_2Se: An efficient photovoltaic and thermoelectric material

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A B S T R A C T

Copper selenide (Cu_2Se) based materials are currently being investigated globally for efficient photovoltaic and thermoelectric (TE) device applications. Despite having enormous device potential its crystal structure and mechanical properties are still not fully explored owing to its complex behavior. Stereographic projection is one of such useful tools to estimate the crystallography of the material conclusively. In the current study, the crystal structure of α and β-phases of Cu_2Se was determined by its stereographic projections in reciprocal space. Further, mechanical properties of Cu_2Se are highly important to avoid catastrophic failure and ensure longevity of the TE devices made out of these materials. Cu_2Se exhibited the compressive strength of $\sim$45 MPa with $\sim$3% of plastic strain and a fracture toughness value of $\sim 2 \pm 0.02$ MPa$\sqrt{m}$, the latter being significantly higher than that of the other known TE materials. Finally, thermal shock resistance, which is one of the crucial parameters for the stability and longevity of the device applications, was calculated to be $\sim 281 \pm 12$ W m^{-1}. Superior mechanical properties coupled with highly reported thermoelectric behavior makes Cu_2Se as a potential candidate for green energy generation.

1. Introduction

The development of promising power generation methods that are eco-friendly in nature require special attention to meet the global needs of large power usage [1]. The direct conversion of heat into electrical energy based on thermoelectric (TE) effect without moving parts in the device is an attractive alternative for power generation [2]. The performance of a thermoelectric device depends on its *figure-of-merit* (*ZT*), a dimensionless quantity of the material defined as $ZT=(\alpha^2\sigma T/\kappa)$, where α, σ, T and κ are Seebeck coefficient, electrical conductivity, temperature and thermal conductivity, respectively. The optimization of *ZT* clearly demands high TE power and electrical conductivity but having low thermal conductivity values. It is known that these three physical quantities (α, σ and T) of materials are correlated in such a way that the optimization of one adversely affects the other. Among several other available TE materials, Cu_2Se has been designated as one of the most promising materials for TE power generation, due to its high *ZT* value [2–8] in spite of its complex crystal structure. Further, it has been reported in literature that phase transition in Cu_2Se occurs from monoclinic (α)→cubic (β) at $\sim$413 K [2,9]. But, all the available literature on Cu_2Se unanimously confirms that the high temperature phase exists as β [3,9,10], while quandary still exists over the low temperature α-phase of Cu_2Se. Various groups [2,3,9] have already reported different crystal structures for Cu_2Se predicting that the low temperature phase is either monoclinic, orthorhombic or tetragonal at room temperature ($\sim$25 °C). But still there are many debates unresolved over the crystal structure of Cu_2Se. Hence, there is a need to address the existence of α-phase in Cu_2Se at low temperature with suitable supporting characterization techniques. Moreover, in the β-phase of Cu_2Se, the surface migration of Cu ions as well as evaporation of elemental Se limits the precise control over the final composition. Furthermore, it is desired to have complete crystallographic information of state-of-art TE materials prior to device fabrication to ensure that these materials are strong enough to operate in the temperature range 500–600 K useful for automobiles. Consequently, these materials have to withstand high internal thermal stresses created due to rapid temperature cycling gradients of two ends of the same TE element. Many of the existing TE materials are strong enough in thermoelectric performance, but poor at their mechanical strength. Hence, the mechanical facets of these TE materials are also to be addressed properly. Very few reports are available on mechanical properties of other state-of-the art TE materials, such as, n-type nanostructured SiGe alloys [11], Co_4Sb_{12} [12], $In_{0.1}Co_4Sb_{12}$ [12] and Bi_2Te_3+0.1 vol% SiC [13]. But for Cu_2Se,

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ORIGINAL RESEARCH

Curcumin-based IKKβ inhibiting anticancer lead design using novel fragment-based group QSAR modelling

Kunal Patel · Chetna Tyagi · Sukriti Goyal · Jaspreet Kaur Dhanjal · Navneeta Bharadvaja · Abhinav Grover

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Abstract NF-κB transcription factor plays a vital role in the protection of transformed cells from apoptosis, thus resulting in the onset/progression of cancer. Activation of NF-κB is strictly controlled by IκB kinase, and therefore IκB kinase inhibition forms the basis for anticancer drug research. We present here a novel fragment-based QSAR model using 4-arylidene curcumin analogues having IκB kinase inhibitory properties. The insights into the contribution of each chemical fragment of the analogues in IκB kinase inhibitory activity were used to generate a combinatorial library containing 167,828 molecules and their inhibitory activities were predicted by the reported G-QSAR model. We report top two scoring compounds BEP and BHP possessing high docking scores of −9.21 and −8.98 kcal/mol, respectively. Molecular dynamics simulations studies showed that the trajectories of the IκB kinase complexed with BEP and BHP were stable over a considerably long time period (16 ns). The two compounds reported here showed high binding affinity and stability with IκB kinase and thus can be taken forward as promising anticancer leads. The G-QSAR model reported here will pave way for the development of novel leads by high-throughput activity prediction of similar compounds.

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Keywords Transcription factor · NF-κB · IκB kinase · Anticancer · Curcumin · QSAR · Simulations

Introduction

Cancer is a class of disease characterized by hyperproliferative cell growth resulting due to the imbalance between cell growth, cell division and apoptosis. Hyperproliferative cell growth results in tumour initiation and promotion, which ultimately leads to metastasis. Quest for a method to cure or control the disease has been going on for many years. In the last 25 years, few proteins have managed to have as profound influence in immunology and cancer biology as the transcription factor NF-κB. NF-κB was first discovered in the light chain of immunoglobulins by Sen and Baltimore while working on B cells in the year 1986 (Sen and Baltimore, 1986). Further studies have shown that it is a frequently expressed inducible transcription factor and plays a role in inflammatory responses, regulation of various genes which are involved in the regulation of cell cycle, cellular transformation, proliferation, invasion and angiogenesis (Baldwin, 2001; Collins *et al.*, 1995; Shishodia and Aggarwal, 2002; Yan *et al.*, 2000). NF-κB exists as a dimer in its functional state and is present in a number of combinations belonging to the Rel family of polypeptides. Various kinds of stimuli like growth factors and inflammatory cytokines activate NF-κB. In response to stimuli, IκB proteins which are bound to NF-κB undergo phosphorylation, ubiquitination and are degraded ultimately. Dissociation of NF-κB from IκBα is catalysed by an enzyme IκBα kinase (IKK) complex; it phosphorylates IκBα which is critical for initiation of pathway leading to the activation of NF-κB. IκBα kinase (IKK) complex has molecular mass of 700 kDa and it is composed of IKK-α,

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Curing kinetics of self-healing epoxy thermosets

**Manorama Tripathi · Devendra Kumar ·
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Abstract The curing kinetics of self-healing epoxy compositions was investigated by non-isothermal differential scanning calorimetric (DSC) studies. Cycloaliphatic epoxy resin was encapsulated in urea–formaldehyde (UF) using emulsion polymerisation technique to prepare epoxy-loaded UF microcapsules. Triethylene tetramine (TETA) hardener was immobilised on a mesoporous siliceous substrate (SBA 15) and both these additives were dispersed into an epoxy resin, which was subsequently cured using TETA. DSC studies revealed the autocatalytic nature of epoxy curing, which remained unaltered due to addition of the above-mentioned fillers, responsible for introducing self-healing functionality. The kinetic parameters of the curing process were determined using both Friedman and Kissinger–Akahira–Sunose (KAS) method. The activation energy at different degrees of conversion (E_α) was found to decrease with increasing degree of cure (α). Although UF resins possess secondary amine functionalities, which have the potential to react with the epoxy groups, no significant differences in the curing kinetics of the base resin were observed. Kinetic parameters were used to predict the curing behaviour of compositions at higher heating rates using KAS method. As expected, the onset curing temperature (T_{onset}) and peak exotherm temperature (T_p) of epoxy shifted towards higher temperatures with increased heating rate; however, introduction of fillers does not affect these characteristic temperatures significantly. Also, the overall order of reaction does not vary significantly which supports the autocatalytic nature of curing reaction. The results suggests that although 2° amino groups are available with the UF resin, these do not directly participate in the curing reaction, as the primary amino groups in TETA are more easily accessible.

Keywords Curing kinetics · Autocatalytic reaction · Non-isothermal differential scanning calorimetry

Introduction

The use of epoxy composites for structural applications has seen a tremendous increase in the last few decades, primarily because of their excellent thermo-mechanical, chemical and environmental stability. One of the major issues associated with these composites arises from the inherent brittleness of the epoxy matrix which renders these materials susceptible to microcrack formation. In the context of structural engineering, microcracking can prove to be rather fatal, as coalescence of microcracks can result in catastrophic failure of the components. An ideal route to increase the lifetime of components includes the usage of self-healing compositions, and in view of the same, such polymers have attracted increasing research interests lately [1–3]. At present, the most common strategy for imparting self-healing functionality involves introduction of fragile microcapsules, which encapsulate the healing agents [4]. During crack propagation, the embedded microcapsules rupture, leading to release of the healing agent into the

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Design of small core tellurite photonic crystal fiber for slow-light-based application using stimulated Brillouin scattering

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Abstract. Stimulated Brillouin scattering (SBS) performances of small core tellurite photonic crystal fibers (PCF) are rigorously studied. We propose a design of tellurite PCF that is used for slow-light-based applications. We developed a two-dimensional finite element mode solver to numerically study the acoustic and optical properties of complex refractive index profiles including tellurite PCF. Our results include the calculation of Brillouin gain spectrum, Brillouin gain coefficient (g_B) and Brillouin frequency shift by taking into account the contribution of the higher-order acoustic modes. Several simulations were run by varying the air-filling ratio of various PCF structures to enhance the SBS. The real scanning electron microscope image of a small core of highly nonlinear tellurite fiber is considered. Optimized results show a frequency shift of 8.43 GHz and a Brillouin gain of 9.48×10^{-11} m/W with a time delay between 21 and 140 ns. Such fibers have drawn much interest because of their capacity for increasing and tailoring the SBS gain. [DOI: 10.1117/1.OE.54.7.075101]

Keywords: stimulated emission; Brillouin scattering; photonic crystal fibers; tellurite glass; slow light.

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1 Introduction

Photonic crystal fibers (PCF) exhibit unique and remarkable guiding and antiguiding properties not only for optical waves but also for acoustic waves paving to create and exploit nonlinear effects.[1] Among these nonlinear effects, the nonlinear inelastic scattering effects have attracted the most notable interest. In the inelastic scattering process, the energy of a light wave is transferred to another wave that is at a higher wavelength such that the energy difference appears in the form of phonons. This process can be electrostrictively amplified and gives rise to stimulated Brillouin scattering (SBS).[2] SBS is considered as a setback to optical communications especially in wavelength-division multiplexing systems. However, it can be useful for different applications such as lasers, optical amplifiers, sensors, and slow light generation.[3–6] SBS as well as other nonlinear effects are very weak and require huge amounts of power and long fiber lengths.

Thus, it is desirable to have a large Brillouin gain in order to lower the power requirements and also to shorten the length of the fiber device.[7] Tellurite glasses offer a range of useful properties not possessed by silica, including good infrared transmittance beyond 2 μm, a higher refractive index and low-phonon energy among oxide glasses and high-optical nonlinearity.[8] These features make tellurite glass a very good candidate for microstructured fibers' fabrication, and calculations of their waveguiding properties have been already reported.[9] A tellurite fiber with a relatively large refractive index of about 2.028, which is about 40% higher than that of silica, is expected to exhibit a large SBS coefficient since it is proportional to the material refractive index raised to the power of 7.[10] Qin et al.[11] have measured the Brillouin gain coefficients of a suspended core microstructured tellurite fiber. The Brillouin gain coefficient of 1.7×10^{-10} m/W around a Brillouin shift of 7.97 GHz, which is almost 3.4 times larger than that of silica fiber, is measured.[11] In this paper, we report on full modal analysis and comparison with experimental results of the SBS in small core microstructured tellurite fibers. We will also focus on an SBS-based slow light application, which makes use of resonant effects that cause a large normal dispersion in a narrow spectral region, which, in turn, increases the group index and thus, reduces the group velocity of optical pulses. Slow light can be very helpful since it holds great promise for many potential applications in telecom including all-optical buffering to overcome data-packet contentions in switchers and routers, all-optical signal processing and quantum computing, which needs a time delay on the order of tens of nanoseconds.[12]

Our analysis is first made in a four air-hole different tellurite PCF. Such fibers have drawn much interest because of their capacity of increasing the SBS gain. A Brillouin gain coefficient, g_B, of 1×10^{-10} m/W, is found around the acoustic frequency of 8 GHz. In our study, we focus on the characterization of the SBS properties in both real [scanning electron microscope (SEM) image] and ideal (without geometrical imperfections) tellurite PCF. The variations of the Brillouin gain and Brillouin shift is evaluated for different tellurite PCF. We have exposed the simulation results of

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Discussion: Consolidation of clayey gouge amid permeating rock masses

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Contribution by S. K. Tewatia, A. Sridharan, Subhash Narayan Singh, K. Tewatia, A. Tewatia and S. Rath

The original paper by Trivedi *et al.* (2014) presented a natural complicated shaped in situ clay idealised as a saturated rectangular body settling in a vertical direction with two-dimensional drainage in vertical and horizontal directions. Theoretical equations were derived for two-dimensional drainage using Fourier series. The discussers suggest a more general theoretical equation for three-dimensional drainage when the soil is stratified in *X*, *Y* and *Z* directions.

Theoretical equation for three-dimensional drainage when the soil is stratified in *X*, *Y* and *Z* directions

The basic three-dimensional (3D) consolidation equation in Cartesian coordinates (Biot, 1941) is given as

47. $$\frac{\partial u}{\partial t} = c_x \frac{\partial^2 u}{\partial x^2} + c_y \frac{\partial^2 u}{\partial y^2} + c_z \frac{\partial^2 u}{\partial z^2}$$

where u is pore pressure, t is time, c_x, c_y and c_z (= c_v) are coefficients of consolidation in the *X*, *Y* and *Z* directions, respectively.

Suppose, L, B and H are the length, breadth and height of a (cuboid) sample draining outwards from all the six phases and settling in *Z* or vertical direction only. The Carillo (1942) type solution of Equation 47 is given by Tewatia (2013b) as

48. $$(1 - U_{xyz}) = (1 - U_x)(1 - U_y)(1 - U_z)$$

and the Terzaghi (1923) type solution of Equation 1 is given by Tewatia (2010, 2013a) as

49. $$U = 1 - \frac{8}{\pi^2} \sum_{N=0}^{N=\infty} \frac{1}{(2N+1)^2}\, \varepsilon^{-\frac{(2N+1)^2 \pi^2}{4} \lambda T}$$

where λ is given as

50. $$\lambda = 1 + \frac{k_y H^2}{k_z B^2} + \frac{k_x H^2}{k_z L^2}$$

and

51. $$T = \frac{c_v t}{H^2}$$

where k_x, k_y and k_z (= k_v) are the permeability of soil in the *X*, *Y* and *Z* directions, respectively. Equation 49 shows that in 3D consolidation, T for a particular t is increased by λ times or c_v is increased by λ times (Tewatia, 2010, 2013a). Hence, U for a particular t increases. Equation 49 can be reduced to a two-dimensional (2D) or one-dimensional (1D) space by putting k_x or k_y or both equal to zero in Equation 50.

From Equation 49, it can be shown (Tewatia, 1998, 2010, 2013a; Tewatia *et al.*, 2007, 2013a, 2014) that a plot of settlement (δ) against rate of settlement ($\mathrm{d}\delta/\mathrm{d}t$) gives Equation 52 after 60% U.

52. $$\delta = -\frac{4H^2}{\pi^2 \lambda c_v}\left(\frac{\mathrm{d}\delta}{\mathrm{d}t}\right) + \delta_{100}$$

Effect of Carbon Nanofibers Supported With Metal Oxide Nanoparticles on H_2S Adsorbent Properties

Authors: Bajaj, Bharat; Kim, Sujeong; Park, Moon Kyu; Yi, Kwang-Bok; Hwang, JunYeon; Joh, Han-Ik; Jo, Seong-Mu; Lee, Sungho

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Composites of polyacrylonitrile (PAN) nanofibers containing zinc oxide (ZnO) and copper (Cu) were synthesized by using electrospinning as an adsorbent for hydrogen sulphide (H_2S). Zinc acetate dihydrate and copper (II) acetate were used as a precursor. Electrospun nanofibers were carbonized at 800 °C in nitrogen atmosphere after partial stabilization at 200 °C in air atmosphere. The carbon nanofibers (CNFs) of PAN with ZnO and Cu were characterized by using TGA, XRD, SEM, TEM and XPS. It was confirmed that diameters of CNFs were 200~300 nm and uniform distribution of ZnO and Cu nanoparticles with size of about 10 nm was observed by SEM and TEM analysis. The products were tested for H_2S adsorption at 300 °C. The adsorption dynamics of the prepared adsorbents were investigated in fixed-bed column as function of the concentration of H_2S. The result showed that CNFs with ZnO nanoparticles exhibit three times higher H_2S adsorption over bulk ZnO and CNFs with Cu nanoparticles. Such features may be used in many applications involving gas–Csolid reactive systems, especially those relying on fast reversible reactions such as environmental clean-up and gas sensing.

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Efficient water soluble nanostructured ZnO grafted O-carboxymethyl chitosan/curcumin-nanocomposite for cancer therapy

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ABSTRACT

The present work deals with the synthesis of efficient water soluble O-carboxymethyl chitosan (O-CMCS) based nanocomposites (NCs) with nanostructured zinc oxide (n-ZnO) by ex-situ grafting method for the delivery of anticancer drug curcumin (Cr). The phase identification, morphology and thermal stability of prepared Cr/O-CMCS/n-ZnO NCs have been investigated by FT-IR, XRD, SEM, TEM and TGA/DTA techniques. The drug entrapment efficiency have found to be 74% and *in vitro* drug release study performed at 37 °C at pH 4.5 and 7.4 indicated slow and controlled release in the initial phase and sustained in later phase. The MTT assay showed higher and preferential toxicity of the Cr/O-CMCS/n-ZnO NCs against cancer cells (MA104). The cellular uptake study by FACS revealed concentration dependent uptake of the NCs. The utilization of this Cr/O-CMCS/n-ZnO nanoformulation offers an efficient strategy and a novel promising soluble nanomatrix for anticancer therapy and other biomedical applications.

1. Introduction

Cancer treatment still remains a big challenge to the medicine world as chemotherapies and radiotherapies are aggressive and poorly effective. These conventional anticancer therapies suffer from side effects such as fatigue, nausea, insomnia, delirium and vomiting which are common troubles for cancer patients [1,2]. For this reason, nanotherapeutics has attracted the attention of several researchers and scientists. In recent years, new development of nanomaterials, nanocomposites signify a promising area in the leading edge between the fields of materials science, life science, medical biology, including cancer therapy, have attracted significant attention. Various strategies in the drawing such as nanostructured materials, with unique size and shape surface morphology, govern the biodistribution, uptake, drug loading capacities, and properties for persistent or controlled release making nanostructured systems ideal and well suited for cancer therapy [3,4]. Nanomaterials has provided optimum size and surface characteristics are capable of enhancing therapeutic activity by prolonging drug half-life, improving solubility of hydrophobic drugs, reducing potential immunogenicity, and/or releasing drugs in a sustained or stimuli-triggered fashion. Thus, the toxic side effects and administration frequency of the drugs can be reduced [5]. Moreover, nanostructured materials can passively accumulate in specific tissues (*e.g.*, tumors) through the enhanced permeability and retention (EPR) effect [6]. In particular, polymeric nanometer sized particles such as micelles, nanospheres, nanocapsules, polymerosomes, polyplexes, hydrogels, *etc.* have been predominantly in the attention as nano-carriers [7]. Polymeric nanoparticles carriers offer a large versatility in both structure and physiochemical properties due to a wide variety of available monomers. Drugs loading is accomplished by infusing the nanoparticles with drugs in aqueous phase resulting in highly controlled cage like or capsule conformations along with highly developed methodologies include trapping drugs by chemical cross-linking, modifying surface properties of nanoparticles, *etc.* [8,9].

Derivatives of chitosan like carboxymethyl chitosan (CMCS) have emerged as a promising functional biomaterial for efficient delivery of many of the highly potent hydrophobic anticancer drugs [10–14]. This is because CMCS can overcome some of the major limitations of chitosan like its poor aqueous solubility [15]. As

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Empirical correlation of estimating global solar radiation using meteorological parameters

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An empirical model for the estimation of solar energy on the basis of Angstrom's model is proposed in this work. Seven regression equations are developed by using different meteorological parameters such as mean sunshine duration per hour, temperature, relative humidity, wind speed, and rainfall. The performance of the model is determined on the basis of statistical indicators like correlation coefficient(r), coefficient of determination (R^2), root mean square error (RMSE), mean percentage error (MPE), and mean bias error (MBE). The results show that the equation with the highest value of r, R^2 and the least value of RMSE, MPE, and MBE provides better results.

Keywords: global solar radiation; meteorological parameter; multiple linear regression; statistical indicator; regression equation

1. Introduction

Data of hourly global solar radiation (GSR) is essential to design the techno-economic viable system based on solar energy. Such data are also equally important in the design of energy efficient buildings. Information of GSR received at any station is useful not only to the locality where the radiation data are collected but also for the wider world community (Benghanem, Mellit, and Alamri 2009). India is a tropical country and it receives nearly 5000 trillion kWh of solar energy per year, which is many times more than the power requirement of the country. Most parts of India receive 4–7 kWh of solar radiations per square metre per day with 250–300 clear days in a year. Such solar potential provides the opportunity to generate power on distributed basis in a country like India where millions of people living in remote areas are deprived from grid supply.

In India, hourly data of measured GSR is not available, even for those stations where measurement has already been done. Since accurate measurement involves cost and man power, therefore, this information is hardly available in many developing countries, including India but such measurement is the need of the hour to meet the energy needs from this environment friendly and clean source of energy. Therefore, it is of great importance to propose an efficient alternative to be used as a solar radiation estimator based on more readily available meteorological parameters.

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Energy and exergy analyses of a new solar-assisted cogeneration cycle for simultaneous heating and triple effect cooling applications

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Abstract: This paper presents the energy and exergy analyses of a new cogeneration cycle for simultaneous production of heating and cooling. The effect of some influenced operating variables is observed on energy output, exergy output, energy and exergy efficiency of proposed cycle. Second law analysis indicates that around 3% of solar heat exergy is available as heating and cooling output and remaining is destroyed due to irreversibility in the various components of the cycle as well as lost via exhaust. It is found that maximum exergy destruction occurs in central receiver (52.5%) and heliostat field (25%) followed by condenser of ejector refrigeration cycle (ERC) (3.98%), heat recovery vapour generator (HRVG) (3.79%) and ejector (3.72%).

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Energy transfer and NIR emission in rare earth tri-doped barium lanthanum fluoro tellurite glasses

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Barium lanthanum fluoro tellurite (BLFT) glasses doped with rare earth ions (ErF_3, PrF_3 and YbF_3) both singly or in combinations were prepared by melt-quench technique and analysed spectroscopically. The prepared glasses were found to be mechanically strong and transparent. Optical absorption and NIR fluorescence were measured to the highly transparent and stable glass samples. Judd–Ofelt parameters and radiative properties were estimated for the single rare earth doped BLFT glasses using the optical absorption spectra. NIR fluorescence is measured using laser excitation. From the NIR emission spectra, energy transfer among the rare earth ions is analysed in the rare earth tri-doped BLFT glasses. These rare earth tri-doped BLFT glasses are found to be highly useful for the multi- wavelength emission in the NIR region for opto-electronic applications.

1 Introduction The rare earth (RE) incorporation in tellurite based glass matrices is being reported extensively in the literature [1]. Adding of fluorine ions is an asset to the properties of tellurite-based glasses due to the phonon reducing nature of the fluoride ions [2, 3]. These materials exhibit better photoluminescence phenomena and are known for efficient down and upconversion processes. As the base matrix can yield excellent properties for the up and down conversions, three ions were doped simultaneously to test the collective photoluminescence properties. The couple Er^{3+} and Yb^{3+} is already well known for the upconversion as well as for the development of optical amplifiers, because of erbium's large emission band around 1.54 μm and the efficient energy transfer process between Yb^{3+} and Er^{3+} ions acting as sensitiser and activators, respectively [4, 5]. The addition of Pr^{3+} may improve the 1.54 μm band of erbium expanding its span of operation.

Hence, in this work, barium lanthanum fluoro tellurite (BLFT) glasses are tri-doped with Er^{3+}, Yb^{3+} and Pr^{3+} ions and spectroscopic properties were investigated.

2 Experimental details The molar composition of rare earth doped BLFT glasses investigated in this work is $(60-(x+y+z))$ $TeO_2 + 20$ $BaF_2 + 10$ $LaF_3 + 10$ $SiO_2 + x$ $ErF_3 + y$ $YbF_3 + z$ PrF_3. The combination of dopant ions with their nomenclature is shown in Table 1. Glasses were prepared by the melt quenching technique. All the above weighed chemicals were well mixed and heated for 30 min in a platinum crucible at 900 °C in an electric furnace. The glasses were obtained by pouring the melt onto a preheated stainless steel plate and then annealed at 350 °C for 5 h to eliminate mechanical and thermal stress. The refractive indices n were measured by Brewster's angle method with He–Ne (632.8 nm) laser source. Densities were measured by the Archimedes's method using distilled H_2O as an immersion liquid. The optical absorption spectra were recorded in the UV–Vis–NIR regions on a double beam spectrophotometer (UV-2101/3101PC, Shimadzu Scientific Instruments Inc. USA). Fluorescence spectra were obtained by exciting the samples with 980 nm diode laser. The fluorescence was detected by passing through monochromator equipped with a InGaAs detector. For lifetime measurements, a mechanical chopper in conjunction with a Lecroy oscilloscope was employed.

3 Results and discussion Figure 1 shows the optical absorption spectra of single Er^{3+}, Er^{3+}–Yb^{3+} and Er^{3+}–

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Enhanced electromagnetic shielding behaviour of multilayer graphene anchored luminescent TiO_2 in PPY matrix

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ABSTRACT

Present research is focussed on the development of a novel composite material for highly-efficient absorption of electromagnetic interference (EMI) pollution. Herein, we report synthesis and characterization of polypyrrole (PPY) composite containing multi-layered graphene (MLG) anchored with titanium dioxide (TiO_2) via in-situ oxidative polymerization of pyrrole. The tuning of the microwave signals has achieved via composites with different weight ratios of MLG and TiO_2. The maximum Total shielding effectiveness (SE_T), 53 dB was observed for PPY/MLG/TiO_2 (5% composite) in the frequency range of 12.4–18 GHz. The observed results suggest that the composite material could be a new alternative for building block of electromagnetic shielding applications.

1. Introduction

Recent innovations in the field of electronic devices and our increased dependency on these products have amplified the need of error free electronic systems. These issues have encouraged scientists to develop materials that can shield the electronic devices against EM radiation [1,2]. Metal coated/plated polymers are the most widely used materials for EMI shielding because of their high conductivity. However, metal shields have poor flexibility, high weight, tendency to corrode, and limited tuning of the SE [3,4]. Literature survey shows that the conducting polymer composites offer various advantageous properties in the use of EMI shielding applications. PPY is a nitrogen based cyclic conducting polymer which offers good conductivity, environmental stability, and ease of synthesis [5,6]. However, conducting polymers lack in mechanical strength, it restricts their fabrication as an EMI shield for commercial applications. To overcome this, in the present work, dielectrics like TiO_2 are incorporated in the polymer matrix to enhance the absorption properties and thermal stability of these polymers (see Supporting information) [3,7] and multi layered graphene (MLG) is incorporated as a conductive reinforcing material. Therefore, PPY composite incorporated with MLG decorated with TiO_2 constitutes a new generation material with great potential for EMI shielding applications.

2. Experimental

MLG was synthesized using chemical exfoliation graphite in the acidic medium [8]. The TiO_2 nano particles were synthesized by sol–gel method [9]. In-situ polymerization of pyrrole was carried out for the synthesis of the composite. Initially, The MLG and TiO_2 nanoparticles were ultra-homogenized in a 0.3 M aqueous solution of Sodium Lauryl Sulphate with distilled pyrrole (0.1 M) for 2 h. The solution was polymerized using $FeCl_3$ (0.2 M). The solution is then filtered and the residue is dried at 60 °C. Several compositions of PPY:MLG:TiO_2 having weight ratios 1:0.01:0.01, 1:0.05:0.05, 1:0:0.05 and 1:0.05:0 were prepared. The schematic of the synthesis of the composite is shown in Fig. 1a.

3. Results and discussions

Fig. 1b shows the XRD pattern of PPY, MLG, TiO_2 and PPY/TiO_2/MLG. TiO_2 nanoparticles show the characteristic peaks at 2θ 25.36°, 36.24°, 37.84°, 39.41°, 48.12°, 54.08°, which correspond to the (1 0 1), (1 0 3), (0 0 4), (1 1 2), (2 0 0) and (1 0 5) crystal

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Enhanced Hydrogenation Properties of Size Selected Pd–C Core–Shell Nanoparticles; Effect of Carbon Shell Thickness

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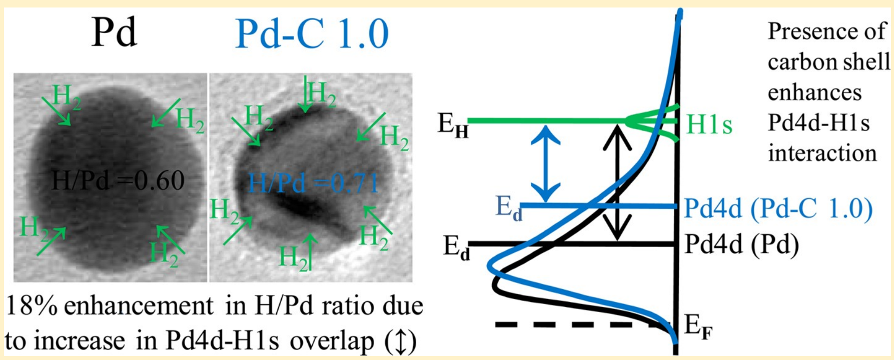

ABSTRACT: Effect of nanoparticle size and alloying has been well studied in Pd and Pd alloy nanoparticles and explained on the basis of modifications in the crystal structure and Pd 4d binding energy position. In the present study, the effect of carbon shell thickness on the hydrogenation properties of gas phase synthesized Pd–C core–shell nanoparticles having controllable nanoparticle core and shell thickness has been investigated. A large improvement in H/Pd ratio and increased hydrogen induced lattice expansion is observed in Pd–C nanoparticles. These results are explained on the basis of lowering of coordination number of Pd surface sites at Pd–C core–shell interface revealed by the increase in the Pd 4d binding energy on increase in shell thickness. By combining the modification in electronic properties due to the size and the alloying effects with that due to carbon shell thickness, as reported in the present study, Pd–H interaction can be significantly enhanced.

■ INTRODUCTION

Palladium, due to its favorable properties of hydrogen sticking, adsorption, chemisorption, and diffusion coefficient, is one of the best choices for hydrogen-related applications, such as production, storage, sensing, and catalysis. The size and surface of the nanoparticles have been shown to affect the Pd–H interaction.[1,2] Pd nanoparticles have shown improved Pd–H interaction and enhanced catalytic properties due to size-dependent shift of Pd 4d centroid and increased surface to volume ratio of atoms.[3−5] The smaller nanoparticles, due to higher surface to volume ratio, have a larger proportion of surface and subsurface sites which results in better Pd–H interaction.[2,4] Theoretical investigations have predicted that modified surface properties at Pd–C interface are favorable for Pd–H interaction.[6,7] Pd nanocrystallites dispersed in the carbon matrix, are observed to selectively detect hydrogen in the presence of methane.[8] Pd and Pd alloy nanoparticles dispersed on graphene layers exhibit enhanced response time in comparison to Pd.[9,10] It is well-known that the Pd 4d centriod position depends on nanoparticle size due to quantum confinement and changes in the coordination number of surface Pd atoms.[11,12] Pulsed molecular beam experiments on carbon free and carbon-containing Pd nanoparticles have shown marked facilitation of subsurface hydrogen diffusion in the latter.[13] Therefore, it is important to study hydrogenation properties of Pd nanoparticles having carbon shell. Different physical and chemical methods have been used to prepare the metal–carbon core–shell nanoparticles, in which both metal nanoparticle size and carbon shell thickness are undefined.[14−17] Palladium carbon core–shell nanospheres have been synthesized through reduction of $PdCl_2$ in ethanol system, in which core size is not controlled.[18] Palladium–carbon composite of core–shell structure has been prepared through simultaneous vaporization.[19] The growth of palladium–multilayer graphene core–shell nanoparticles with controllable core size but uncontrolled shell thickness has been reported.[20] In the present study, Pd–C nanoparticles having a well-defined nanoparticle size and carbon shell thickness prepared by gas phase synthesis technique have been used to investigate Pd–H interaction as a function of thickness of the carbon shell by carrying out X-ray

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Enhanced Hydrogenation Properties of Size Selected Pd–C Core–Shell Nanoparticles; Effect of Carbon Shell Thickness

Vinod Singh,[†,⊥] Bodh R. Mehta,[*,†] Saurabh K. Sengar,[†] Pawan K. Kulriya,[‡] Saif A. Khan,[‡] and Sonnada M. Shivaprasad[§]

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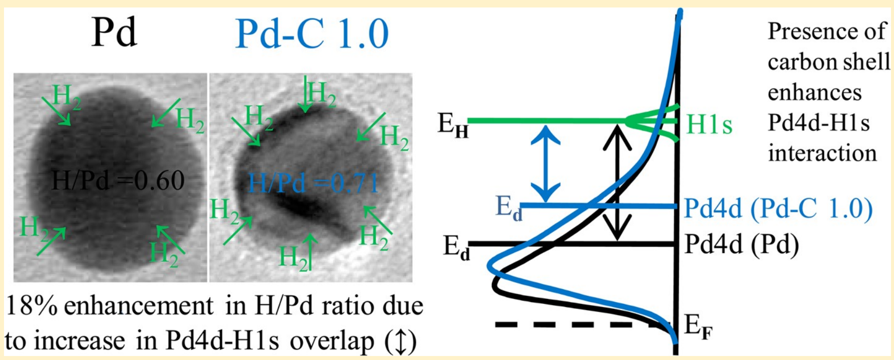

ABSTRACT: Effect of nanoparticle size and alloying has been well studied in Pd and Pd alloy nanoparticles and explained on the basis of modifications in the crystal structure and Pd 4d binding energy position. In the present study, the effect of carbon shell thickness on the hydrogenation properties of gas phase synthesized Pd–C core–shell nanoparticles having controllable nanoparticle core and shell thickness has been investigated. A large improvement in H/Pd ratio and increased hydrogen induced lattice expansion is observed in Pd–C nanoparticles. These results are explained on the basis of lowering of coordination number of Pd surface sites at Pd–C core–shell interface revealed by the increase in the Pd 4d binding energy on increase in shell thickness. By combining the modification in electronic properties due to the size and the alloying effects with that due to carbon shell thickness, as reported in the present study, Pd–H interaction can be significantly enhanced.

■ INTRODUCTION

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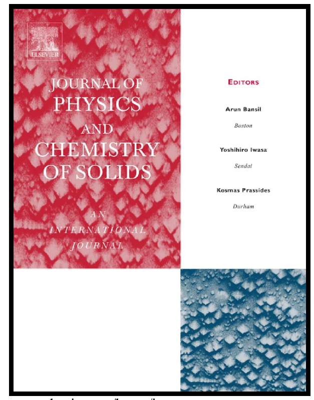

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Enhanced thermoelectric performance of spark plasma sintered copper deficient nanostructured copper selenide

Kriti Tyagi, Bhasker Gahtori, Sivaiah Bathula, M. Jayasimhadri, Niraj Kumar Singh, Sakshi Sharma, D. Haranath, A.K. Srivastava, Ajay Dhar

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Fano resonance in chains of dielectric nanoparticles with side-coupled resonator

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In this paper we study the resonant transmission through a waveguide formed by a periodically placed high-index dielectric nanoparticles with a side-coupled resonator. We show that a resonator with high enough *Q*-factor allows control of the signal transmission through a waveguide. We suggest a practical realization of such scheme that employs a multipole resonance of a dielectric particle with large radius.

1 Introduction

In the past few years we observe a rapid development of the field of all-dielectric nanophotonics aimed at the manipulation of optically-induced electric dipole (ED) and magnetic dipole (MD) resonances in dielectric nanostructures composed of nanoparticles with high refractive index [1–3]. ED and MD resonances were theoretically predicted [1, 4] and experimentally observed [2, 5] for particles with linear size less than the operating wavelength, and it was shown that their resonance frequencies depend on the particle size and shape. Owing to these properties and to very low losses in dielectric materials a lot of different optical nanostructured devices based on such nanoparticles were suggested [6–10]. Amidst them are chains of dielectric nanoparticles with high refractive index. These structures were suggested as a realization of optical waveguides with subwavelength light localization and low overall losses, required for design of highly efficient integrated photonic circuits [7, 11].

The common practical scheme that employs a coupling between an optical waveguide and a high-Q cavity was suggested for controling a light propagation and realization an optical bistable devices [12–14]. Most of studies were carried out for photonic crystal waveguides with different geometries and different types of cavities [15–18]. In this case the interference between the continuum of states (transmission band of a waveguide) and a discrete resonant state (resonance of a cavity) provides the conditions for the Fano-type resonance, that gives rise to sharp and assymetric line shapes, which reduces the frequency shift and the value of energies required for all-optical nonlinear switching, logic, and information processing.

In this work we study the resonant transmission of light in a waveguide formed by a chain of high-index dielectric nanoparticles with side-coupled defect nanoparticle. In contrast to photonic crystal waveguides, the considered structure is an open system and its guiding properties originate from the long-range coupling between the particles. Subwavelength size of the waveguide and the possibility to control light transmission makes it promising for designing the efficient optical integrated circuits.

2 Theoretical model

We consider a chain of closely spaced high-index dielectric nanoparticles with side-coupled defect nanoparticle as shown in Fig. 1. We fix the permittivity of dielectric particles $\mathrm{Re}(\varepsilon_p) = 16$ with small material losses $\mathrm{Im}(\varepsilon_p) = 0.02$, radius $R = 70\,\mathrm{nm}$ and the period of the chain $a = 140\,\mathrm{nm}$. The radius R_d, and the permittivity ε_d of the side-coupled particle vary for different cases.

For theoretical description of the considered system we use analytical approach when applicable,

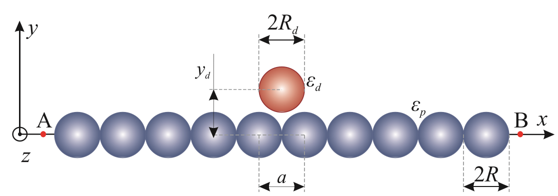

Figure 1: Chain of high refractive index dielectric nanoparticles with side coupled particle.

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Flexible Silk Fibroin Films for Wound Dressing

Chandra Mohan Srivastava, Roli Purwar*, Rekha Kannaujia[1], and Deepak Sharma[2]

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(Received January 5, 2015; Revised March 9, 2015; Accepted March 17, 2015)

Abstract: In the present study, an effort has been made to create dextrose incorporated (5-15 % w/w) flexible silk fibroin films for wound dressing applications. The flexibility of silk fibroin films increases with increase in dextrose content. The elongation at break properties of dextrose modified silk fibroin (DMSF) films increases from 3.2 % to 40 % with increase in dextrose content. The glass transition temperature (T_g) of the films decreases from 176 °C to 155 °C with increase in dextrose content. This shows that dextrose is acting as plasticizer for silk fibroin films. The structural and morphological properties of dextrose modified silk films (DMSF) are characterized by Fourier transform infrared spectroscopy (FTIR), X-ray diffraction (XRD) scanning electron microscopy (SEM) and atomic force microscopy (AFM). FTIR and XRD studies show that the dextrose content does not affect the crystalline structure of silk fibroin films. The surface roughness of the films also increases with increases in dextrose content in DMSF films. The addition of dextrose enhances the swelling and hydrophilicity of silk fibroin films. The adherence, proliferation and viability of L929 fibroblast cells cultured on DMSF films indicate that it has ability to support cell growth and proliferation as compared to SF film. The 15 % DMSF film showed significantly higher mass loss than SF film after 50 days of incubation in Protease XIV. Further, the data presented here constitute strong evidence that dextrose modified film has the great potential to be utilized as dermal wound dressing material.

Keywords: Silk fibroin, Wound dressing materials, Hydrophilicity, Cytocompatibility, Biodegradation

Introduction

The skin forms a self renewing and self repairing interface between the body and the environment. It provides an effective barrier against microbial invasion and has properties that can protect against mechanical, chemical, osmotic, thermal and photo damage [1]. Skin is composed of three structural layers, the epidermis, dermis and subcutis. Trauma to skin can be categorized into several degrees. The least damaging trauma relates to damage done at the epidermis layer and wound healing takes place via re-epithelialization. More serious trauma can lead to partial or complete damage of epidermis, dermis and subcutis layer of skin [2]. Wounds that extend partially through the dermis are capable of regeneration, but unfortunately the body can not heal deep dermal injuries adequately. With burn injuries arising from fire, accidents, terrorist attacks and an aging population (for chronic wound), there will always be a continual demand for skin regeneration products [3]. Many skin substitutes such as xenografts, allografts and autografts have been employed for wound healing. However, these approaches have many disadvantages such as higher cost, limited availability of skin grafts in severely burned patients, problems of disease transmission and immune response [2,4]. One strategy for dealing with serious skin damage is to develop tissue engineered skin substitute. Various synthetic and natural polymers such as chitosan, silk, collagen, poly(glycolic acid), poly(L-Lactic acid) and poly(lactic acid-co-glycolic acid) are currently being employed as tissue scaffolds for skin reconstruction [5,6].

Silk has been used in textile industries for centuries. The silk protein from silkworm *Bombyx mori* contains two fibroin proteins fibers held together by glue like protein called sericin. When sericin is presented to a body, it is detected as an antigenic factor by T-cells and causes immunologic reactions. Therefore, sericin is needed to be removed from cocoon fibers by a process called degumming. These degummed *Bombyx mori* silk fibroin exhibit unique properties as biomaterials. Fibroin was reported to be a perfect substrate for the proliferation and adhesion of large variety of cells. Silk fibroin has found diverse applications in the biomedical field, which can be attributed to its high tensile strength, controlled biodegradability, haemostatic properties, non-inflammatory characteristic [7-10]. To develop an ideal skin substitute, the performance of regenerated membranes from silk fibroin and its blends was examined by several researchers. Studies evaluated the biocompatibility of the membrane with fibroblasts and endothelial cells, which are the most important tissue repairing cells in healing. It was found that regenerated silk fibroin membrane does not show any toxicity [11] or genotoxicity [12]. Regenerated silk fibroin materials in the form of films, nano-fibrous membrane and woven textile have been employed as wound dressing for skin regeneration. Liu *et al*. [13] have explored the feasibility of using regenerated silk fibroin membrane to construct artificial skin substitute for wound healing. They observed that silk fibroin film does not have an adverse influence on the growth and biofunction of fibroblast and vascular endothelial cells. It also does not interfere with the secretion of angiogenesis

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1

Fundamental Forces in Particle Adhesion

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Abstract

van der Waals, capillary, and electrostatic forces acting at the interface between a particle and a surface drive the adhesion behavior of the particles. If one can describe the nature and the strength of these forces as a function of the properties of the two interacting solids and the intervening medium, it is possible to predict and, in many cases, to control particle adhesion. This chapter focuses on the factors that influence the nature and strength of the forces, the fundamental theories that describe them, and the relevant mathematical expressions required to quantify them, with a caveat that the analysis presented is limited to systems with ideal geometry. Specifically, more advanced analysis, which may account for aspects such as roughness, non-uniform shape, deformation, and other complicating aspects, is not treated.

Keywords: Particle adhesion, van der Waals force, Hamaker constant, electrostatic force, double layer, capillary force, surface tension, surface energy.

1.1 Introduction

Particle adhesion influences many areas of science and engineering, including semiconductor fabrication, pharmaceuticals, cosmetics, mining, separations, petroleum production, surface coating, and food processing, to name a few. In the context of this chapter, adhesion is an interfacial

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K.L. Mittal and Ravi Jaiswal (eds.) Particle Adhesion and Removal, (3–80)

1

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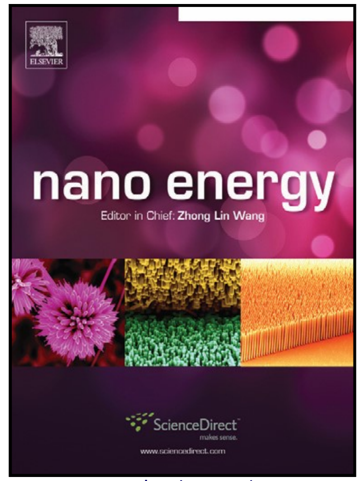

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Giant enhancement in thermoelectric performance of copper selenide by incorporation of different nanoscale dimensional defect features

Bhasker Gahtori, Sivaiah Bathula, Kriti Tyagi, M. Jayasimhadri, A.K. Srivastava, Sukhvir Singh, R. C. Budhani, Ajay Dhar

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Improved production of reducing sugars from rice straw using crude cellulase activated with Fe_3O_4/Alginate nanocomposite

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Abstract

Effect of Fe_3O_4 nanoparticles (NPs) and Fe_3O_4/Alginate nanocomposites (NCs) have been investigated on production and thermostability of crude cellulase enzyme system obtained by newly isolated thermotolarent *Aspergillus fumigatus* AA001. Fe_3O_4 NPs and Fe_3O_4/Alginate NCs have been synthesized by co-precipitation method and characterized through various techniques. In presence of Fe_3O_4 NPs and Fe_3O_4/Alginate NCs, Filter Paper activity of crude cellulase was increased about 35 and 40%, respectively in 72 h as compared to control. Fe_3O_4/Alginate NCs treated crude enzyme was thermally stable up to 8 h at 70 ^oC and retained 56% of its relative activity whereas; control samples could retain only 19%. Further, the hydrolysis of 1.0% alkali treated rice straw using Fe_3O_4/Alginate NCs treated cellulase gave much higher sugar

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Incorporating Information from Trusted Sources to Enhance Urban Navigation for Blind Travelers

Byung-Cheol Min[1], Suryansh Saxena[2], Aaron Steinfeld[1], and M. Bernardine Dias[1]

***Abstract*—Dynamic changes can present significant challenges for visually impaired travelers to safely and independently navigate urban environments. To address these challenges, we are developing the NavPal suite of technology tools [1]. NavPal includes a dynamic guidance tool [2] in the form of a smartphone app that can provide real-time instructions based on available map information to guide navigation in indoor environments. In this paper we enhance our past work by introducing a framework for blind travelers to add map/navigation information to the tool, and to invite trusted sources to do the same. The user input is realized through audio breadcrumb annotations that could be useful for future trips. The trusted sources mechanism provides invited trusted individuals or organizations an interface to contribute real-time information about the surrounding environment. We demonstrate the feasibility of our solution through a prototype Android smartphone-based outdoor navigation aid for blind travelers. An initial usability study with visually impaired adults informed the design and implementation of this prototype.**

I. Introduction

The World Health Organization (WHO) estimates that 285 million people in the world are visually impaired, of whom 39 million are blind [3]. Although safe and independent mobility is a critical element of modern life, our needs assessment over the past few years [1] revealed that due to limited tools and information, traveling in unfamiliar environments can be challenging and often daunting for visually impaired people. We envision smart cities of the future that are truly accessible and navigable by everyone, including people with disabilities. These future smart cities are likely to benefit from assistive robots and a variety of other technology that could potentially enhance the safety and independence of visually impaired people during urban travel. However, smartphones are still likely to be the primary modality that connects visually impaired travelers to these other technology solutions and smart infrastructure in future smart cities.

To realize this vision of accessible smart cities, we are developing the "NavPal" suite of technology tools that combine a variety of technologies including robots, crowdsourcing, advanced path-planning and multi-modal interfaces to enhance the safety and independence of visually impaired people navigating urban environments [1], [2]. A key component of our work on accessibility and navigation is our commitment to a human-machine solution where humans and technology work together to achieve the best outcomes possible in any given scenario. In this paper, we explore three ways in which blind users can be empowered to influence their assistive navigation aids - first, by adding audio annotations for themselves to use at future times; second, by choosing to share useful information with others who invite them as trusted sources; and third, by inviting trusted sources of relevant information to influence their navigation decisions. The contribution of this work is therefore a framework to empower blind travelers to influence their technology-based navigation aids via audio breadcrumb annotations and relevant information from user-designated trusted sources.

The remaining sections of this paper are organized as follows. In section II, related work from the literature is discussed. Our system architecture and iterative design process are presented next in sections III and IV respectively. In section V, we describe our mechanism to insert audio breadcrumbs and to invite trusted sources. Sections VI and VII detail relevant use-case scenarios for audio breadcrumb annotations and trusted sources. Finally, section VIII concludes this paper with a summary of the presented work, a discussion of the strengths and limitations of our approach, and an outline of relevant future work.

II. Related Work

Assistive technologies have played an essential role in the safety and independence of people with disabilities. Long white canes, dog guides [4], and smartphones [2], [8], [9] are current assistive tools that are widely used by visually impaired people to aid in navigation. Several research efforts have also created a variety of guide robots [5], [6], [7] for this purpose.

A white cane is the most ubiquitous and universally identifiable navigation tool for visually impaired travelers and is used to detect and avoid obstacles and warn others in the path of travel [10]. A dog guide is another modality that visually impaired travelers often employ for the purpose of guidance in navigation. A white cane and dog guide have proven useful, but do not include a point-to-point navigation (route planning from a starting point to the intended destination) capability that is often necessary for visually impaired people to navigate safely and independently in unfamiliar environments.

In recent years, the use of smartphones has grown rapidly in visually impaired communities as they become more affordable and integrate several key functions needed for their daily life such as text-to-speech, gesture recognition, and localization using sensors. This follows similar trends showing rapid increases in smartphone market share [11].

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Journal of Applied Polymer Science

Influence of Microcapsule Shell Material on the Mechanical Behavior of Epoxy Composites for Self-Healing Applications

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ABSTRACT: In this article, we have studied the effect of microcapsule shell material on the mechanical behavior of self-healing epoxy composites. Liquid epoxy healant was encapsulated in melamine-formaldehyde (MF) and urea-formaldehyde (UF), using emulsion polymerization technique to prepare microcapsules of different shell walls. The core content of the microcapsules, as determined by solvent extraction technique was found to be $65 \pm 4\%$, irrespective of the shell wall of microcapsule. Morphological investigations reveal a rough texture of the spherical microcapsules, which was attributed to the presence of protruding polymer nanoparticles on the surface. Epoxy composites containing UF and MF microcapsules (3–15% w/w) were prepared by room temperature curing and their mechanical behaviour was studied under both quasi-static and dynamic loadings. The tensile strength, modulus, and impact resistance of the matrix was found to decrease with increasing amount of microcapsule in the formulation, irrespective of the shell wall material used for encapsulation. Interestingly, substantial improvement in the fracture toughness of the base resin was observed. Morphological investigations on the cracked surface revealed features like crack pinning, crack bowing, microcracking and crack path deflection, which were used to explain the toughened nature of microcapsule containing epoxy composites. Our studies clearly indicate that the microcapsule shell wall material does not play any significant role in defining the mechanical properties of the composites. In addition, presence of secondary amine functionalities in UF and MF shell wall do not interfere with the reaction of epoxy with triethylene tetramine hardener during the curing process. © 2014 Wiley Periodicals, Inc. J. Appl. Polym. Sci. **2014**, *131*, 40572.

KEYWORDS: composites; morphology; structure-property relations

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INTRODUCTION

The last few years have seen major advances in the field of smart polymeric materials, which respond autonomically to a specific stimulus, due to their "in situ" functionality.[1,2] Self-healing polymers belong to a sub-category of such smart materials, where the primary objective is complete repair of minor damage in the absence of any manual intervention. In this case, the propagating crack acts as the mechanical triggering stimulus, and the response is the process of autonomic repair of the resultant damage.[2]

While several general self-healing strategies have been investigated, one of the most successful and versatile approach utilizes the introduction of fragile microcapsules filled with a liquid healing agent,[3–7]within the polymeric matrix. When the propagating crack ruptures the embedded microcapsules, the healing agent is slowly released into the crack plane through capillary action, which undergoes polymerization to reestablish the structural integrity across the crack plane. Depending on the type of healing agent employed, it may undergo polymerization by ring opening reaction (ROP), e.g., ROP of dicyclopentadiene (DCPD) with organometallic catalyst[8] or alternatively, the healing agent may be chosen to undergo curing reaction with the chemical agents encapsulated separately.

Different containment structures have been explored for encapsulating liquid healing agents, and presently, urea-formaldehyde (UF) and melamine-formaldehyde (MF) are most commonly used in view of their reasonable cost, adequate strength and long shelf-life. Studies on the mechanical behavior of isolated liquid filled microcapsules have highlighted significant differences in the mechanical behavior between UF and MF microcapsules,[9,10] however, both exhibit a clear bursting phenomenon upon compression, with the extent of deformation being much lesser in the UF based microcapsules.[11]

Due to the fragile nature of microcapsules, their inclusion into the polymeric resin results in substantial deterioration in the

Additional Supporting Information may be found in the online version of this article.

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Input impedance of small antenna provides Purcell factor

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The Purcell effect, which consists in change of a spontaneous decay rate, is a fundamental effect in a quantum electrodynamics of a quantum source–resonator interaction. However, a spontaneous decay effect is not a purely quantum phenomenon and is well known in classical physics. In this article the expression for the Purcell factor calculation through imaginary part of the Green's function in relation to small dipole antenna is obtained. Developing this concept, we propose a new methodology of calculation and measurement of an electric and magnetic Purcell factor through an input impedance. The results of experimental verification of the proposed method in a microwave range are presented.

1 Introduction

The Purcell effect is a change in an excited state lifetime of the quantum source depending on the conditions of its environment [1–10]. The excited state lifetime τ is inversely proportional to the spontaneous decay $\gamma = 1/\tau$. The possibility of such modification was first pointed out by E. M. Purcell [1] in 1946 in relation to the nuclear magnetic resonance. The Purcell effect is one of the fundamental effects in quantum electrodynamics [4]. At present, this effect is widely used in microcavity light-emitting devices [11, 12], in the single-molecule optical microscopy [13–16], microscopy of single NV centers in nanodiamonds [17], of Eu^{3+}-doped nanocrystals [8] and for visualization of biological processes with participation of large molecules, such as DNA [18].

In the cavity quantum electrodynamics, there are two limiting regimes: weak and strong coupling [19]. These regimes are different by comparing the so-called atom–field coupling constant $\chi = (|\mathbf{d}|^2\omega_0/(2\hbar\varepsilon_0 V))^{1/2}$ with the decay rate of the photon in a cavity γ_{cav}. Here ω_0 and $\mathbf{d} = e\langle 2|\mathbf{r}|1\rangle$ are the atomic transition frequency and its dipole moment (matrix element), respectively, e is an electron charge, V is the volume of the resonator mode, ε_0 is dielectric constant. In the weak-coupling regime, when $\chi \ll \gamma_{\mathrm{cav}}$, the ratio of the decay rate γ in inhomogeneous environment to the one in free space γ_0 can be written as [19]:

$$F \equiv \frac{\gamma}{\gamma^0} = 1 + \frac{6\pi\varepsilon_0}{|\mathbf{d}|^2}\frac{1}{q^3}\mathrm{Im}[\mathbf{d}^* \cdot \mathbf{E}_{\mathrm{s}}(\mathbf{r}_{\mathbf{d}})], \qquad (1)$$

where $\gamma^0 = \omega_0^3|\mathbf{d}|^2/(3\pi\varepsilon_0\hbar c^3)$ [19], $q = \omega/c$ is wavenumber in free space, $\mathbf{E}_{\mathrm{s}}(\mathbf{r}_{\mathbf{d}})$ is the magnitude of an electric field scattered from an inhomogeneous environment at the source. The quantity F is called the Purcell factor (PF). In the weak-coupling regime, the magnitude of the PF does not depend on the magnitude of $\mathbf{d}$, because the scattered field value is directly proportional to the dipole moment. In addition, the expression for the PF in the classical problem formulation is similar to (1) up to replacing the transition matrix element by the dipole moment, following the correspondence principle [20].

In practice, the value of the PF is usually measured by the direct method of the time-resolved photoluminescence [9] or indirectly, for example, by Raman spectroscopy [22]. High values of F can be achieved by using the nanoantennas, i.e. devices that effectively convert the near field of quantum sources to propagating optical radiation [23, 24]. This transformation is carried out by impedance matching between quantum source and nanoantenna [25–28]. Moreover, quantum source has large values of the PF [defined as (1)] in hyperbolic metamaterials (see, for example, Ref. [9]).

In this paper, we looked at the Purcell effect from another viewpoint. Namely, we study the Purcell effect within the classical framework, since it is known that a spontaneous decay effect is *not a purely quantum phenomenon* [29, 30]. Developing

Just in Time Implementation Issues in Indian Corrugated Packaging Industries

An empirical study in Natioanl Capital Region (NCR)

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***Abstract*—Just in time is an advanced manufacturing philosophy, which is practiced all over the world by organizations to achieve excellence in their performance. As most of the Original Equipment Manufacturers (OEM) are managing their supplies on JIT basis, their vendors are under tremendous pressure to adopt JIT. The JIT principles seems easy to adopt, yet many organizations fail to implement it. The implementation of JIT requires a radical change in the way of working at all level of the organization starting from top management to maintaining good customer relations. Indian Corrugated Packaging Industries play a very important role especially at the final dispatch of the product. This research paper tries to find out the readiness of ICPI for the implementation of JIT. Also it tries to find out whether the type of company matters in the implementation of JIT. The survey was conducted in companies in National Capital Region (NCR) of India, mainly Delhi, Noida, Ghaziabad, Gurgaon and Faridabad. The implementation readiness of these companies based on company type was analyzed using analysis of variance (ANOVA). The result shows that there was a distinction between industries type (family owned, Private Limited and Limited) and level of JIT implementation. Further the Friedman test was used to find out the predominant principle in each type of the industries. The purpose of this study is to provide a roadmap to Indian Corrugated Packaging Industries to implement JIT successfully. The contribution of this paper is the identification of the implementation JIT issues for ICPI as well as the status of these companies based on their classification. The results of this study is matching with studies in other type of components, proving the universal nature of JIT principles.**

Keywords: JIT, JIT implementation, Indian Corrugated Packaging Industry, ANOVA, Friedman test

I. Introduction

In today's competitive global business environment, the goal of all manufacturing systems is long-term survival. A manufacturing company's survival in an increasingly competitive market closely depends upon its ability to produce highest quality product at lowest possible cost and in a timely manner with shortest possible lead-time. The booming Indian economy and a flourishing organized retail have raised the expectations that consumption of corrugated packaging will begin to expand again as the number and volume of goods packaged in corrugated increases. MNCs are demanding corrugated boxes of international standards as the pattern of buying the packaging is changing. Prices of corrugated sheet and corrugated boxes have remained low due to the overcapacity, manual operations and low productivity. Besides, transport constraints and high freight costs have meant that small to medium sized corrugated box plants are located near the customers. Strong competition and the high demands of consumer goods companies for just –in-time delivery together with high standards of product and service quality are

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Luminescent properties of orange emissive Sm^{3+}-activated thermally stable phosphate phosphor for optical devices

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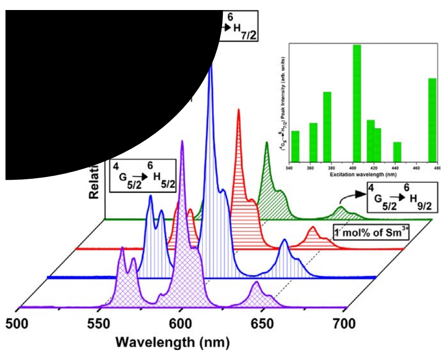
HIGHLIGHTS

- Successfully synthesized Sm^{3+} doped $NaCaPO_4$ (NCP) phosphors.
- Structural and luminescent properties have been investigated.
- Strongest excitation peak nearly matches with the emission of GaN based LEDs.
- CIE coordinates of Sm^{3+}:NCP phosphor indicate pure orange emission.
- Sm^{3+} doped NCP is suitable for UV based pc-LEDs and other optoelectronic devices.

GRAPHICAL ABSTRACT



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ABSTRACT

Rare earth ion activated orthophosphates have a great deal of interest due to their thermal stability for white light emitting diodes. In this regard, thermally stable Sm^{3+} doped $NaCaPO_4$ (NCP) phosphor was synthesized by conventional solid state reaction technique. The phase and the structure of the as prepared powders were characterized by X-ray diffraction (XRD), field emission scanning electron microscope (FE-SEM), FT-IR, emission and excitation properties were extensively investigated for NCP phosphors. X-ray diffraction analysis confirmed the formation of $NaCaPO_4$ with orthorhombic structure. The excitation spectra indicate that this phosphor can be effectively excited by UV light from 350 to 500 nm. All the transitions in the excitation spectrum of Sm^{3+} start from the ground state $^6H_{5/2}$ to various excited states. The emission spectra indicated that the emitted radiation was dominated by the emission peak wavelength at 599 nm originated from the transition of $^4G_{5/2} \rightarrow {}^6H_{7/2}$. The optimum concentration of Sm^{3+} is determined as 1.0 mol% based on the concentration dependent emission spectra. These results suggest that the $NaCaPO_4$:Sm^{3+} phosphor is a promising orange emitting phosphor under 404 nm excitation with CIE coordinates of $x = 0.545$, $y = 0.41$, which might be used in the development of materials for LED's and other optical devices in the visible region.

Introduction

Considerable attention has been paid recently to the solid state lighting due to its great potential to significantly surpass the energy efficiencies of traditional incandescent and fluorescent lighting [1–6]. In general, there are several ways to make white LEDs. The present strategy to produce white light utilizes combination of blue LED with yellow luminescence from $Y_3Al_5O_{12}$:Ce^{3+}(YAG:Ce^{3+}) phosphor materials [7,8]. However, there is a possibility to obtain white light emission in different crystalline hosts with single phased phosphors by mixing of blue, cyan and orange emitting

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Mechanistic analysis elucidating the relationship between Lys96 mutation in *Mycobacterium tuberculosis* pyrazinamidase enzyme and pyrazinamide susceptibility

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Supplement

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Yi-Ping Phoebe Chen and Hsien-Da Huang
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Abstract

Background

Pyrazinamide (PZA) is one of the most effective first line treatments against tuberculosis disease. The drug generally has bacteriostatic action. It also acts on bacterial spores which eliminates the chances of resurfacing of the infection. However, in recent years there has been a major increase in the occurrence of drug resistant bacterial strains. Resistance against PZA is caused by mutations in pyrazinamidase (PncA) protein which is the activator of the prodrug PZA. In the present study, we have tried to gain insights into the mechanism by which resistance develops due to K96R mutation occurring in the PncA catalytic region

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Mediator-free Total Cholesterol Estimation using Bi-enzyme Functionalized Nanostructured Gold Electrode

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Abstract

We report the fabrication of bienzyme functionalized nanostructured Au electrode for the mediator-free determination of total cholesterol. The one-step electrochemical route for the synthesis, functionalization and deposition of Au nanostructures via electroreduction of gold chloride onto the indium tin oxide (ITO) coated glass plates has been proposed. The covalent biofunctionalization of the optimized Au electrode has been done with cholesterol esterase (ChEt) and cholesterol oxidase (ChOx) to investigate the kinetic parameters and the sensing characteristics. The ChEt-ChOx/Glu-NanoAu/ITO bioelectrode shows surface-controlled electrode reaction with electron transfer coefficient and charge transfer rate constant of 0.68 and 7.09 s^{-1}, respectively. Under the optimal conditions, the bioelectrode undergoes direct electron transfer reaction and exhibits high sensitivity of 0.53 A M^{-1} cm^{-2} and low detection limit of 1.57 µM for cholesterol ester without use of any redox mediator. In addition, the kinetic analysis reveals that the bioelectrode exhibits surface concentration as 8.82×10^{-12} mol cm^{-2}. The sensor has also been validated with clinical samples. The proposed biosensor shows good sensitivity, stability and selectivity towards total cholesterol and may thus find implications towards the fabrication of a biosensing device.

Keywords: gold chloride, electrochemical synthesis, kinetic analysis, total cholesterol biosensor, mediator-free

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Microencapsulated cardanol derived benzoxazines for self-healing applications

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ABSTRACT

Benzoxazine (Bz) monomer was synthesized from renewable cardanol, a by-product from cashew-nut industry, using a solventless approach. The monomer was encapsulated in poly(styrene) (PS) shells by solvent evaporation technique to obtain spherical microcapsules. The microcapsule dimensions and core content could be tailored by optimizing the operating parameters, particularly stirring speed and PS concentration. Successful demonstration of this simple and versatile methodology widens the scope for large-scale application of benzoxazines in the field of self-healing.

1. Introduction

Polybenzoxazines belong to a class of phenolic thermosetting resins, which exhibit interesting properties, mainly zero-volume shrinkage, low water absorption, high thermal stability and chemical resistance, high glass transition temperature (T_g), long shelf life and self-curing characteristics. Benzoxazine precursors hold enormous potential as healing agents in self-healing compositions [1], provided they are encapsulated in fragile microcontainers, prior to their inclusion in the polymeric matrix. Surprisingly, attempts towards usage of oxazine monomers for this purpose have not been reported till date. Presently, dicyclopentadiene (DCPD) is the most common healing agent used for self-healing applications, which undergo ring opening metathesis polymerization in the presence of organometallic catalysts [2]. Although, compositions based on encapsulated DCPD have reached the stage of commercial maturity, in view of the exceptionally high cost of the organometallic catalyst, it is desirable to explore alternate healing agents.

Benzoxazines, interestingly, do not require any catalyst for their curing, and hence are ideal candidates for the aforementioned purpose. What makes these materials even more attractive is the possibility of deriving these monomers from renewable sources like cardanol; a by-product of the cashew nut processing industry [3–5]. Benzoxazines undergo thermally activated ring-opening polymerization (ROP) reaction at elevated temperatures and it is possible to alleviate the curing conditions by making structural modifications. Recently, Lochab et al. have successfully reduced the Bz–C curing temperature from 242 to 161 °C by blending with oxazines containing higher and acidic functionalities [6]. Other functional groups such as allylic [7], methylol [8] etc. has also been reported to lower the curing temperature.

Unfortunately, the possibility of curing of Bz monomers under acidic conditions imposes a restriction on the technique used for its encapsulation. The conventional micro-encapsulation procedure involves in-situ emulsion polymerization of urea or melamine with formaldehyde on the surface of the hydrophobic dispersed phase of the precursor [9]. The condensation process requires low pH (<3); [2,10] but the acidic conditions may induce curing in Bz [11]. We believe that this issue can be addressed by encapsulating Bz in soluble polymers by solvent evaporation, which surprisingly has not been attempted till date.

In this paper, we demonstrate a technique for physical encapsulation of cardanol derived Bz in PS shells. We adopt a "green" approach for the synthesis of cardanol based benzoxazines (Bz–C), where the role of cardanol is extended to that of a reactive diluent. This is followed by its encapsulation in PS microcapsules. Of particular interest is to investigate the effect of operating parameters to arrive at optimized conditions for preparation of microcapsules.

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Mixed Solution Strategy for MCGDM Problems Using Entropy/Cross Entropy in Interval-Valued Intuitionistic Fuzzy Environment

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Although several weight determining methods have been studied for multiple criteria group decision making (MCGDM) problems under intuitionistic fuzzy environment, in the present study, besides the criteria values provided by the decision makers (DMs), we propose to also use the historical data of alternatives-criteria to compute the criteria weights. This is a reasonable thought as the past information may influence the decision makers' choice of entries in their respective alternatives-criteria decision matrices. To this aim, we introduce a novel mixed solution strategy to derive the criteria final weight vector. Initially, the alternatives-criteria decision matrices provided by the DMs are taken to involve interval-valued intuitionistic fuzzy numbers (IVIFNs). The entropy measure for IVIFNs, studied by Ye [2010a], is used to aggregate these decision matrices. We also introduce a new definition of cross entropy for IVIFNs and used it to rank the alternatives. Finally, an example is presented to illustrate the proposed approach.

Keywords: Multiple criteria group decision making; interval-valued intuitionistic fuzzy number; weight vector; entropy; cross entropy.

Subject Classification: 90B50, 62C25

On the Assessment of Segmentation Methods for Images of Mosaics

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- Gianfranco Fenu, Nikita Jain, Eric Medvet, Felice Andrea Pellegrino, Myriam Pilutti Namer
- Google Scholar

The present paper deals with automatic segmentation of mosaics, whose aim is obtaining a digital representation of the mosaic where the shape of each tile is recovered. This is an important step, for instance, for preserving ancient mosaics. By using a ground-truth consisting of a set of manually annotated mosaics, we objectively compare the performance of some existing recent segmentation methods, based on a simple error metric taking into account precision, recall and the error on the number of tiles. Moreover, we introduce some mosaic-specific hardness estimators (namely some indexes of how difficult is the task of segmenting a particular mosaic image). The results show that the only segmentation algorithm specifically designed for mosaics performs better than the general purpose algorithms. However, the problem of segmentation of mosaics appears still partially unresolved and further work is needed for exploiting the specificity of mosaics in designing new segmentation algorithms.

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Ontology Based Framework for Automatic Software's Documentation

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Abstract— Over the last few years, research has continuously shown integration among research fields of Software Engineering and Semantic Technologies when development teams are present at different geographical and virtual locations. Their integration has opened fresh opportunities for development teams to develop software using Semantic Technologies. However, as opportunity comes so as the issues and challenges. Issues and challenges,which will keep this integrated field dynamic and lively for years to come. Among such issues, one is to automate the process software's documentation using ontologies. This paper presents a framework as well as implementation approach for the above issue.

Keyword—Automatic, Documentation, Ontology, Semantic Web, Software Engineering

NOMENCLATURE

NLP- Natural Language Processing
ML- Machine Learning
OWL- Web Ontology Language
RIF- Rule Interchange Format
LODE- Live OWL Documentation Environment
HTML- Hyper Text Markup Language

I. INTRODUCTION

Over the last few years, research has continuously shown integration among research fields of Software Engineering and Semantic Technologies. The reason for integration among above research fields was to discover mechanism for 'reusing' and 'sharing' of software engineering knowledge when development teams are present at different geographical and virtual locations. In the absence of mechanism for reusing and sharing of software engineering knowledge, the development process faced many problems and resulted into the generation of inconsistent information. This inconsistency is further followed by the development of undesired software. Research has overcame this problem by applying semantic web techniques to the field of software engineering because semantic web allows reusing and sharing of data across various community boundaries [1]. In this regard, Ontology, which is one of the components of semantic web and is formal and explicit specification of a shared conceptualization [2], played the important role for solving many issues that aroused due to this integration. However, this integration still possesses various issues and challenges that are still need to be addressed. Issues and challenges, which will keep this integrated field dynamic and lively for years to come [3], [4]. Among such issues, one is to automate the process of software's documentation using ontologies.

Documentation is a critical activity in software development process. Documentation helps in maintenance and reverse engineering activity as it helps in understanding the software. However due to cost and schedule constraint along with the complexity of software system, documentation is often ignored. This ignorance becomes a critical problem and results into a drastically increased cost for maintenance and reverse engineering activity. When we have ontology based software development, automation of documentation process can be achieved.

In ontology based software development, documentation ontology can be used for automation of documentation process. Documentation ontology defines all the concepts that are expected to appear in documentation file. It can consist concepts related to various documents generated during various phases of software development. Documents such as formal specification, context diagram, data flow diagram generated during requirement engineering phase; flow chart, entity relationship diagrams generated during design phase; source code listing, cross- reference listing generated during source code implementation phase; test data, test result generated during testing phase [5],[6], [7]. We can take help from application domain ontology, software architecture ontology and software artifact ontology in developing this documentation ontology. Application domain ontology represents all the knowledge about a particular domain. It also represents the relationships that exist between various concepts, which are used to represent the domain[8], [9], [10], [11], [12]. Software architecture ontology models the architecture related concepts, which are used to represent structure of the software system. It also includes concepts for elements or components of software system along with their properties and relationship. It can include architecture style

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Optimisation of biodiesel production from bitter groundnut oil using Taguchi method and its performance and emissions characteristics on a 4-cylinder Tata Indica engine

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Abstract: In this study, the production, performance and emission characteristics of biodiesel blends produced from bitter ground nut oil were compared to the diesel fuel. In first part of research, the production of biodiesel from bitter groundnut oil and optimisation of process parameters were undertaken. In second part, performance of 4-cylinder Tata Indica diesel engine has been studied at different engine speeds. During engine performance tests, the biodiesel blends showed higher brake specific fuel consumption and exhaust gas temperature, while marginally lower brake power, torque and brake thermal efficiency than the diesel fuel were noticed. Engine emissions showed higher carbon dioxide and nitrogen oxide releases, but decreased amount of carbon monoxide for biodiesel blends compared to the diesel fuel. From the experimental results, it is clear that the bitter groundnut oil-based biodiesel can also be used in a CI engine without any modifications.

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Pointwise approximation by Bernstein type operators in mobile interval

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ABSTRACT

In the present paper, we study pointwise approximation by Bernstein–Durrmeyer type operators in the mobile interval $x \in \left[0, 1-\frac{1}{n+1}\right]$, with use of Peetre's K-functional and $\omega^2_{\varphi^\lambda}(f,t)\,(0 \leqslant \lambda \leqslant 1)$, we give its properties and obtain the direct and inverse theorems for these operators.

1. Introduction and axillary results

In the year 2008, the operators $\tilde{B}_n$, were introduced and studied by Deo et al. [6] and defined as:

$$\tilde{B}_n(f,x) = \sum_{k=0}^{n} p_{n,k}(x) f\left(\frac{k}{n}\right), \tag{1.1}$$

where

$$p_{n,k}(x) = \left(1+\frac{1}{n}\right)^n \binom{n}{k} x^k \left(1-\frac{1}{n+1}-x\right)^{n-k} \tag{1.2}$$

and $x \in \left[0, 1-\frac{1}{n+1}\right]$. If n is sufficient large then operators (1.1) convert in the classical Bernstein operators:

$$B_n(f,x) = \sum_{k=0}^{n} \binom{n}{k} x^k (1-x)^{n-k} f\left(\frac{k}{n}\right). \tag{1.3}$$

Now we consider Durrmeyer type operators

$$V_n(f,x) = \frac{(n+1)^2}{n} \sum_{k=0}^{n} p_{n,k}(x) \int_0^{\frac{n}{n+1}} p_{n,k}(t) f(t)\,dt. \tag{1.4}$$

In 2003, a very interesting general sequence of linear positive operators was introduced by Srivastava and Gupta [18] and investigated as well as estimated the rate of convergence. Then the faster rate of convergence was studied by Deo [2] for

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Preparation of flexible zinc oxide/carbon nanofiber webs for mid-temperature desulfurization

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Desulfurization

ABSTRACT

Polyacrylonitrile (PAN) derived carbon nanofiber (CNF) webs loaded with zinc oxide (ZnO) were synthesized using electrospinning and heat treatment at 600 °C. Uniformly dispersed ZnO nanoparticles, clarified by X-ray diffraction and scanning electron microscopy, were observed on the surface of the nanofiber composites containing 13.6–29.5 wt% of ZnO. The further addition of ZnO up to 34.2 wt% caused agglomeration with a size of 50–80 nm. Higher ZnO contents led the concentrated ZnO nanoparticles on the surface of the nanofibers rather than uniform dispersion along the cross-section of the fiber. The flexible composite webs were crushed and tested for hydrogen sulfide (H_2S) adsorption at 300 °C. Breakthrough experiments with the ZnO/CNF composite containing 25.7 wt% of ZnO for H_2S adsorption showed three times higher ZnO utilization efficiency compared to pure ZnO nano powders, attributed to chemisorption of the larger surface area of well dispersed ZnO particles on nanofibers and physical adsorption of CNF.

1. Introduction

Zinc oxide (ZnO) has been widely used to remove hydrogen sulfide (H_2S), which is one of toxic gases to degrade industrial facilities and pollute environment. Even though various adsorbents such as metal oxides [1], metal oxide modified alumina [2,3], and zeolites [4,5] were applied to remove H_2S at relatively high temperature range from 500 to 800 °C, ZnO is recognized to be the most effective adsorbent under hot gas stream condition [6–8]. The volatility of Zn at reducing environment over 600 °C has been known as a serious drawback so that the effort to reduce the reaction temperature using ZnO nanoparticles has been studied because they are much more reactive due to the increased surface area and enhanced gas diffusion characteristics [9–11]. However, it is known that aggregations of ZnO nanoparticles can be formed even at 300 °C due to relatively unstable characteristics of ZnO, which reduces efficient surface area for adsorption of H_2S [9]. Therefore, ZnO nanoparticles on stable supports such as Al_2O_3, silica, and carbon have been investigated to increase the thermal durability of ZnO nanoparticles [10–14]. Desulphurization takes place on ZnO as following well-known reaction [6].

$$ZnO(s) + H_2S(g) \rightarrow ZnS(s) + H_2O(g) \quad (1)$$

Fang et al. reported activated carbon (AC) supported metal oxides as H_2S adsorbents [15]. Metal precursors (1 wt%) were impregnated into commercial AC in solution, and heat treatment at 300–450 °C for 4 h led to the adsorbents, showing as high as 125 min in breakthrough time. Even though similar *ex situ* loadings of metal oxides on carbon materials were studied, there was a limitation on uniform dispersion of a large amount of metal nanoparticles, which is critical to minimize the fixed cost on facilities [16,17]. Previously, we reported well dispersed ZnO nanoparticles, loaded on reduced graphene oxide, showing significantly high breakthrough time in H_2S adsorption test at 300 °C without any aggregation of ZnO nanoparticles [9].

In this study, we report *in situ* preparation of ZnO nanoparticles dispersed on nanofibers using simple and fast electrospinning for

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Protein functionalized Pt nanoparticles-conducting polymer nanocomposite film: Characterization and immunosensor application

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Pulse Width Modulator using CDBA based relaxation oscillator

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***Abstract*— This paper presents a pulse width modulator (PWM) designed using current differencing buffered amplifier (CDBA) based relaxation oscillator.The theoretical propositions are verified through SPICE Simulations Experimental results are also presented which are in tune with the proposed theory.**

***Keywords*— CDBA; PWM; Relaxation Oscillator**

I. INTRODUCTION

Pulse width modulation is a modulation technique that controls the pulse duration, based on modulator signal information. This technique is widely used to encode information for transmission, to control speed of DC motors, to control the power supplied to electrical devices, and in photovoltaic solar battery chargers.[1-3].A Pulse width modulated signal in simplest way can be generated by comparing a reference signal with a sawtooth or triangular waveform. The circuit generating pulse width modulated signal is known as pulse widthe modulator (PWM). The pulse width modulation scheme can be implemented using a simple relaxation oscillator [4], which can be designed using analog building blocks (ABB). The PWM designed using operational amplifier (op-amps) [5], have a limitation on their high frequency operations due to lower slew rate and constant gain-bandwidth product of the op-amps. [6]. The current conveyor II (CCII) based PWM generator has been presented in [6] whereas OTA based PWM circuit configurations are proposed in [7]. These PWM generators use excessive number of active elements. In [8] an operational transresistance amplifier based PWM is presented.

Recent advancements in current mode techniques have resulted in emergence of the current differencing buffered amplifier (CDBA) as an alternate analog building block. The input terminals of CDBA are internally grounded, thereby eliminating response limitations due to parasitic capacitances and resistances and hence is appropriate for high frequency operation. It provides further flexibility to the designers, enabling a variety of circuit designs, as it can operate in both current and voltage mode [9].

In recent past CDBA has been extensively used for realizing a number of linear applications such as filters [10-12], oscillators [13,14], and immittance simulation circuits [15] but to the best of authors' knowledge CDBA has not been used extensively to develop nonlinear applications. Therefore, this paper aims at presenting a nonlinear circuit application, namely pulse width modulator, which is based on circuit scheme presnted in [8].

This paper is organized as follows. In Section II, the function of a CDBA is briefly described, followed by the operation principle of the proposed PWM circuit. The feasibility of the presented circuits is verified through circuit simulations and experimentally in Section III. It is observed that the simulation and experimental results are in close agreements with theoretical propositions. Paper is concluded in section IV.

II. CIRCUIT DESCRIPTION

The circuit symbol of CDBA is shown in Fig. 1 and the port characteristics are given by (1)

$$\begin{bmatrix} I_z \\ V_w \\ V_p \\ V_n \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 & -1 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} V_z \\ I_w \\ I_p \\ I_n \end{bmatrix} \tag{1}$$

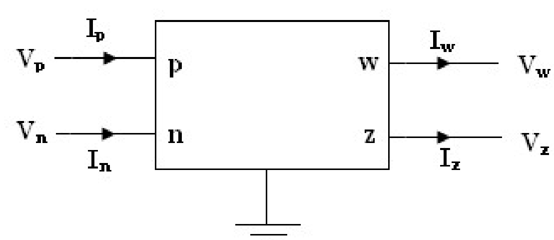

Fig. 1 circuit symbol of CDBA

The general scheme of PWM is depicted in Fig.2 wherein a reference signal (modulating signal) is compared with a sawtooth/triangular (carrier signal) waveform. The generated PWM signal attains a saturation level V_{sat}^{+} / V_{sat}^{-} depending upon whether the reference signal is greater/smaller in magnitude than the carrier. This PWM generation scheme is known as the intersective PWM.

Real-Time Distributed Multi-object Tracking in a PTZ Camera Network

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Abstract

A visual surveillance system should have the ability to view an object of interest at a certain size so that important information related to that object can be collected and analyzed as the object moves in the area observed by multiple cameras. In this paper, we propose a novel framework for real-time, distributed, multi-object tracking in a PTZ camera network with this capability. In our framework, the user is provided a tool to mark an object of interest such that the object is tracked at a certain size as it moves in the view of various cameras across space and time. The pan, tilt and zoom capabilities of the PTZ cameras are leveraged upon to ensure that the object of interest remains within the predefined size range as it is seamlessly tracked in the PTZ camera network. In our distributed system, each camera tracks the objects in its view using particle filter tracking and multi-layered belief propagation is used for seamlessly tracking objects across cameras.

Keywords

Distributed multi-camera tracking   Real-time tracking   PTZ camera network
Collaborative multi-object tracking   Belief propagation

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ARTICLE

Recent advances in graphene and its metal-oxide hybrid nanostructured for lithium-ion batteries

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Today, one of the major challenges is to provide green and powerful energy sources for a cleaner environment. Rechargeable lithium-ion batteries (LIBs) are promising candidates for energy storage devices, and have attracted considerable attention due to their high energy density, rapid response, and relatively low self-discharge rate. The performance of LIBs greatly depends on the electrode materials; therefore, attention has been focused on designing a variety of electrode materials. Graphene is a two-dimensional carbon nanostructure, which has a high specific surface area and high electrical conductivity. Thus, various studies have been performed to design graphene-based electrode materials by exploiting these properties. Metal-oxide nanoparticles anchored on graphene surfaces in hybrid form have been used to increase the efficiency of electrode materials. This review highlights the recent progress in graphene and graphene-based metal-oxide hybrids for use as electrode materials in LIBs. Particularly, emphasis has been placed on the synthesis methods, structural properties, and synergetic effects of metal-oxide/graphene hybrids towards producing enhanced electrochemical response. These hybrid materials have shown significant improvement in the performance of electrode materials.

1. Introduction

In response to the needs of modern society and rapid industrial development, it is necessary to design high-efficiency, environmentally friendly, and low-cost energy sources.[1-4] Conventional energy sources based on combustion technologies are playing a major role in meeting energy needs. Nevertheless, major issues are associated with these sources, such as rapidly increasing prices, environmental consequences, and global climate change. These serious problems have necessitated the development of alternative energy sources. In this regard, biomass,[5] wind,[6] solar cells,[7] fuel cells,[8] high energy density batteries,[9] and supercapacitors[10] are becoming appealing. High energy density batteries, supercapacitors, and fuel cells are based on electrochemical energy conversion and storage principles, and they can fulfill the requirements in applications ranging from portable electronics to heavy electric vehicles. Moreover, these devices are environmentally friendly, as they directly convert chemical energy into electrical energy with little or negligible pollution. Batteries and supercapacitors are electrochemical energy storage devices, whereas fuel cells are electrochemical energy conversion devices.[11-13] Among these various types of energy storage devices, rechargeable LIBs are particularly important. They have revolutionized portable electronic devices, and are presently the dominating power sources used for laptops, digital cameras, camcorders, and cell phones. They can store energy with 2-3 times higher density than that of conventional rechargeable batteries. Since the release of the first commercial LIB product by the Sony Corporation in 1991, they have attracted great attention from both industrial and academic communities. The global market of LIBs is now valued at over 12 billion USD per annum, and is expected to reach ~25 billion USD by 2017.[14] Although LIBs are attractive energy storage devices with high energy density, their power density is generally low. This low power density is mainly due to the high level of polarization at high charge/discharge rates.[15] In addition, major problems are associated with high cost, charge/discharge cyclic stability, and operability, which are related to the electrode materials. The performance of LIBs significantly depends on the charging/discharging rates, which characterize the migration of electrons and Li^+ through the electrode and electrolyte. Therefore, strategies have focused on the design of new electrode materials to facilitate high transport rates for Li^+/electrons and to reduce the diffusion length.[16]. In order to improve the performance of LIBs, considerable efforts have been made to design different types of electrode materials.[1-3,11-17]. Carbon has been widely studied as an electrode material in electrochemical energy storage devices due to its excellent chemical stability, environmental friendliness, and abundance.

Recently, various types of carbon nanostructures and their hybrids have been studied as electrode materials for LIBs, including carbon nanotubes,[18-23] mesoporous carbon/CNTs,[24] carbon fiber/CNTs,[25] carbon nanocages/nanographene shells,[26] CNTs/graphene nanosheets,[27] CNTs/polymer hybrid,[28-29] organic radical polymer/mesocellular carbon foam,[30] activated carbon nanostructures, natural graphite, expended graphite,[31-40] carbon/silicon hybrids,[31-38] CNTs/silicon hybrid,[39-40] nitrogen-doped porous carbon nanofiber and multi-walled carbon nanotubes (MWCNTs),[41-42] carbon-$Li_4Ti_5O_{12}$,[43-46] carbon/manganese oxide,[47-48] carbon/lithium-based spinel-type metal oxide,[49-53] carbon/vanadium oxide,[54-55] carbon/titanium oxide,[56-58] hybrid TiO_2/α-Fe_2O_3 with core/shell arrays on carbon,[59] and carbon/SnO_2 hybrids.[60-64]

Red light emitting $BaNb_2O_6$: Eu^{3+} phosphor for solid state lighting applications

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Abstract:

Europium doped barium niobate (Eu^{3+}:$BaNb_2O_6$) phosphors were successfully synthesized by conventional solid state reaction method. Thermogravimetric analysis-differential scanning calorimetry (TGA-DSC), x-ray diffraction (XRD) and scanning electron microscopy (SEM) characterization techniques have been used to disclose thermal, structural and morphological properties of the synthesized phosphors. X-ray diffraction pattern for the synthesized phosphor calcined at 1200 ^oC confirms the formation of pure orthorhombic phase for $BaNb_2O_6$. In addition to the above mentioned characterizations, photoluminescence properties were also investigated for the $BaNb_2O_6$ phosphor under near-UV/blue excitations. Intense red emission observed at 611 nm due to $^5D_0 \rightarrow ^7F_2$ transitions of Eu^{3+} under the excitations of both 394 nm ($^7F_0 \rightarrow ^5L_6$) and 466 nm ($^7F_0 \rightarrow ^5D_2$). The CIE chromaticity coordinates evaluated from the emission spectra are falling in the pure red region of the CIE 1931 diagram, which are very much close to the commercial red phosphor (Y_2O_2S :Eu^{3+}). The above results indicate that Eu^{3+} doped $BaNb_2O_6$ phosphors may be potential candidates to use in white LEDs in which tricolor (red/green/blue) phosphors are excited by near ultraviolet light.

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ORIGINAL PAPER

Seasonal variation and sources of aerosol pollution in Delhi, India

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Abstract Urbanization and industrialization in Delhi are growing very rapidly. As a consequence, aerosol emissions are increasing, thus leading to poor ambient air quality for human health. The precise sources and chemical composition of carbonaceous aerosols are not well known. In India, carbonaceous aerosols represent a major part, of around 50 %, of $PM_{2.5}$: the particulate matter with aerodynamic diameter lower than 2.5 µm. Here, we investigated carbonaceous aerosol in $PM_{2.5}$ fraction monthly in the industrial area of Delhi in 2011. Results show annual average concentrations of $PM_{2.5}$ of 145.59 µg/m^3, of organic C of 41.12 µg/m^3 and of elemental C of 13.25 µg/m^3. Organic C and elemental C were higher in post-monsoon and winter seasons. Organic and elemental C were correlated in pre-monsoon with R^2 of 0.83, and in winter with R^2 of 0.79, implying the existence of similar emission sources. The organic/elemental C ratios in $PM_{2.5}$ ranged from 2.71 to 5.29 with an annual average of 3.28, indicating that vehicle exhaust, coal smoke and biomass burning are the sources of carbonaceous fractions in Delhi.

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Keywords Particulate matter · Organic carbon · Elemental carbon · Aerosol · Seasons · Urban air pollution

Introduction

Atmospheric aerosols are gaining considerable importance in present-day scenario in urban cum industrial areas due to growing anthropogenic activities as well as in terms of their effects on human and climate. Recent interest has centered on fine particles ($PM_{2.5}$) and chemical species, particularly carbonaceous fractions (Fenger 2009), since they act as both air pollutants and climate agents (Yu et al. 2007, 2004, 2001). The secondary sources contribute particles below 1 µm via conversion of natural and anthropogenic trace gases into solid and liquid particles. Therefore, researchers are focusing on chemical composition of atmospheric aerosol. Carbonaceous aerosols are the single largest absorber of solar radiation, and their heterogeneous reactions change the dynamics of atmospheric boundary layer which reduces visibility and also create health hazard (Yang et al. 2011). Elemental and organic C are the most important carbonaceous fine fractions in industrial cum urbanized areas of India. Elemental C is a primary pollutant, emitted as by-product of all combustion processes such as industrial emission, traffic, outdoor fires and household biomass fuels. Organic C is emitted directly or formed in situ in the atmosphere. It is a major component in scattering light and cooling the atmosphere. Primary organic C (POC) is directly emitted to the atmosphere, while secondary organic C (SOC) is formed through atmospheric oxidation of volatile organic compounds and subsequent gas-to-particle conversion processes (Plaza et al. 2006). Delhi is a humid sub-tropical climate city in northern India with an area of 1,484 km^2. Atmospheric pollution and its associated risk to

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Second Law Efficiency Analysis of Heat Exchangers

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Analytical analysis of unbalanced heat exchangers is carried out to study the second law thermodynamic performance parameter through second law efficiency by varying length-to-diameter ratio for counter flow and parallel flow configurations. In a single closed form expression, three important irreversibilities occurring in the heat exchangers—namely, due to heat transfer, pressure drop, and imbalance between the mass flow streams—are considered, which is not possible in first law thermodynamic analysis. The study is carried out by giving special influence to geometric characteristics like tube length-to-diameter dimensions; working conditions like changing heat capacity ratio, changing the value of maximum heat capacity rate on the hot stream and cold stream separately and fluid flow type, i.e., laminar and turbulent flows for a fully developed condition. Further, second law efficiency analysis is carried out for condenser and evaporator heat exchangers by varying the effectiveness and number of heat transfer units for different values of inlet temperature to reference the temperature ratio by considering heat transfer irreversibility. Optimum heat exchanger geometrical dimensions, namely length-to-diameter ratio can be obtained from the second law analysis corresponding to lower total entropy generation and higher second law efficiency. Second law analysis incorporates all the heat exchanger irreversibilities.
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Key words: heat exchangers, second law efficiency, irreversibilities, streams imbalance loss, condenser, evaporator

1. Introduction

Heat exchangers have wide applications and play a major role in energy conservation opportunity. Energy waste in any form results in a reduction of available work from the energy resources considered. The losses due to process irreversibility can be calculated using second law analysis. The property exergy serves as a valuable tool in determining the quality of energy and comparing work potentials of different energy sources or systems. There exists a direct proportionality between irreversibility, quantity of entropy generated, and the amount of available work lost in the process. Second law analysis seeks to minimize these losses by keeping the entropy generated to a minimum. A realistic design approach for systems is to base the design on minimum entropy production. In other words, entropy generation can be used to determine quantitatively the quality of

SEGMENTATION OF TERAHERTZ IMAGES USING 3D GRAPH-CUTS

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ABSTRACT

In this paper, we describe a novel technique for the extraction of object shapes from Terahertz images using a 3D graph-cut segmentation scheme. This approach to segmentation includes images in temporal domain by creating nodes and edges between consecutive images in order to obtain improved segmentation results and compensate for the high levels of noise in the Terahertz images. The foreground and background pixels are defined to provide hard constraints for segmentation. Graph cuts are thus used to extract the object shapes in absence of any other direct mean of object identification.

Index Terms— 3D graph-cuts, segmentation, Terahertz imaging

1. INTRODUCTION

This paper addresses the problem of efficient extraction of object shapes embedded in other objects within images obtained from a Terahertz camera. Many problems of vision can be expressed as a problem of energy minimization. The problem of foreground-background separation in images is of great practical importance in a wide multitude of fields including medical vision, multi-camera scene reconstruction, stereo imaging, image restoration, and motion and target identification. Common cameras are used for foreground estimation when the object in clearly visible to the naked eye. In case of objects embedded within another object, we require non-destructive imaging techniques like Terahertz camera. However images obtained from Terahertz cameras have low resolution and very high noise levels. Image segmentation based on a single image (i.e. spatial segmentation) will give incorrect foreground estimation in case of partial occlusion of the object in the image. To make up for these errors, we propose a novel method for segmentation by adding a temporal direction, hence using also the correlations between consecutive images - acquired at 15fps - together with the spatial information within the 2D image.

For segmentation, we have used energy minimization using graph cuts. Graph cuts showed a major improvement over previously used methods in terms of results accuracy. Use of graph cuts in images gave birth to a new approach to image segmentation [1]. The graph cut finds a solution with very low energy, and in some cases it even finds the global minimum. The only limitation of graph cuts is that it can be applied to a limited class of energy functions. There are a multitude of algorithms which implement max-flow for general graphs: Boykov- Kolmogorov [2], Ford Fulkerson [3], Kohli (dynamic Boykov Kolmogorov algorithm) [4] and various implementations exist for graph-cut based minimization for image segmentation like Boykov-Jollys interactive graph cuts [5] for optimal region segmentation of objects. Some algorithms use iterative graph-cuts [6], reduce run-time to logarithmic functions by making approximations [7], and implement fast segementation [8].

Graph cuts are used in vision based algorithms for applications like texture synthesis [9], multi-scene reconstruction [10], stereo-vision, image restoration and medical image synthesis [11] [12] . In this paper, we have adapted the grab-cut method [13] for finding the global optimum segmentation of an interconnected graph in 3 dimensions (and not only spatial, as in [13]), in order to obtain a smooth segmentation of Terahertz images. The obtained segmentation is hence a 3D structure which is further used to determine the 2D structure of the original object embedded in the outer object. Our paper is organized as follows: Section 2 introduces the basics of graph-cut energy minimization, Section 3 describes the proposed 3D segmentation algorithm. Experimental results are explained in Section 4, prior to conclusion in Section 5.

2. GRAPH-CUT BASED IMAGE SEGMENTATION

A directed weighted graph $G =< V, E, W >$ consists of a set of nodes V and a set of directed edges E that connect the nodes. The nodes correspond to pixels, or voxels or other features depending on how the graph has been defined [14]. A graph also contains two special nodes called terminals(source and sink). Connections made between the nodes are called edges and a weight $w \in W$ or cost, is assigned to each edge. There are two types of edges in a graph: n-links and t-links. N-links connect pairs of neighboring pixels, thus defining the neighborhood of each node and the cost of

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Simultaneous Reconfiguration, Optimal Placement of DSTATCOM, and Photovoltaic Array in a Distribution System Based on Fuzzy-ACO Approach

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***Abstract*—In this paper, a combination of a fuzzy multiobjective approach and ant colony optimization (ACO) as a metaheuristic algorithm is used to solve the simultaneous reconfiguration and optimal allocation (size and location) of photovoltaic (PV) arrays as a distributed generation (DG) and distribution static compensator (DSTATCOM) as a distribution flexible ac transmission system (DFACT) device in a distribution system. The purpose of this research includes loss reduction, voltage profile (VP) improvement, and increase in the feeder load balancing (LB). The proposed method is validated using the IEEE 33-bus test system and a Tai-Power 11.4-kV distribution system as a real distribution network. The results proved that simultaneous reconfiguration and optimal allocation of PV array and DSTATCOM unit leads to significantly reduced losses, improved VP, and increased LB. Obtained results have been compared with the base value and found that simultaneous placement of PV and DSTATCOM along with reconfiguration is more beneficial than separate single-objective optimization. Also, the proposed fuzzy-ACO approach is more accurate as compared to ACO and other intelligent techniques like fuzzy-genetic algorithm (GA) and fuzzy-particle swarm optimization (PSO).**

***Index Terms*—Ant colony optimization (ACO), distribution static compensator (DSTATCOM), distribution system, fuzzy sets, photovoltaic (PV), reconfiguration.**

I. Introduction

DISTRIBUTION systems have two types of switches, i.e., 1) tie and 2) sectionalizing [1]. By changing the switches status between feeders, the structure of the distribution network will change and it is known as reconfiguration. The main objective of reconfiguration is to reduce losses, increase stability and reliability, improve voltage profile (VP), and relieve overload in the distribution network. The concept of reconfiguration of distribution network was first proposed by Merlin and Back [2] in 1975.

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Color versions of one or more of the figures in this paper are available online at http://ieeexplore.ieee.org.

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A number of methods of reconfiguration in distribution networks have been proposed by researchers and also available in literature. Recently, Kavousi-Fard and Niknam [3] have proposed the reconfiguration problem with respect to the reliability using a self-adaptive modified optimization algorithm.

In restructured power systems, the use of distributed generation energy resources including photovoltaic (PV), fuel cells, small wind turbines, etc., is playing an important role because of various advantages. The advantage of distributed generation energy resources includes reduction in power loss, improvement in VP, and increase in the reliability of the network. To achieve the benefits of DG units, the selection of optimal locations and capacity is becoming the major problem. Various methods have been proposed by researchers in order to find the optimal placement and capacity of DG units. These methods are often based on artificial intelligence and heuristic algorithms. Kollu *et al.* [4] proposed a Harmony Search (HS) algorithm-based novel method to allocate DG units optimally in distribution system for power loss reduction and VP improvement.

Distribution flexible ac transmission system (DFACT) devices are used in distribution systems with different applications and controlling methods for improving the power quality indices. DSTATCOM, unified power flow controller (UPFC), and dynamic voltage restorer (DVR) are widely used DFACT devices. To find the optimal location and capacity of DFACT devices has a considerable impact in distribution systems. Some researchers have proposed various methods to find the optimal location and size of DFACT unit. Farhoodnea *et al.* [5] presented a firefly algorithm-based novel method to optimally place the DSTATCOM in distribution system.

In addition, several methods have been proposed for the simultaneous reconfiguration and optimal allocation of DG or DFACT unit in distribution system. However, simultaneous reconfiguration with both DG and DFACT is rarely available in the literature.

In this paper, the ant colony optimization (ACO) approach has been used for simultaneous multiobjective reconfiguration and optimal allocation of PV and DSTATCOM in a distribution network. The main objective of the work includes loss reduction, VP improvement, and equalizing the feeder load balancing (LB). To avoid the convergence problem, the input and output data are normalized in the same range based on fuzzy sets.

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Spectroscopic studies of Nd^{3+} doped lead tungsten tellurite glasses for the NIR emission at 1062 nm

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A B S T R A C T

Lead Tungsten Tellurite (LTT) glasses doped with different concentrations of Nd^{3+} ions were prepared by using the melt quenching technique to study the absorption, emission and decay spectral profiles with an aim to understand the lasing potentialities of these glasses. From the absorption spectra, the Judd–Ofelt (J–O) parameters are evaluated and in turn used to calculate the transition probability (A_R), total transition probability (A_T), radiative lifetime (τ_R) and branching ratios (β_R) for prominent emission levels of Nd^{3+}. The emission spectra recorded for LTT glasses gives three emission transitions ${}^4F_{3/2} \rightarrow {}^4I_{9/2}$, ${}^4F_{3/2} \rightarrow {}^4I_{11/2}$ and ${}^4F_{3/2} \rightarrow {}^4I_{13/2}$ for which effective band widths ($\Delta\lambda_P$) and stimulated emission cross-sections (σ_{se}) are evaluated. Branching ratios (β_R) measured for all the LTT glasses show that ${}^4F_{3/2} \rightarrow {}^4I_{11/2}$ transition is quite suitable for lasing applications. The intensity of emission spectra increases with increase in the concentrations of Nd^{3+} up to 1.0 mol% and beyond concentration quenching is observed. Relatively higher emission cross-sections and branching ratios observed for the present LTT glasses over the reported glasses suggests the feasibility of using LTT glasses for infrared laser applications. From the absorption, emission and decay spectral measurements, it was found that 1.0 mol% of Nd^{3+} ion concentration is aptly suitable for LTT glasses to give a strong NIR laser emission at 1062 nm.

1. Introduction

In recent years, rare earth doped materials are playing a vital role in the modern optical technology as an active constituents to produce low price integrated laser sources, integrated optical amplifiers, 3D display devices, sensors, up-conversion fibres and low loss components [1]. The above mentioned applications possessed by the rare earth doped materials have stimulated the research on rare earth doped glasses [2–6]. Among different rare earth ions, neodymium ion is one of the utmost efficient ions used to prepare solid-state lasers because of its intense emission at 1060 nm [7]. For this reason, trivalent neodymium (Nd^{3+}) ion doped variety of crystals and glasses were studied extensively under 808 and 885 nm laser diode excitation with an aim to develop high power NIR (at 1060 nm) solid state lasers [8,9]. Different glass hosts like borates, phosphates, germanates, vanadates and tellurite families have been studied extensively for this purpose [10–14]. Among all oxide glasses, Lead Tungsten Tellurite (PbF_2–WO_3–TeO_2) glass system (LTT) has unique optical properties. Tellurite based glasses besides having high linear and third order nonlinear optical constants (nonlinear refractive indices), can possess high mechanical stability, good corrosion resistance and low phonon energies equal to 750 cm^{-1}. All these novel properties make them to have their transitions range extended up to mid IR (5–6 μm) region. Tellurite based glasses are also having good capacity to accept lanthanide dopants at different concentrations [15]. The low phonon energy, extended transmission range and high refractive index of tellurite glasses allow the observation of laser emission from rare earth ions in a wide spread spectral range [5,16–20]. Such materials are also useful in optical waveguides. Tungsten oxide (WO_3) is a precise noble semi conducting and transition-metal oxide which has fascinated considerable attention for several years. It is also one of the most examined and used material for electro-chromic and photo-chromic devices in which colouration and bleaching can be reversibly obtained by

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Spin mixed charge transfer states of iridium complex Ir(ppy)$_3$: transient absorption and time-resolved photoluminescence†

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Nanosecond transient absorption and time-resolved spectroscopic techniques were applied to study an organometallic phosphorescent emitter Ir(ppy)$_3$ complex, tris[2-phenylpyridinato-C^2,N] iridium(III) dissolved in tetrahydrofuran (THF) under degassed conditions at ambient temperature. Transient absorption curves obtained at a pump pulse of 355 nm and at a probe wavelength of 430–600 nm show positive and negative signals, indicating triplet–triplet (T–T) absorption and triplet–singlet (T–S) emission. Tri-exponential global fitted transient absorption curves and time-resolved photoluminescence (PL) decays demonstrated the presence of four close low lying triplet states, of which, two emit green PL with a lifetime of 210 ns and 1.71 μs. The emitting states are spin mixed metal-to-ligand charge transfer (^{3}MLCT) states produced from a non-equilibrium ^{1}MLCT state following fast intersystem crossing (ISC), whereas the ^{1}MLCT state is produced directly and indirectly depending on the excitation wavelength. Moreover, the electronic structures for the ground state and low-lying excited states of Ir(ppy)$_3$ were studied using quantum chemistry calculations.

Introduction

The green phosphorescent emitter Ir(ppy)$_3$ is known for its highly efficient photoluminescence (PL) and electroluminescence (EL) in organic light emitting devices (OLEDs). This is because phosphorescent materials, such as iridium complexes, can provide very high exciton formation efficiency of nearly 100%.[1–4] Such high quantum efficiencies result from efficient intersystem crossing because of strong spin–orbit coupling (SOC) of the iridium atom, which mixes the singlet (S) and triplet (T) states of the Ir(ppy)$_3$ complex, resulting in the large cross-section for visible absorption of the ground state and great molecular stability.[4] The fast intersystem crossings (∼100 fs) from excited singlet to the triplet states result in nearly no fluorescence but a strong phosphorescence emission,[5,6] a weak fluorescence is also reported at around ∼400 nm.[7] The assignment of the emitting states is the low-lying metal-to-ligand charge transfer singlet (^{1}MLCT) and triplet (^{3}MLCT) states,[2,5–15] in which an electron located in the metal based d-orbital transferred to the π orbital of ligand. The high quantum yield and molecular stability of Ir complexes make them suitable for diverse applications. Due to the importance of Ir complex Ir(ppy)$_3$ for green OLEDs, it is of great interests to study the electronic structure of the metal complex in more detail. Especially, the role of triplet substates in the strong PL and EL is worthy further investigation, which might hint some guidance for constructing more efficient OLEDs. Furthermore, application of external electric field to the Ir(ppy)$_3$ doped in a PMMA film under vacuum condition at different temperature (300–40 K) demonstrated two major effects the Stark shifts and field-induced photoluminescence quenching.[13] The field-induced PL quenching which arises due to the decreased lifetime and the emitting state population is independent on excitation energy and temperature. The fundamental molecular parameters, *e.g.*, changes in dipole moment and polarizability following photoexcitation have also been reported.[13] Here, we used pump–probe technique and measured the nanosecond transient absorption spectra together with time-resolved PL spectra & PL decays in solvent under degassed conditions. The transient absorption together with time-resolved PL decay curves allow us to quantify the existence of low-lying singlet and triplet states, spin-mixed states, *i.e.*, metal-to-ligand charge transfer (MLCT) states, which may or may not essentially emit photoluminescence. The low-lying excited states are intramolecular charge transfer states and possess ligand-to-ligand charge transfer (LLCT) and MLCT characters.

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Steady State Thermal Analysis of Gas Turbine Power Plant Cycles at Higher Temperatures

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Increasing the cost of fuels, growing concern of global warming and increasing demand of electrical energy, a compact, less polluting and efficient gas turbine power plant with regenerator and a suitable Waste Heat Recovery Steam Generator (WHRSG) presents a very attractive concept. Developments in metallurgical sciences, protective coatings and cooling methods have provided the options to design the components and a higher Turbine Inlet Temperature (TIT) may be achievable in near future. A design and analysis methodology for thermodynamic evaluation of the gas turbine cycles has been developed, validated and applied for the analysis. The analysis reveals that a higher TIT (1900K) is possible to achieve higher performance (70% first law efficiency and 55% second law efficiency) with lower fuel consumptions and pressure ratio (20).

Keywords: Cogeneration, Turbine inlet Temperature, Specific fuel consumption, Power-to-heat ratio, Process heat, pinch point.

Introduction

In the present times of fast depleting conventional fuel resources, growing concerns for environment damage and a sharp-increasing demand for electricity and process heat, the need for more efficient and less polluting cogeneration systems with regenerator and a suitable waste heat recovery steam generator (WHRSG) presents a very attractive concept. Moran[1] has established an analysis methodology for the regenerative gas turbine cogeneration system. This simple system integrated with regenerator and a waste heat recovery steam generator (WHRSG) is attached to utilize the waste heat. Y. Tamarin[2] has worked on super alloy and ceramic coatings and Hiroshi Harada[3] have studied on the improved high temperature unique materials proposed in Japan and being evaluated. Khaliq and Kaushik[4] have evaluated the thermodynamic performance of combustion gas turbine cogeneration system with reheat and studied the efficiency of system with WHRSG. Doek *et al*.[5] worked out the exergy analysis of gas turbine cogeneration system and calculated performance of gas turbine cogeneration systems as well as the exergy destruction in each component in the system when it is operated at part and full load conditions. Butcher and Reddy[6] analysed the second law efficiency of waste heat recovery and studied the effect of pinch point temperature on the efficiency of HRSG. Korakianitis[7] performed analysis of combined cogeneration power plant with various power and efficiency enhancement techniques. A conceptual gas turbine based cogeneration cycle with compressor inlet air cooling and evaporative after-cooling of the discharge has been proposed by Khaliq and Chaudhary[8]. Yokoyana *et al*.[9] worked on optimal design of gas turbine cogeneration plants in consideration of discreetness of equipment capabilities. Dellenback[10] studied a reassessment of an alternative regenerative cycle that can produce efficiency higher than conventional only for limited set of conditions. Kumar and Krishna[11,12] described the characteristics of gas turbine power plant adopting the air-cooling at intake with alternative regenerative configuration and performed the second law analysis. Kumar and Kachhwaha[13] analysed a regenerative cogeneration plant for first & second law efficiencies. The recently developed cogeneration system features the introduction of $CH_4 - O_2$ combustion system and the 1700°C

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Study of diffuse phase transition in $Pb(Cd_{1/3}Nb_{2/3})O_3$ compound

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ABSTRACT

Present paper contains study of phase evolution, dielectric properties and complex impedance spectroscopy of lead based ferroelectric ceramic $Pb(Cd_{1/3}Nb_{2/3})O_3$ synthesized by double step solid state reaction route. X-ray diffraction pattern shows that the material has single cubic phase. Temperature dependence of relative dielectric constant exhibits diffuse phase transition in the present compound. Frequency dependence of the real (Z') and imaginary (Z'') parts of the electric impedance spectroscopy reveal contribution due to grain (bulk) resistance in a wide temperature range and indicate that the relaxation mechanism is less temperature dependent and strongly influenced by oxygen vacancies and charge carrier. The conductivity spectrum has been observed to follow the Jonscher's universal power law. The existence of week ferroelectricity is confirmed from hysteresis loop study.

1. Introduction

Lead based ferroelectric oxides with a general formula $Pb(B'_{1/3}B''_{1/3})O_3$ (where B′ = Mg, Zn, Ni, etc.; B″ = Nb and Ta) have drawn attention because of their attractive relaxor characteristics or diffuse phase transition (DPT) useful for a wide range of industrial application such as electrical, optical, electromechanical devices [1–4]. These materials exhibit excellent physical properties (i.e., high dielectric constant, frequency dependent broad maximum as a function of temperature, large electrostriction and small hysteresis loop) for device applications [3–6]. It is commonly believed that the diffuse phase transition behavior of the materials is due to the presence of two or more cations of different ionic radii and valencies on the octahedral B-site of the perovskite ABO_3 (A = mono or divalent and B = trivalent to tetravalent cations). The change in physical properties are associated with ionic radii, charge distribution and competition between B′-site and B″-site ordering. Many of the materials of the perovskite family do not give stable and single perovskite phase, and/or solid solutions with normal ferroelectric behavior. They provide high dielectric constant and low dissipation factor near morphotropic phase boundary [7–9]. Most common problem in the synthesis of lead-based single-phase ceramics is the strong inclination of this type of material to form detrimental secondary pyrochlore (Py) phase(s). The presence of the secondary phases reduces the dielectric, electrostrictive and other properties of the materials [7,8]. Though various attempts have been made to solve this problem using various synthesis routes, columbite synthesis method has been found very effective to increase the percentage of perovskite to the higher possible level (i.e., to obtain single phase material) [10]. In this methodology, divalent oxides (B′O) /carbonate ($B'CO_3$) and Nb_2O_5 are taken as precursor compounds to obtain another $B'Nb_2O_6$ precursor, and in sequence, it reacts with a stoichiometric amount of PbO to obtain $Pb(B'_{1/3}Nb_{2/3})O_3$ powder with dominant perovskite phase. The main advantages of columbite method are: (a) requires the short time and low temperature heat treatment, (b) better homogeneity and (c) uniform cation distribution. To obtain pure perovskite compound $Pb(B'_{1/3}Nb_{2/3})O_3$, some essential steps have been followed. PbO volatilization or deficiency is a main source of pyrochlore phase of $Pb(B'_{1/3}Nb_{2/3})O_3$ compounds. Though several synthesis techniques have been tried to avoid the formation of undesirable pyrochlore phase [11–13], addition of small amount (5–10%) of PbO (to compensate for PbO volatilization) was found effective [14–16]. The role of excess amount of PbO in the formation of pure in $Pb(B'_{1/3}Nb_{2/3})O_3$ is still not clear. Only indirect effects of PbO excess have been reported on the dielectrics and micro-structural properties in PMN bulk ceramics [13–15]. The

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Chapter 11
Green Entrepreneurship in India: Global Evaluation, Needs Analysis, and Drivers for Growth

Ashish Sharda, Abhishek Goel, Ankit Mishra and Satish Chandra

11.1 Introduction and Literature Review

Eco-preneurship or green entrepreneurship is a new term for academic research, although some work began in 1970s, but the topic received a little attention in 1980s and 1990s. The issues like the links between sustainability and innovation, the importance of sustainability in strategic business development are receiving greater recognition and this lays the foundation stone for the creation and growth of viable, commercially successful business ventures (Schaper 2010).

Green entrepreneurship is an eco-innovation to build a low-carbon economy. It promotes the use of green power such as electricity produced from solar, wind, geothermal, biogas, biomass, and low-impact small hydroelectric sources

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Synergy of bone marrow transplantation and curcumin ensue protective effects at early onset of diabetes in mice.

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Abstract

BACKGROUND: The aim of this study was to investigate the early onset effects of diabetes on pro-angiogenic signaling pathway, total number of bone marrow cells, organs (pancreas and kidney) damage and the reversal effect of diabetes by combinatorial treatment of curcumin and bone marrow transplantation in streptozotocin (STZ) induced diabetic mice.

METHODS: In the present study, Streptozotocin induced diabetic mice were transplanted with bone marrow cells (2 × 10(6)) followed by the administration of curcumin (80 mg/kg bodyweight). Effect of diabetes on the different organs was studied by H&E, Western blotting and immunofluorescence using vascular endothelial growth factor (VEGF), platelet/endothelial cell adhesion molecule (PECAM), insulin, Caspase-9 and Caspase-3 antibodies.

RESULTS: The effect of diabetes results in the reduction of the total cell number and viability of the bone marrow cells, organ degeneration and lower VEGF/PECAM expression. However, transplantation with normal bone marrow cells significantly reduced the blood glucose levels (above normal range) and initiated the organ regeneration via the VEGF/PECAM mediated manner. Curcumin treatment further reduced the blood glucose level (near normal); and accelerated the organ regeneration, enhanced VEGF/PECAM expression and decreased caspase expression level in the organs. Curcumin also had a protective role against the glucotoxicity test performed on the bone marrow cells.

CONCLUSION: This study suggests that bone marrow transplantation and curcumin administration is an effective treatment in reversing the early onset effects of diabetes via the VEGF/PECAM signaling pathway.

KEYWORDS: bone marrow transplantation; curcumin; diabetes; platelet/endothelial cell adhesion molecule; vascular endothelial growth factor; 关键词：骨髓移植，姜黄素，糖尿病，血小板/内皮细胞粘附分子，血管内皮生长因子

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Role of nanoscale defect features in enhancing the thermoelectric performance of p-type nanostructured SiGe alloys

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Abstract

Despite SiGe being one of the most widely studied thermoelectric material owing to its application in radioisotope thermoelectric generators (RTG), the thermoelectric figure-of merit (ZT) of p-type SiGe is still quite low resulting in poor device efficiencies. In the present study, we report a substantial enhancement in ZT ~ 1.2 at 900°C for p-type nanostructured $Si_{80}Ge_{20}$ alloys by creating several types of defect features within the $Si_{80}Ge_{20}$ nanostructured matrix, in a spectrum of nano to meso-scale dimensions, during its nanostructuring, employing mechanical alloying followed by spark plasma sintering. This enhancement in ZT, which is ~ 25% over the existing state-of-the-art value for p-type nanostructured $Si_{80}Ge_{20}$ alloy, is primarily due to its ultralow thermal conductivity ~ 2.04 W/mK at 900°C, resulting from the scattering of low-to-high wavelength heat-carrying phonons by different types of defect features in a range of nano to meso-scale dimensions in the $Si_{80}Ge_{20}$ nanostructured matrix. These include point defects, dislocations, isolated amorphous regions, nano-scale grain boundaries and more importantly the nano to meso-scale residual porosity distributed throughout the $Si_{80}Ge_{20}$ matrix. These nanoscale multi-dimensional defect features have been characterized employing scanning and transmission electron microscopy and correlated with the electrical and thermal transport properties, based on which the enhancement of ZT has been discussed.

Keywords: $Si_{80}Ge_{20}$ nanostructured alloys, thermoelectrics, nanostructuring, spark plasma sintering, figure-of-merit

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Toughening of epoxy with preformed polyethylene thermoplastic filler

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Abstract

The potential of polyethylene as a thermoplastic filler towards improving the fracture properties of epoxy resin was explored. Oxo-degradable films were subjected to thermo-oxidative exposure, and the oxidised polyethylene (OPE) was extracted with acetone to remove low molecular weight products (APE). The presence of functionalities led to its homogenous dispersion in the epoxy matrix. Blending of epoxy with OPE and APE led to significant improvement in both quasi-static and impact properties, as evidenced by 44 % increase in G_{IC} and 21% increase in impact strength at loadings of 3% w/w. The strain rate sensitivity of the composites was also investigated.

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Typical comparisons between plasma bubble and blob distributions at different altitudes over the Indian sector using a unique combination of satellite-based observations – a case study

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We report in this article, for the first time, on the altitudinal variations of ionospheric irregularities during post-sunset hours between 14 and 17 October 2001 at Indian longitudes by using a unique combination of Challenging Mini Satellite Payload (CHAMP), Republic of China Satellite (ROCSAT-1), and Defense Meteorological Satellite Programme (DMSP) satellites located at about 400, 650, and 850 km, respectively. It became possible for us to study the width of plasma bubbles and plasma blobs in the longitudinal (zonal) direction at different altitudes along with temporal variations of ion velocity components in horizontal (V_y) and vertical (V_z) directions as probed by ROCSAT-1 and DMSP satellites. The dominant features noticed in V_y and V_z components are their anti-correlation relationship at the ROCSAT-1 satellite's altitude (mirroring effect). The most important observation from this study is that plasma bubbles are found to have occurred immediately after post-sunset hours, whereas plasma blobs were observed after three hours following the bubbles' appearance time and continued until pre-sunrise hours at higher altitudes between around ±5° and ±20° from the magnetic equator, which indicate that the plasma blobs emanate from plasma bubbles that generated at the bottomside of the ionospheric F-layer shortly after sunset on similar lines to a few recent research studies. It is therefore believed that the polarized electric fields generated inside plasma bubbles might have played a role in the generation of higher-altitude plasma blobs. Importantly, the calculated power spectra of bubbles and blobs show a nearly equal trend, indicating that they are intricately connected with each other.

1. Introduction

At low latitudes steep density gradients at the bottomside of the F-layer during post-sunset times, which are formed due to the combined effects of pre-reversal enhancement (PRE) in the vertical plasma drifts (electric field ($\boldsymbol{E}$) × magnetic field ($\boldsymbol{B}$) drifts) over the magnetic equator and the fast chemical recombination of dominant molecular ions, become unstable when density instabilities occur. Consequently, plasma density irregularities with scale sizes ranging from a few tens of centimetres to hundreds (or perhaps thousands) of kilometres will be formed. These plasma density irregularities are often termed equatorial spread F

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Use of ligand-based pharmacophore modeling and docking approach to find novel acetylcholinesterase inhibitors for treating Alzheimer's.

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Abstract

Alzheimer's disease is a neurological disorder in which the patient suffers from memory loss and impaired cognitive abilities. Though the main cause of the disease is not yet known, depletion of neurotransmitter at synaptic junctions, accumulation of insoluble beta amyloid plaques and neurofibrillary tangles are the main pathologies associated with it. The FDA approved drugs for alzheimer's belong to the category of acetylcholinesterase inhibitors. But most of the drugs have been observed to be associated with adverse side effects. In this study, we have developed a pharmacophore (responsible for interaction with acetylcholinesterase active site) based on the already existing drugs and drug candidates. This pharmacophore was used to search for novel AChE inhibitors with altogether different chemical scaffold using high throughput virtual screening and docking studies. Finally, we have reported two compounds, OPA and OMT, which possess high affinity for catalytic site of AChE enzyme and thus, can be considered as potential AChE inhibitors for the symptomatic treatment of Alzheimer's.

KEYWORDS: Acetylcholinesterase inhibitors; Alzheimer's; Drug design; Molecular docking; Pharmacophore

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Visible, Up-Conversion and NIR (~ 1.5 μm) Luminescence Studies of Er^{3+} doped Zinc Alumino Bismuth Borate Glasses

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Abstract

Er^{3+} doped Zinc Alumino Bismuth Borate (ZnAlBiB) glasses with composition 20 ZnO+10 Al_2O_3+(10-x) Bi_2O_3+60 B_2O_3+xEr_2O_3 (where x=0.1, 0.5, 1.0 and 2.0 mol %) were prepared by using melt quenching technique to study their luminescence efficiency in different regions of electromagnetic spectrum using absorption, emission, up-conversion and time resolved photoluminescence spectral studies at room temperature. The Judd-Ofelt (JO) parameters evaluated by applying JO theory to the absorption spectra of Er^{3+} doped ZnAlBiB glasses were used to calculate the radiative properties such as transition probability (A_R), Branching ratios (β_R), radiative lifetimes (τ_R), stimulated emission cross-section (σ_{se}), gain band width ($\sigma_{se} \times \Delta\lambda_P$) and optical gain ($\sigma_{se} \times \tau_R$) parameters for the prominent luminescent levels of Er^{3+}. Visible and near infrared (NIR) emission spectra have been recorded by exciting the glass samples at 486 nm and 980 nm respectively. Quantum efficiency (η) values for the prepared glasses were evaluated from the decay curves recorded for the NIR transition $^4I_{13/2}\rightarrow{}^4I_{15/2}$. The up-conversion luminescence shown by these glasses were recorded and analysed to understand utility of these glasses as up-conversion lasers by exciting them with 980 nm laser diode. The visible, up-conversion and NIR luminescence studies indicates that Er^{3+} ions doped ZnAlBiB glasses are aptly suitable for solid state lasers and optical amplifiers.

Key words:

Glasses, Erbium, JO parameters, up-conversion, radiative properties, emission cross-section

Empirical Comparison of Machine Learning Algorithms for Bug Prediction in Open Source Software

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***Abstract*— Bug tracking and analysis truly remains one of the most active areas of software engineering research. Bug tracking results may be employed by the software practitioners of large software projects effectively. The cost of detecting and correcting the defect becomes exponentially higher as we go from requirement analysis to the maintenance phase, where defects might even lead to loss of lives. Software metrics in conjunction with defect data can serve as basis for developing predictive models. Open source projects which encompass contributions from millions of people provide capacious dataset for testing. There have been diverse machine learning techniques proposed in the literature for analyzing complex relationships and extracting useful information from problems using optimal resources and time. However, more extensive research comparing these techniques is needed to establish superiority of one technique over another.**

This study aims at comparison of 14 ML techniques for development of effective defect prediction models. The issues addressed are 1) Construction of automated tool in Java to collect OO, inheritance and other metrics and detect bugs in classes extracted from open source repository, 2) Use of relevant performance measures to evaluate performance of predictive models to detect bugs in classes, 3) Statistical tests to compare predictive capability of different machine learning techniques, 4) Validation of defect prediction models.

The results of the study show that Single Layer Perceptron is the best technique amongst all the techniques used in this study for development of defect prediction models. The conclusions drawn from this study can be used for practical applications by software practitioners to determine best technique for defect prediction and consequently carry out effective allocation of resources.

Keywords*— *Machine learning, Bug prediction, Object-oriented metrics, Open source software, Software reliability.

I. Introduction

Surprises while building software are inevitable and hence, every software, especially complex ones are prone to defects. In recent years, various models to predict defective classes have been constructed using software metrics. Detection of defects in early phases enable in delivering high quality and low cost software to the customers in a timely manner. There is a need for evaluation of various techniques and determination of best technique for defect prediction which will be of great practical application to software practitioners and researchers. It will enable researchers to use the best technique for development of defect prediction model.

The defect prediction models are used to predict a dependent variable on the basis of independent variables. Various metrics are used as independent variables and a software quality attribute is used as dependent variable. The model can be created using various techniques like statistical techniques or machine learning technique. The capability of various techniques has been assessed by evaluating the model developed using performance measures like precision, recall, area under curve (AUC) and receiver operating characteristics (ROC). The models developed are assessed using tenfold cross validation. The study also statistically compares the models developed using Friedman statistical test [1]. The study analyses top open source projects on Github and uses them as a subject which increases generalizability and applicability of the study's results.

The study empirically validates 9 open source data sets to assess and compare performance of 14 ML techniques using Weka tool. The models are further statistically compared using Friedman statistical test on SPSS software. The Friedman test assigns a mean rank to each of the techniques using a specific performance evaluation measure and measures the statistical difference between the predictive performances of the various techniques. The data sets used in the study have been collected from top 9 open source projects on Github using a tool developed in Java.

The rest of the paper is organized as follows: Section II summarizes the related work in this field. Section III describes the experimental design. Section IV states the research methodology. Section V describes the results and analysis. Section VI discusses and interprets the result. Section VII presents the conclusions of the research.

II. Related Work

Many previous researches have pointed to the relation between software metrics and defect prediction. Lessmann et al. [2] explored various classification algorithms and made a framework for software defect prediction by benchmarking

Journal of Enterprise Information Management

A multi-analytical approach to understand and predict the mobile commerce adoption
Rajan Yadav Sujeet Kumar Sharma Ali Tarhini

A retrospective view of ambient noise standards in India: Status and proposed revisions

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The objective of this paper is to investigate the status and validity of ambient noise standards in India and propose revisions for noise abatement and control based on the available knowledge on noise policies and regulations followed around the world. The annual average L_{day} (06–22 h) and L_{night} (22–06 h) values observed under the pilot project on the establishment of National Ambient Noise Monitoring Network (NANMN) across seven major cities in India are analyzed for ascertaining the magnitude of annual average ambient noise levels, planning for noise abatement action plans and formulation of revised ambient noise standards in India. It is envisaged that the proposed revisions shall be instrumental in execution of noise abatement action plans for controlling noise pollution in India.

Primary subject classification: 52.1; Secondary subject classification: 82

1 INTRODUCTION

Noise pollution has become a serious concern globally. Every nation is concerned about the health effects of noise emitted from the expanding number of vehicles moving on the roads. It is thus imperative to adopt noise monitoring strategies to monitor the accentuated noise levels and planning for suitable noise abatement measures for reduction. The European Environmental Noise Directive 2002/49/EC[1] relating to the assessment and management of environmental noise establishes that the member states should create noise maps and action plans for the parts of their territory. The noise maps should present noise levels expressed in harmonized indicators: day–evening–night level, L_{den}, and night equivalent level, L_{night}. The long term noise monitoring studies are thus required not only for ascertaining the magnitude of ambient levels, but also for devising suitable control plans. There have been many such studies reported in different parts of the world[2–9]. Road traffic noise has been observed to be the major source of noise pollution in most of these studies carried out in the different parts of the world[10–12]. Also, the annoyance towards railway and aircraft related noise is reported to be different across the globe. For instance, annoyance caused by railway noise is more severe in Japan than in Europe attributed to the distance from noise sources to the houses[13]. There have been no such comprehensive long-term noise monitoring studies previously reported in India[14–17]. The development of a validated road traffic noise model for Indian conditions[18,19] similar to that used in developed nations is essential in conducting Environmental Impact Assessment (EIA) studies. The Central Pollution Control Board (CPCB), New Delhi, has taken many initiatives and carried out numerous studies in monitoring the ambient sound levels at noise hot-spots in metropolitan cities like Delhi city with an aim of implementation of suitable measures for noise mitigation. CPCB, India initiated the process of developing National Ambient Noise Monitoring Network (NANMN), a follow-up of Section 5.2.8 (IV) of National Environmental Policy (NEP)-2006, through which it was decided to include ambient noise as a regular parameter for monitoring in specified urban areas[20,21]. The real time noise monitoring network, NANMN project was established in year 2011 with an objective of collecting the real-time continuous noise monitoring data. Phase I of the NANMN began in 2011 and covers 35 locations in seven metropolitan cities and by phase II and phase III, 160 locations spread over 25 cities in 18 states will be established[22]. The network has resulted in creation of the base line data and facilitates its analysis for policy makers and implementation agencies to take appropriate actions for noise control at regional and national level. Thus, a retrospective view of the ambient noise

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A Review on Lipase Catalysed Synthesis of DHA Rich Glyceride from Fish Oils

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Abstract: - **Docosahexaenoic Acid (DHA) is one of the most useful polyunsaturated fatty acid (PUFA) with pharmaceutical and neutraceutical potential and important for the prevention & control of various human diseases and disorders such as cardiovascular disease, inflammation, allergy, cancer, immune response, diabetes, hypertension and renal disorders. DHA is also known as "brain food" as it is highly concentrated in the membranes of brain cells and retinal cells of eye. The most widely available source of DHA is cold water fishes such as tuna, sardine, salmon, cod and herring etc. However, the concentration of DHA in fish oil is available in a small quantity. DHA can be isolated from fish oil and concentrated in glyceride form by using different methodologies such as selective hydrolysis, selective esterification and transesterification by using different lipases. Although this paper focusses on synthesis of DHA rich glycerides from fish oil but an additional section has been incorporated including new developments in the field of PUFA synthesis, using different micro-organisms (fungi, algae and bacteria). In the present paper, the published research work on the above aspects has been reviewed & summarized.**

Key words: **Docosahexaenoic acid, fish oil, lipase, hydrolysis, esterification, microorganism.**

1. INTRODUCTION

Human health and nutrition has always been a major challenge for researchers. Therefore, the need is to focus on the synthesis of nutritionally valuable components which not only prevent the onset of disease but also provide the means of treatment. Such nutritionally important food ingredients include various long chain polyunsaturated fatty acids (PUFAs) in tri-glycerides form which are easy to consume in diet. One of the essential ω-3 PUFAs include DHA. Fish oils such as tuna, salmon, cod liver, herring etc., are rich source of these ω -3 fatty acids. The application of lipase for the synthesis of DHA rich glycerides is reported as a promising method as few of them are highly selective for enrichment of PUFA.

DHA is an even numbered, straight-chain, ω-3 PUFA which is an essential fatty acid because it cannot be synthesized in the human body [1]. DHA ($C_{22}H_{32}O_2$) is designated as C22:6 ω3 means DHA contain 22 carbon atoms, 6 double bonds and the term "ω" refers to the position of the double bond of the fatty acid closest to the methyl end of the molecule. All double bonds are in cis-configuration. The chemical structure of DHA is shown in Fig 1.

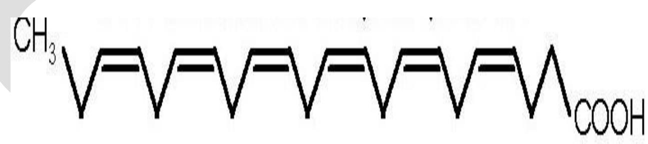

Fig 1.Chemical Structure of DHA

The natural source of DHA is fish oil which contains very little alpha-linolenic acid (ALA), but is rich in the EPA and DHA. Fish oils with the highest levels of EPA and DHA include tuna, sardine, cod and salmon etc. However, the concentration of DHA in various fish oils which has been reported to be approximately in the range of 10-30%. Several marine organisms like algae (*Thraustochytrium aureum*, *Thraustochytrium roseum*, *Schyzochytrium*, microalgae, *Crypthecodinium cohnii*, *Gyrodinium nelsoni*, *Amphidinium carteri*, *Gonyaulax)*, bacteria (*Vibrio spp.*, *Rhodopseudomonas spp*.) produce DHA, especially a triglyceride DHA [2]. The synthesis of DHA and EPA from fish oils has been reported with both chemical and enzymatic methods [3-5]. Enzymatic methods are largely preferred over conventional chemical method because of reduced cost of solvents [6-9], mild reaction conditions of pH, temperature, high enzyme specificity, ease of reaction [10-11]. This makes the enzymatic process much cleaner and energy efficient than the conventional thermal fat splitting alternative, which requires operation at elevated temperature and pressure.

Lipases (EC 3.1.1.3 triacylglycerol acylhydrolyase) can catalyze both hydrolysis and esterification reaction [12-13] of oils with a reasonable rate, depending upon their type such as *Candida rugosa*, *Candida antarctica*, *Pseudomonas*, *Mucor miehei*, *Rhiopus oryzae etc* [14-19]. For the synthesis of DHA rich glycerides, lipase catalyzed hydrolysis of oil is reported as the first step to release free fatty acids from the breakdown of ester bonds of triglycerides in fish oil. *Candida antarctica* lipase-B has been categorized as a selective lipase for long

Active Vibration Control Modeling in Bond Graph for Underwater Flexible Single Arm Robotic Manipulator

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ABSTRACT

Active control is an important technique for vibration control in underwater conditions. The steady state is achieved using bond graph model representing active vibration control of a flexible single arm underwater robotic manipulator. Flow information of both the base and tip of the underwater manipulator is considered and accordingly controller acts. Simulation results indicate that the proposed bond graph model is well suited for underwater flexible single arm robotic manipulator.

Author Keywords

Active vibration; underwater; robot; Euler Bernoulli.

INTRODUCTION

In past few years many control strategies have been developed for underwater vehicles and robots. Despite this there are still some areas in which optimization are needed, e.g. instability due to the base vibration produced by some external source. It is very difficult to achieve steady state once base vibrates in underwater condition. In most of the cases adaptive, PD or other such controls has been developed for the control of sliding, track, motion or force/position of end effector of underwater robotic manipulator. The linear and nonlinear theories of vibration damping for on ground conditions has well documented in the literature [1]. Vibration can be damped primarily by passive, semi-active or by active control. The use of adaptronic electronic components for actuators, sensors and control directly with materials, active control has become favourite latest technics of vibration control [2, 3, 4]. Vibration of robotic manipulator, integrating structures flexible beams using different algorithms and strategies has been developed by many researchers for on-ground robots. The damping of base oscillation can be taken care by approaches like task-space feedback [5, 6], acceleration feedback [7] and active damping on bases of fuzzy logic controller [8, 9, 10]. The effect of vibration on the trajectory has been determined can be reduced or removed [11]. Collocation concepts within a mechanical structure for the control of vibration by passive based active control laws methods has been explored in terms of bond graphs by Jan Holter [12]. Bond graph method is effective tool for the any type of system modeling and has been used for the modeling of robot manipulators [13, 14, 15] and also method has been used to achieve steady state by implementing active vibration control of different systems [16, 17, 18].

In present study an attempt has been made to implement active vibration control on the underwater robotic manipulator. To achieve steady state of base and tip of the flexible single arm underwater bond graph technique has been used. The bond graph model has been created in SYMBOL SONATA software. Flow signal from the base and tip of the robot manipulator is considered in active control. The arm is modeled as Euler Bernoulli model in which arm is divided in to six equal parts. Sub systems (capsules) were modeled for base, arm and a part of active vibration controller and further are integrated. Simulation results indicate that purposed model is well suited for the active vibration control of underwater robotic manipulator.

MODELING OF ACTIVE CONTROLLER

Active vibration control is based on the sensors and actuators within the system, through signal conditioning. The steady state response is achieved by coupling active controller with robotic manipulator.

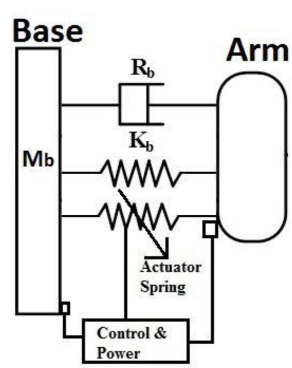

Figure 1: Sematic diagram of Active vibration control of one arm robot manipulator

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Research Article

Adaptive recursive inverse-based control algorithm for shunt active power filter

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Abstract: A new adaptive control technique is proposed for a three-phase shunt active power filter (SAPF) in this study. The proposed control algorithm is based on recursive inverse theory which is used here to extract weighted values corresponding to fundamental active and reactive power components of load currents. This adaptive control algorithm possesses advantages over other control algorithms in terms of its reduced computational complexity, fast weight convergence and robust performance in distorted environment. The SAPF is used to mitigate current related power quality problems such as harmonics, reactive power and load unbalancing in both modes of power factor correction and voltage regulation. The performance of proposed control algorithm of SAPF is demonstrated through simulation results in Matlab/Simulink environment, which are validated with test results obtained on the developed experimental prototype of SAPF in the laboratory.

1 Introduction

The increasing use of power electronics-based loads has deteriorated power quality at distribution level. These loads use mainly power converters, which are non-linear in nature and draw current from the ac mains with high level of harmonic distortion. These loads generate harmonics that results in overheating of equipment, vibrations in motor load connected and drop of supply voltage at network impedance [1]. The non-linear loads are used in industry as well as for domestic purposes. Some common examples are ac or dc converters, switching mode power supplies, arc furnaces, computers, televisions, inverters and so on [2]. Conventional passive filtering technique for reducing harmonics becomes ineffective due to its interaction with the system and leads to harmonic resonance. Advancement in the semiconductor technology, over the last few years has drawn attention towards active power filters (APFs), which is considered a good solution for different power quality problems. The APFs are categorised into two types namely series APFs and shunt APFs (SAPFs). Series APFs are effective for voltage related power quality problems [3, 4]. However, SAPFs are effective for current related power quality problems such as harmonics, reactive power and load unbalancing. Recent developments in digital signal processors (DSPs), high power devices and sensors have made an implementation of SAPFs cost effective [5, 6].

The performance of SAPF in load compensation depends on the type of control algorithm used for extraction of reference currents. Various time domain control algorithms are reported in the literature. Some conventional control algorithms are based on instantaneous active–reactive (p–q) power theory, which perform better under undistorted balanced voltages [7], synchronous reference frame theory [8], power balance theory [9] and improved hysteresis current control of three-level inverter [10]. Other time domain control algorithms are Icosϕ theory [11] which is designed using analogue controller, simple peak detection-base technique [12], one cycle control [13] which has robust performance, provides simple and improved harmonic suppression, composite observer based [14], double deadbeat-loop control method [15] and improved direct power control strategy [16].

Other methods of reference current estimation are based on intelligent techniques such as supervised neural network [17], neural network-based conductance estimation [18] and back propagation control [19]. Many control algorithms are also reported in the literature based on an adaptive filtering algorithm for SAPF [20, 21]. The main advantages of these adaptive algorithms are that they self-adjust their parameters according to system dynamics and are simple in implementation requiring only mathematical operations. An adaptive control algorithm such as leaky least mean square (LMS) [22] has advantage in improved dynamic response and fast convergence and neural network-based adaptive control [23] where the learning rate is obtained using Lyapunov stability. New strategies for adaptive filters for APF are described in [24], where the authors have described two cases, one is based on LMS algorithm and another is based on recursive least square (RLS) algorithm. Adaptive algorithm for selective harmonic cancellation is presented in [25] and improved linear sinusoidal tracer control algorithm is discussed in [26]. In signal processing application, the RLS algorithm shows good performance in distorted environment [27]. However, these algorithms have high computational complexity due to the estimation of the inverse of autocorrelation matrix [28].

In this paper, a recursive inverse (RI)-based control algorithm is proposed for three-phase SAPF. This algorithm is robust under distorted environment, with considerable reduction in computational complexity and achieves faster convergence than RLS algorithm. The weighted values of fundamental active and reactive power components of load currents are extracted and reference supply currents are generated using this algorithm. The proposed algorithm is used for harmonics elimination, reactive power compensation and load balancing in power factor correction (PFC) and voltage regulation modes along with regulation of self-sustained dc bus voltage. The implementation of this algorithm is simple and is based on some mathematical operations such as multiplication, division and addition, for error calculation and weight updation.

2 System configuration and control algorithm

Fig. 1 shows that a three-phase ac mains feeds non-linear load with small series impedance, which acts as a feeder impedance. A voltage source converter (VSC)-based SAPF is connected at the point of

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AGC of a two-area multi-source power system interconnected via AC/DC parallel links under restructured power environment

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SUMMARY

In this paper, automatic generation control (AGC) of a two-area multi-source power system interconnected via alternating current/direct current (AC/DC) parallel links under restructured power environment is proposed. Each area is equipped with multipower generating sources such as thermal and hydro/gas. To execute the different market contracts in restructured power system, the optimal regulators are designed and implemented using optimal control theory. It is observed that the system dynamic results effectively satisfy the AGC requirements in restructured power system, as well as the system dynamic performance is improved by using AC/DC parallel links in comparison with that obtained with AC link as an area interconnection between the control areas. Furthermore, the eigenvalue study is performed to examine the system stability with and without AC/DC parallel links. Finally, the effectiveness of the optimal regulators is checked for the system under study with physical constraints like time delay, boiler dynamics, generation rate constraints, and governor dead band nonlinearity and variations in system parameters from the nominal values. It is shown that the optimal regulators optimized for linear system are robust enough and work well in the proposed realistic AGC system incorporating physical constraints and wide variations in parameters.

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KEY WORDS: automatic generation control; optimal regulators; generation rate constraints; deregulation; optimal control; optimal control applications; robust control

1. INTRODUCTION

A power system is usually segregated into a number of control areas interconnected by the tie-lines. A control area represents a coherent group of generators swinging in unison and endeavors to meet its own demand as well as the scheduled interchanges with other control areas [1, 2]. The mismatch between total power generation and total load demand plus associated system losses, may lead to undesirable effects. Automatic generation control (AGC) plays a vital role for efficient, reliable, economic, and quality operation of interconnected electric power systems. The main objectives of an AGC system are to maintain system frequency at or very near to specified nominal value, to keep the scheduled exchange of power between the control areas, and to assist each source's generation at the most economic value. An up-to-date literature survey of all dimensions of AGC systems is available in References [3–5]. Controllers relying on approaches such as optimal control [6, 7], sub-optimal control [8], Lyapunov stability theorem [9], neural sliding mode [10], hybrid firefly algorithm and pattern search technique [11], genetic algorithm [12], bacterial foraging optimization algorithm [12, 13], fuzzy logic control [13, 14], type-2 fuzzy logic control [15], big bang big–crunch

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An assessment of effects of various parameters on target detection using hyperspectral Data

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ABSTRACT

Hyperspectral imaging has become a standard for most applications that require precision based analysis. This is due to the fine spectral resolution that hyperspectral data offers. Target detection based on hyperspectral imaging is one of the significant applications required for numerous defence, surveillance as well as many civilian studies. This involves detailed analysis of all bands of hyperspectral data for presence of the desired target. However, there exist many parameters which may have bearing on the performance of detection algorithm. These include sensor related parameters like noise, calibration *etc.*, spatial parameters like size, shape and location *etc.* and scene parameters like illumination variation, target composition, colour, background *etc.* This paper demonstrates the implications of three scene parameters namely illumination, background and colour on detection of many known targets using the hyperspectral data. The hyperspectral data acquired over Rochester Institute of Technology (RIT) for experimental purposes has been used [13]. Three popular detection algorithms namely, ACE, MF, SAM have been implemented for target detection and the impact of selected parameters is assessed.

Keywords: Scene parameters, target detection, hyperspectral imaging, detection statistics

1. INTRODUCTION

Remote sensing based target detection is one of the primary applications used for numerous defense and surveillance purposes. It is defined as the process of finding the desired target in the image. This may be performed spatially on the basis of size and shape *etc*. as well as spectrally on the basis of composition of target which creates a unique spectral signature for it. Target detection algorithms may be categorised into i) Spectral matching algorithms ii) Anomaly detection algorithms [1]. Spectral matching algorithms use *a priori* reference spectra of desired target. Each pixel spectrum of image is matched with desired reference spectra to detect the target. These reference spectrums can be derived from the image *i.e.* using *in scene* pixel or from spectral libraries. The anomaly detection algorithms are based on image segmentation, where abrupt variation between pixel and background spectra is used to detect target. Literature suggests that spectral matching algorithms exhibit better performance than the anomaly detectors, because they look for specific spectrally defined targets [2]. Moreover, spectral matching algorithms can further be categorised into [3]

i) Deterministic algorithms- Decisions are taken on the basis of physical and geometrical properties of pixel spectrum and reference spectrum. For example Spectral Angle Mapper (SAM), Euclidean Distance Measure (ED), Spectral Correlation Measure (SCM) *etc*.

ii) Stochastic Algorithms- Decisions are taken on the basis of spectral distribution of target pixels. For example Spectral Information Divergence (SID) and Constrained Energy Minimization (CEM). Matched Filter (MF), Adaptive Cosine Estimator (ACE) *etc*.

Although numerous novel target detection algorithms have been developed, many factors constrain the performance of these algorithms. S. Shen (2003) describe that the spectral quality of an image can be related with four sensor/image parameters namely ground sample distance (GSD), spectral resolution, SNR, and scene complexity to the probability of correct detection for the object/anomaly detection applications. Stefanou *et.al.* (2010) demonstrated effect of spectral image quality for target detection applications using used three images *i.e.* HYDICE image with 210 spectral bands, HyMap image with 126 spectral bands and Quickbird image with four spectral bands. Their results demonstrated that

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An efficient hierarchical 16-QAM dynamic constellation to obtain high PSNR reconstructed images under varying channel conditions

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Abstract: Startling growth in multimedia services over wireless channels emphasizes the need for bandwidth and power efficient modulation techniques. This study investigates the suitability of hierarchical quadrature amplitude modulation (HQAM) for image transmission over erroneous wireless Gaussian channels. HQAM provides unequal error protection, to compressed and coded image data, transmitted without increasing the required bandwidth, unlike channel coding. A discrete cosine transform based image coder is used to divide the image data bit stream into high-priority (HP) and low-priority (LP) sub-streams for significant and non-significant data respectively. The ratios between the constellation distances are then dynamically adjusted with the objective to achieve an acceptable bit-error rate (BER) for HP sub-stream over varying channel conditions at the cost of increased BER for LP sub-stream. The work highlights HQAM implementation using conventional quadrature amplitude modulation (QAM) demodulator at the receiver which does not require the knowledge of varying constellation distance ratios at the transmitter. An analysis of 16-HQAM transmission for different values of distance ratios is presented to obtain high peak signal-to-noise ratio (PSNR) values of reconstructed images under poor as well as good channel conditions and the performance is compared qualitatively and quantitatively with 16-QAM.

1 Introduction

For the wireless transmissions of multimedia, higher transmission rate and reliable transmission channels are required. Hence, for transmission of images or video over wireless channels, bandwidth scarcity and high bit-error rate (BER) are two major issues. To overcome these two issues, efficient source coding and channel coding techniques can be employed. Source coding is used for limiting the bandwidth required for transmission by reducing redundant data while channel coding provides reliable transmission by controlling errors. However, the additional check bits in channel coding further increase the required bandwidth [1].

The issue of bandwidth limitation can be targeted by using quadrature amplitude modulation (QAM) which provides equal error protection (EEP) to all the transmitted bits. However the issue related to BER still exists and is worsened by the compression techniques, which increase the bit dependency, thus sensitising transmissions to errors, that is, in an efficiently coded image/video data significant (critical) data bits need more protection which a non-hierarchical modulation method such as QAM cannot provide [2].

To address both these main issues related to the wireless channels, that is, the BER problem and bandwidth efficiency, this paper examines the suitability of unequal error protection (UEP) method of transmission. The basic idea behind UEP is to ensure transmission of significant or basic information in all channel conditions. To achieve this, the transmitted information can be divided into two or more classes where every class should have a different degree of protection. This protection level depends on the importance of the information contained in that class [3]. To provide UEP, one can apply channel coding schemes using different code rates for each class of segregated information (i.e. low code rate for more important data and high code rate for comparatively less important data class). However, this strategy of achieving UEP is not bandwidth efficient, since channel coding increases the bandwidth requirement. Another bandwidth efficient method to achieve UEP is hierarchical modulation (HM) [2, 4].

HM is a simple modification of conventional modulation where non-uniform constellation is used to provide UEP for transmitted bit stream. Using HM, a transmitted data stream can be divided into two or more classes of data sub-streams with different levels of protection for each layer or sub-stream depending on the importance of information contained, that is, the high priority (HP) sub-stream for significant data and low priority (LP) sub-streams for comparatively less significant data. The benefit of HM is that one can achieve UEP for different classes/layers of multimedia data depending upon their significance, without an increase in bandwidth, unlike channel coding [2–4]. However, channel-coding techniques are able to provide better protection under extremely poor channel conditions. A combination of these two methods can take advantage of both as in [5]. HM is a technique that can also provide differentiated quality of service (QoS) for simultaneously transmitted different classes of data. For example in multimedia or image transmission, the HP sub-stream or basic information layer and LP sub-stream or refinement layer bit streams can be multiplexed onto single stream and transmitted using HM. This technique helps all receivers to receive the most important information (basic layer or HP data). The less important information (refinement layer or LP data) however, can only be recovered by some users or receivers which have good propagation or channel conditions (e.g. closer to the transmitter and/or with a direct line-of-sight path) or from sophisticated RF devices (e.g. low noise amplifiers or higher antenna gain receivers). Hence users with good channel conditions or better channel signal-to-noise ratio (SNR) can receive both layers and can get maximum QoS. While users with poor channel SNR can anyway receive basic information layer and can get minimum guaranteed QoS [2–8].

Analyzing and Assessing the Security-Related Defects

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***Abstract*— The use of the Internet has become an integral part of everyone's life. Due to this, the introduction of virus and other malicious crackers is increasing everyday. This in turn leads to the introduction of defects which adversely affect the security. Thus, protecting vital information in this cyber world is not an easy task. We need to deal with security related defects to ensure failure free and smooth functioning of the software. Thus, in this paper, we intend to study and analyze various aspects of security-related defects by analyzing the defect reports available in various open-source software repositories. Besides this, prediction models can also be constructed which can be used by researchers and practitioners to predict various aspects of security - related defects.**

Such prediction models are especially beneficial for large-scale systems, where testing experts need to focus their attention and resources to the problem areas of the system under development. Thus, application of software prediction models in the early phases of the software life cycle contributes to efficient defect removal and results in delivering more reliable and better quality software products.

Empirical studies lack the use of proper research methodology and thus result in reporting inconsistent results. This study will review the sequence of steps followed in the research process for carrying empirical and replicated studies. The steps include a) literature survey and definition of variables b) data collection c) report findings using statistical and machine learning techniques d) analyzing performance measures for evaluating the performance of the predicted models and e) interpretation of the obtained results for developing a software prediction model. These steps are explained with the help of experimental public domain data set. In addition, the paper provides an overview of repositories for mining software engineering data, tools for analyzing this data and various categories of machine learning methods. It also discusses existing research avenues and provides future research directions in this area.

Keywords—Empirical Validation; Security- Related Defects; Security Vulnerabilities; Statistical Methods; Machine Learning.

I. Introduction

Cyber security has become an increasingly critical crisis due to the extensive technology dependence that characterizes much of our world today. The problem with the pervasive use and need of cyber security, as with many other fields of discipline, is that there are many software errors or defects. The defects once introduced can lead to serious consequences if not handled at the right time using the appropriate amount of resources [1]. Among a number of types of defects, this paper deals with the defects which adversely affects the security. The security related defects are most critical as they expose the system to security vulnerabilities and hamper the integrity and confidentiality of the system [2]. Thus, it is very important to locate such defects and remove them from the system as soon as possible.

In this paper, we intend to study and analyze various aspects of security-related defects by analyzing the defect reports available in various open- source software repositories. Analyzing these aspects of the security-related defects can prove to be very useful as it would help industry professionals in making the correct assessment, thereby leading to optimum utilization of the available resources in terms of money and man-power. We further explain how the unstructured data present in the form of 'defect descriptions' is converted to a structured form by employing text mining techniques. As the final and most crucial step, we provide insights to the development of prediction models which are necessary to predict various aspects of security-related defects like the type of defect or the severity level associated with the defect which would signify the extent to which that particular defect can be harmful for the system. But, in order to ensure the integrity of the prediction models developed, a series of systematic empirical studies are required. Unfortunately, it has been observed that most of the empirical studies which have been conducted in the past lack the use of proper research methodology and thus result in reporting inconsistent results. Keeping the above issue in mind, this paper provides steps for conducting successful empirical studies. The initial steps that are needed to be performed to conduct an empirical study are described. The paper also elucidates the procedure for descriptive statistics and outlier analysis [3]. These steps include identifying and describing the dependent variables, independent variables and empirical data collection. The paper also provides a description of methods used for hypothesis testing and model prediction. The use of statistical and machine learning techniques for developing models to predict and analyze software quality attributes is an important and crucial research area. Moreover, there has been a surge of a new set of techniques, which are evolutionary in nature. Another set of techniques have emerged which combine machine learning techniques and evolutionary techniques. Such techniques are called hybrid techniques. These techniques also need to be evaluated for building models on software quality experimental data. Finally, the paper summarizes the various performance measures used in model evaluation [4].

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Analyzing and Evaluating Security Features in Software Requirements

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***Abstract*— Software requirements, for complex projects, often contain specifications of non-functional attributes (e.g., security-related features). The process of analyzing such requirements is laborious and error prone. Due to the inherent free-flowing nature of software requirements, it is tempting to apply Natural Language Processing (NLP) based Machine Learning (ML) techniques for analyzing these documents from the point of view of comprehensiveness and consistency. In this paper, we propose novel semi-automatic methodology that can assess the security requirements of the software system from the perspective of completeness, contradiction, and inconsistency. Security standards introduced by the ISO are used to construct a model for classifying security-based requirements using NLP-based ML techniques. Hence, this approach aims to identify the appropriate structures that underlie software requirement documents. Once such structures are formalized and empirically validated, they will provide guidelines to software organizations for generating comprehensive and unambiguous requirement specification documents as related to security-oriented features. The proposed solution will assist organizations during the early phases of developing secure software and reduce overall development effort and costs.**

Keywords*— *Software Requirements; Security; Quality of Service; Natural Language Processing; Concept Graphs; Machine Learning.

I. Introduction

Today's systems are often complex, distributed, and software-intensive. As we trust such systems more and more to control many important facets of our lives, their security is becoming paramount. Despite of its criticality, the security of software systems is considered many times as an after-thought. Such an approach is not only naïve but also inappropriate, rather security should be considered as an integral feature of complex systems right from the onset. Hence, a careful identification, creation and analysis of security features are required at early phases of the software development. There are many facets of security varying from features such as authentication, encryption, secure communication, access control and time-sensitive policies for the management of user data. These security requirements are often ignored during the early stages of the software life cycle and if they at all exist, most of the time they are incomplete. Identifying the security features and their impacts on the system design during the requirements analysis phase of the software lifecycle have the following benefits:

- Reduction of defects – Determining the adequacy and consistency of the security requirements provides a fundamental basis for estimating costs, defining the scope of the project, constructing the design and testing specifications, and helping in understanding possible consequences of either a successful or unsuccessful deployment of the system.
- Early discovery of errors – The earlier the software vulnerabilities (e.g., incompleteness of the security requirements) are discovered in the life cycle of a project, sooner they can be corrected and thus decreases the cost drastically.
- Standardization – Assessing software requirements, using available standards (such as security standards introduced by International Organization for Standardization), helps in generating guidelines for the future creation of requirements.

These benefits do emphasize the need for a formal technique to analyze and evaluate security requirements. Rojas and Sliesarieva [1] indicate the desirable qualities of software requirements to be accuracy, verifiability, and unambiguity. However, software requirements, which typically are written as free flowing text, for complex and often distributed, projects present myriad of challenges to stakeholders such as the domain experts, designers, developers, testers, and user. The process of analyzing these requirements is not only

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Atomic Force Microscopy Studies of Homoepitaxial GaN Layers Grown on GaN Template by Laser MBE

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Abstract. We have grown homoepitaxial GaN films on metal organic chemical vapor deposition (MOCVD) grown 3.5 µm thick GaN on sapphire (0001) substrate (GaN template) using an ultra-high vacuum (UHV) laser assisted molecular beam epitaxy (LMBE) system. The GaN films were grown by laser ablating a polycrystalline solid GaN target in the presence of active r.f. nitrogen plasma. The influence of laser repetition rates (10-30 Hz) on the surface morphology of homoepitaxial GaN layers have been studied using atomic force microscopy. It was found that GaN layer grown at 10 Hz shows a smooth surface with uniform grain size compared to the rough surface with irregular shape grains obtained at 30 Hz. The variation of surface roughness of the homoepitaxial GaN layer with and without wet chemical etching has been also studied and it was observed that the roughness of the film decreased after wet etching due to the curved structure/rough surface.

Keywords: Gallium Nitride, GaN template, Laser molecular beam epitaxy, Homo-epitaxial growth, Atomic force microscopy, Wet chemical etching.

INTRODUCTION

The III-nitride semiconductors and their alloys constitute a diverse and fascinating class of materials which have wide application in the field of laser diodes, light-emitting diodes, high electron mobility transistors and ultra- violet detectors due to their remarkable properties such as wide direct band gaps, good thermal conductivity and high breakdown field [1]. For the growth of epitaxial GaN, conventionally hydride vapor phase epitaxy (HVPE) [2], molecular beam epitaxy (MBE) [3] and metal organic chemical vapor deposition (MOCVD) [4] growth techniques are used. There is a high probability of formation of interfacial compounds on chemically vulnerable substrates for GaN film grown by HVPE and MOCVD due to their high growth temperature. Laser MBE (LMBE) is originated as an alternative technique to grow GaN at a relatively lower temperature because in it, laser ablation produces high kinetic energy film precursors [5-8]. Here, we report the effect of laser repetition rate on the surface morphology of homoepitaxial GaN films grown on GaN template using LMBE.

It has been well known that wurtzite GaN has two different polarities along the c-axis, e.g. Ga-polar (0001) and N-polar (000-1). Polarities of GaN surface greatly affect the growth [9] and device performances [10, 11] so it is of key importance to determine the polarity of GaN surface. A simple method of determining the polarity uses an aqueous solution of KOH that etches selectively N-polar surface of the GaN smooth layer while there is almost no effect of KOH on Ga-polar surface [12]. Thus, it is of great importance to know that how this KOH etching affects the surface morphology of LMBE grown GaN layers, especially when the GaN surface is rough. Here, we report the etching behavior in KOH solution of GaN layers prepared by LMBE at different laser repetition rates. It is found that KOH etches the surfaces and decrement in surface roughness has been observed. Maximum change in rms roughness has been observed for rougher GaN layer grown at large repetition rate (i.e.30 Hz).

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Building Concordant Ontologies for Drug Discovery

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***Abstract*— In this study we demonstrate how we interconnect three different ontologies, the BioAssay Ontology (BAO), LINCS Information FramEwork ontology (LIFEo), and the Drug Target Ontology (DTO). The three ontologies are built and maintained for three different projects: BAO for the BioAssay Ontology Project, LIFEo for the Library of Integrated Network-Based Cellular Signatures (LINCS) project, and DTO for the Illuminating the Druggable Genome (IDG) project. DTO is a new ontology that aims to formally describe drug target knowledge relevant to drug discovery. LIFEo is an application ontology to describe information in the LIFE software system. BAO is a highly accessed NCBO ontology; it has been extended formally to describe several LINCS assays. The three ontologies use the same principle architecture that allows for re-use and easy integration of ontology modules and instance data. Using the formal definitions in DTO, LIFEo, and BAO and data from various resources one can quickly identify disease-relevant and tissue-specific genes, proteins, and prospective small molecules. We show a simple use case example demonstrating knowledge-based linking of life science data with the potential to empower drug discovery.**

***Keywords*— drug discovery; bioinformatics; cheminformatics**

I. Introduction

Big data are ubiquitous in business, technology and science. Life science research data are no exception. However, the nature of research data, in particular in the life sciences brings additional challenges due to broad diversity of data types and formats, the quick evolution of knowledge and advancements in technologies to generate data. Despite large investments in information systems in the pharmaceutical industry and non-profit research organizations, the difficult problem of describing, organizing, integrating, analyzing diverse, fast evolving and large scale data in the context of biological knowledge remains a critical and not fully solved challenge.

In this study we demonstrate in a simple case study how to represent and organize such data better by using Semantic Web technologies. Although this approach is not novel, we contribute by leveraging three ontologies developed in our group and that are largely aimed at addressing different aspects of drug discovery data.

The BioAssay Ontology (BAO) [3] has been developed to formally describe knowledge of chemical biology assays and screening results using Description Logic (DL) [14] and OWL (OWL2.0) [17]. The first version of BAO [9] focused on High Throughput Screening (HTS) assays and contained descriptions of many assays from PubChem. BAO since evolved to better integrate with other ontologies and better align with established upper level models and improve usability. BAO was also extended to support profiling assays such as those in LINCS [21]. The systems biology nature of LINCS data required a formal model to describe the relations of cells, disease, tissues and relevant bio-molecules, such as proteins, transcribed genes, used in different roles the various assays. The LINCS Information FramEwork (LIFE) [20] was developed to process, integrate, query, and explore this data. The LIFE application ontology (LIFEo) was developed as a knowledge model to capture the relevant relationships to facilitate this functionality. The Drug Target Ontology (DTO) is being developed as a reference framework to formalize knowledge about drug targets in the context of simple assays and more complex model systems; it is developed as part of the Illuminating the Druggable Genome (IDG) project [22]. For example DTO can readily be used in BAO or in LINCS to describe protein targets in an assay or known targets of small molecule drugs.

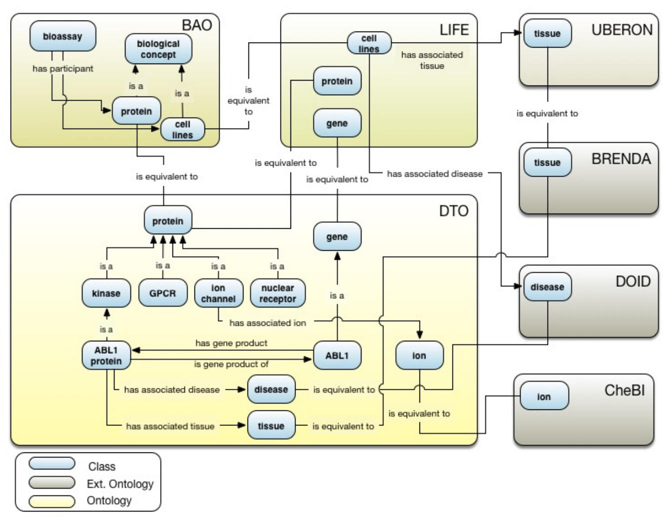

Figure 1 BAO, LIFEo, and DTO with select external ontologies

Clustering Analysis of the Electrical Load in European Countries

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***Abstract*—In this paper we used clustering algorithms to compare the typical load profiles of different European countries in different day of the weeks. We find out that better results are obtained if the clustering is not performed directly on the data, but on some features extracted from the data. Clustering results can be exploited by energy providers to tailor more attractive time-varying tariffs for their customers. In particular, despite the relevant differences among the several compared countries, we obtained the interesting result of indentifying a single feature that is able to distinguish weekdays from holidays and pre-holidays in all the examined countries.**

I. Introduction

A. Motivation

There are two main motivations to accurately analyze electrical load consumption data: the first reason is to make the power grid operate in a more efficient way, possibly close to real-time. In fact, the recent increase of power generated from renewable sources, mainly PhotoVoltaic (PV) plants and wind farms, has in turn increased the quantity of power that is injected in the grid in a non-dispatchable and fluctuating manner. On the other hand, conventional power plants (e.g., thermo-electric power plants) are continuously maintained switched on at a low-level, as a back-up to match the energy demand, if needed (i.e., if they were switched off, then it would take a too long time before they could effectively be used as a back-up). Such an operation is very expensive, especially as it is usually very rare that they are used in practice. In this framework, the ability to predict the load in an accurate manner would clearly provide a helpful information to the energy suppliers to schedule the operation of power plants in a more efficient, and economically convenient, way.

There is also a second motivation to learn the patterns of electrical load consumption. The electricity market is in fact shifting towards a more dynamic, liberalized and competitive environment; the number of Distributed System Operators (DSOs) and energy retailers is increasing inside single countries, and have also started competing in other national markets. In such a context, energy suppliers have started to offer more diversified energy tariffs, following the trend of diversified bills in other more-established fields (e.g., telecommunications). From this perspective, the ability to know the typical load consumption patterns of different classes of customers can be used by energy suppliers to offer tailored, and in principle more attractive, energy tariffs.

Accordingly, the objective of this paper is to analyze the consumption data of some European countries of different sizes and of different latitudes. While it is clear that the load is different for a number of reasons, namely, other than size and geographical reasons, there are also different levels of the industrial sector, and use of electrical energy for different purposes (e.g., heating), an interesting finding of this paper is that there are also some important common patterns. In particular, as it will be further elaborated in the paper, some features are equivalently informative in all the considered countries.

This paper is organized as follows: the remainder of the Section is dedicated to explain why we are interested in applying clustering algorithms to the load data, and to review the current state of the art in this specific application. Section II introduces the used data-base, provides some initial insight on the available data, and shortly illustrates the used clustering algorithms and the adopted performance indices. Section III thoroughly compares the hourly load patterns among the considered countries in different cases. Finally, we summarize our findings and outline our current ongoing research in Section IV.

B. Clustering

Classification and clustering of time series signals is an important area of research in several fields, such as economics, engineering, finance, medicine, biology, physics, geology, and many others. Clustering refers to the ability to aggregate similar objects together, and the basic clustering operation corresponds to take a set of N objects and group them into K clusters. There are three main motivations for doing so (from [1]):

(i): First, a good clustering has predictive power; in this case, we perform clustering because we believe the underlying cluster labels are meaningful, will lead to a more efficient description of our data, and will help us choose better actions. This type of clustering is sometimes called "mixture density modelling", and the objective function that measures

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Color based Human Detection and Tracking Algorithm using a Non-Gaussian Adaptive Particle Filter

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***Abstract*— In this paper, an algorithm is presented that can detect and isolate moving skin colored pixels, or more generally humans, from a static background, and then track them using a non-Gaussian recursive Bayesian Particle filter. Particle filter (PF) is an adaptive filter based on sequential Monte Carlo methods, and represents probability densities in terms of particles. It is of vital importance that the elements of non-linearity and non-Gaussianity are included so that the physical system being modeled can be more and more close to the real world, and all the estimations and analysis carried out could hold practical. Key aspects of our tracking algorithm such as background removal with illumination compensation, skin color detection and Particle filter implementation have been explained and demonstrated. This is followed by the results of our tracking algorithm and a conclusion.**

Keywords*— *Non-Gaussian, Bayesian, Monte Carlo, Illumination, Background, Particle filter, Tracking

I. INTRODUCTION

Tracking refers to a process in which the movements of a mobile object in a static or moving background are recorded and analyzed. Medical imaging, traffic management, security and surveillance, video communication, human tracking, 2D/3D computer animation etc. are all applications of tracking.

Tracking consists of three major steps[1]: object detection, object tracking and trajectory analysis. Object detection/recognition is a process that uses a variety of algorithms to detect and isolate the object in interest, also known as the foreground, from the background. Prior to object detection, object representation is one imperative thing to consider. Object representation means how the object in interest is being modeled in the tracking process, like for e.g. point-based, contour-based, patch-based, skeleton-based, silhouette-based, etc[1]. In our algorithm, we have opted for point-based representations because of their relative ease in use. Another important thing to consider is feature selection, i.e. selection of a feature in the foreground that will separate and distinct it from the background. For example, color is used as a feature for histogram-based appearance representations, while for contour-based representation, object edges are usually used[1]. In general, many tracking algorithms use a combination of these features. In our algorithm, we have opted for color-based feature selection. Object tracking, as also defined above, is a process to track the trajectory of a moving object in interest. Now, the tasks of object detection and tracking can either be carried out independently or jointly, but in both, object modeling using various means described above is carried out first. These representations are used to approximate the motion of objects in scene. For e.g., for a non-rigid object, silhouette or contour based modeling is widely used, while for rigid objects like humans, point based models can be employed[1].

Previous works on human tracking like [2] recognizes a human based upon a codebook, which uses code vectors to match features extracted from a human contour. It also firsts normalizes the size of the object to 20 by 40 for extracting these features. Our algorithm represents a rather simple solution that recognizes human movement by identifying moving skin-colored pixels, and requires no re-sizing. This makes our tracker to work even for movements that do not involve whole human bodies, like for e.g. with face or hand movements only. Another work modeled on colored voxels [3], does not utilize the feature of background subtraction that makes tracking more efficient. Our algorithm along with these features also employs Particle filter for tracking, which is a robust and efficient solution to handle non-linearity during state modeling.

II. TRACKING BASED ON ADAPTIVE NON-GAUSSIAN PARTICLE FILTER

A. *Statistical/Probabilistic methods for point based modeling.*

Statistical or Probabilistic methods employ the state-space approach for modeling various parameters of motion such as position, velocity, etc. According to state-space approach, an object's next state of position or its change of state over time, x_t, is governed by a dynamic equation and can be represented as[4]:

$$x_t = f_t(x_{t-1}) + w_t \quad (1)$$

where f_t represents the state transition function, x_{t-1} is the last known state, and w_t stands for process noise. Also, the relationship between the state x_t and the measurement z_t is represented by[4],

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RESEARCH

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Comparative study of anti-angiogenic activities of luteolin, lectin and lupeol biomolecules

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Abstract

Background: Angiogenesis is a hallmark feature in the initiation, progression and growth of tumour. There are various factors for promotion of angiogenesis on one hand and on the other hand, biomolecules have been reported to inhibit cancer through anti-angiogenesis mechanism. Biomolecules, for instance, luteolin, lectin and lupeol are known to suppress cancer. This study aims to compare and evaluate the biomolecule(s) like luteolin, lupeol and lectin on CAM assay and HT-29 cell culture to understand the efficacy of these drugs.

Method: The biomolecules have been administered on CAM assay, HT-29 cell culture, cell migration assay. Furthermore, bioinformatics analysis of the identified targets of these biomolecules have been performed.

Result: Luteolin has been found to be better in inhibiting angiogenesis on CAM assay in comparison to lupeol and lectin. In line with this study when biomolecules was administered on cell migration assay via scratch assay method. We provided evidence that Luteolin was again found to be better in inhibiting HT-29 cell migration. In order to identify the target sites of luteolin for inhibition, we used software analysis for identifying the best molecular targets of luteolin. Using software analysis best target protein molecule of these biomolecules have been identified. VEGF was found to be one of the target of luteolin. Studies have found several critical point mutation in VEGF A, B and C. Hence docking analysis of all biomolecules with VEGFR have been performed. Multiple allignment result have shown that the receptors are conserved at the docking site.

Conclusion: Therefore, it can be concluded that luteolin is not only comparatively better in inhibiting blood vessel in CAM assay, HT-29 cell proliferation and cell migration assay rather the domain of VEGFR is conserved to be targeted by luteolin, lupeol and lectin.

Keywords: CAM assay, Flavonoids, HT-29 cell, Anti-angiogenesis, Luteolin, Lupeol, Lectin

Background

Angiogenesis process is regulated by several factors that have a critical role in governing the initiation and progression of tumour. Angiogenic factors such as bFGF, HGF, VEGF, hyluronatelyase, collagenase, MMP supports the formation of new blood vessels. In addition, cell cycle markers, for instance, cyclin A2, Cyclin Dependent Kinase-2, 6 and MAPK1, 14, 10 promote the tumour progression whereas caspase 3 inhibits the tumour progression. Mounting evidence is suggesting the critical role of cyclin inhibitors, and inducers of apoptotic markers in cancer therapy. Furthermore, several biomolecules elicit the anti-cancerous property such as, luteolin, lectin and lupeol but comparative studies in terms of anti-angiogenic activity remain unsettled.

Luteolin is a flavonoid; lupeol is a triterpene and lectin is a protein possessing carbohydrate. Flavonoids are polyphenols that play an important role in defending plant cells against microorganisms, insects, and UV

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TECHNICAL NOTE

Comparison of ANN and Analytical Models in Traffic Noise Modeling and Predictions

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Abstract This paper demonstrates the applications of artificial neural networks to predict the equivalent continuous sound level (L_{Aeq}) and 10 Percentile exceeded sound level (L_{10}) generated due to traffic noise for various locations in Delhi. A Model based on back-propagation neural network was trained, validated, and tested using the measured data. The work shows that the model is able to produce accurate predictions of hourly traffic noise levels. A comparative study shows that neural networks out-perform the multiple linear regression models developed in terms of total traffic flow and equivalent traffic flow. The prediction model proposed in the study may serve as a vital tool for traffic noise forecasting and noise abatement measures to be undertaken for Delhi city.

Keywords Traffic noise · Artificial neural network (ANN) · Equivalent continuous sound level · L_{Aeq}

1 Introduction

Technological development has led to urbanization which has also given rise to the problem of increasing traffic noise. It has been scientifically proven that high noise levels seriously affect the health of the people exposed to it. Different studies have been conducted to generate a model which can predict the noise levels with a definite accuracy. In the Indian context, there have been many studies reported on modeling traffic noise for various cities. Since Delhi has been facing severe traffic-related problems, so a model based on Delhi's traffic noise would be sufficient to generalize this problem and can be used to predict the traffic noise in other parts of the country as well. The previous studies in Indian context are generally focused on a regression-based approach [1–6].Various models have been developed for different Indian cities in the past few years. Rao et al. [1] developed a regression equation for modeling L_{A10} as a function of traffic density. In urban areas, most of the traffic flow is often interrupted by traffic signals and thus interrupted traffic flow conditions on urban roads create substantially different noise characteristics from the highways to expressways [2,3]. Rajakumara et al. [3] developed a regression noise prediction model for both acceleration and deceleration lanes. Agarwal [4] introduced equivalent number of light and heavy vehicles for the calculation of L_{eq} values. Light motor vehicles have been found to be the major culprit in noise pollution. The recent investigations of Kalaiselvi [5] also accounted a horn noise component. It has been observed that horn noise occurs with a frequency of 16 events per minute and raises the L_{eq} by 12 dB(A). Mishra et al. [6] did a comprehensive field survey with an objective to quantify and analyze the traffic noise emissions along the bus rapid transit corridor in Delhi. The recent studies by Kumar et al. [7] and Sharma et al. [8] have also developed the traffic noise models using artificial neural network (ANN) and regression approach. Even with a small database, the results of ANN have been shown to be satisfying [7]. In the developed nations, there has been an extensive

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Comparison of ARIMA and ANN approaches in time-series predictions of traffic noise

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The paper analyzes the long-term noise monitoring data using autoregressive integrated moving averages (ARIMA) modeling technique and artificial neural networks (ANNs) methodology. Box–Jenkins ARIMA and ANN approach have been utilized to simulate daily equivalent L_{Day} (06–22h) and L_{Night} (22–06h) in A and C weightings for a period of 1 year. The forecasting performance is ascertained using the statistical tests. The work draws a comparison of time-series ARIMA and ANN approach for ascertaining their suitability for traffic noise modeling and forecasting. It is observed that the artificial neural network (ANN) models outperform the ARIMA models so developed. The pattern of ARIMA forecasting models is directional and as such the time-series predictive model utilizing ANN approach has demonstrated superior performance over the ARIMA model.

Primary subject classification: 76.1.1; Secondary subject classification: 52.3

1 INTRODUCTION

A continuous long-term noise monitoring of ambient noise levels is cumbersome and quite expensive. Thus, short-term strategies like temporal samplings[1] and forecasting techniques should also be investigated. The time-series analysis of traffic noise shall be thus instrumental in forecasting the future noise levels in addition to the continuous noise monitoring attributed to the stochastic nature of traffic noise. It can also serve as a suitable substitute to the continuous long-term noise monitoring provided the predicted data matches well with the actual measured data. There have been very few studies reported so far on the application of this approach to noise modeling. Kumar and Jain analyzed the short-term noise levels measured at 10 s intervals in the vicinity of a busy road utilizing the ARIMA approach[2]. ARIMA methodology has not been implemented so far in time-series prediction of traffic noise levels except a few studies[2–4], although it has been extensively used in air and water pollution predictions[5,6]. The present work extends Kumar and Jain's work[2] by utilizing ARIMA approach for long-term traffic noise levels prediction and forecasting. The recent work[7] demonstrates the suitability and reliability of ARIMA approach for time-series modeling of long-term traffic noise levels for a smaller period of 6 months.

An artificial neural network (ANN) is a soft computing tool inspired by human brain and has been observed to be a good substitute in solving the least squares problem or multiple regression analysis. The advantages of ANN approach over the conventional methods are that they are fast and are reliable for the computation of multi-variable, non-linear and complex computations[8]. This paper demonstrates the application of ANN methodology for time-series modeling and forecasting of traffic noise levels. A statistical comparison between the results observed from ARIMA and ANN approaches are presented to ascertain their suitability for long-term noise modeling and forecasting. Although the developed ARIMA and ANN models are site-specific, yet the main objective behind the present work is to demonstrate their suitability and applicability for time-series modeling and forecasting which can be thus utilized for any site or location in general. Thus, these modeling techniques in conjunction with short-term noise monitoring strategies can serve as an alternative to the cumbersome and expensive long-term noise monitoring[9–12].

2 LONG-TERM TRAFFIC NOISE DATA ANALYSIS

The traffic noise monitoring data analyzed in the present study is reported from Central Pollution Control board (CPCB) noise monitoring station situated in a commercial zone of Delhi. The noise monitoring terminal is

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COMPUTATION OF OPTIMUM PARAMETERS OF A HALF EFFECT WATER-LITHIUM BROMIDE VAPOUR ABSORPTION REFRIGERATION SYSTEM

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Keywords: Half effect, exergy analysis, Vapour Absorption Refrigeration, Water-lithium bromide
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ABSTRACT

In this research paper, energy and exergy analyses of water lithium bromide half effect vapour absorption refrigeration system has been carried out. Based on energy and exergy analysis the optimum intermediate pressure is computed corresponding to maximum values of coefficient of performance and exergetic efficiency under various operating conditions. It is found that the optimum intermediate pressure corresponding to maximum values of coefficient of performance and exergetic efficiency is same. The effects of low and high pressure generator temperatures, evaporator temperature, effectiveness of solution heat exchangers and difference between low and high pressure generator temperatures have been considered in computing optimum intermediate pressure. The maximum COP varies between 0.415 - 0.438 and maximum exergetic efficiency varies between 6.96-13.74%.

INTRODUCTION

Refrigeration and air-conditioning systems have a major impact on energy demand with nearly 30% of the total energy consumption in the world (Buzelin et al., 2005). The fast depletion of fossil fuels has led the scientists to search for refrigeration systems that consume less high grade energy for their operation. The vapour absorption refrigeration (VAR) systems are a good option in this context. Arivazhagan, Saravanan and Renganarayanan (2006) expressed that low temperature heat sources such as waste heat, low pressure steam, solar heat, geothermal energy, etc. can be used as input in the absorption machines. A half effect absorption cooling cycle promises the utilization of low temperature heat source such as geothermal energy or waste heat available at 60ºC to 80ºC (Herold, Radermacher and Klein, 1996). Many researches have reported theoretical and experimental works on single and double effect absorption systems in the recent years. However the literature on half effect VAR systems is scant. Ma and Deng (1996) carried out theoretical analysis of low-temperature hot source driven two-stage half effect water lithium bromide absorption refrigeration system. The effects of varying hot water and chilled water temperatures on COP of the system have been examined. Their results revealed that the COP of half effect cycle is lower than that of single effect VAR system using water lithium bromide. Sumathy, Huang and Li (2002) developed a model of two-stage lithium bromide solar absorption chiller and reported that two stage chiller could be driven by low temperature hot water ranging from 60 to 75°C. Arivazhagan et al. (2005) carried out simulation studies of a half effect vapour absorption cycle using R134a-DMAC refrigerant-absorbent pair with low temperature heat sources for cold storage applications. The intermediate pressure of the cycle was optimized for maximum COP. It was reported that the effect of the temperature of the low absorber on the performance is more pronounced than that of the high absorber. The COP for the baseline system was found to vary from 0.35 for low evaporating and high condensing temperatures to 0.46 for high evaporating and low condensing temperatures. The second law efficiency was reported to be varying between 28-

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Consequence of pH Variation on the Dielectric Properties of Cr-doped Lithium Ferrite Nanoparticles Synthesized by the Sol-gel Method

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Controllable one step copper coating on carbon nanofibers for flexible cholesterol biosensor substrates†

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Electrospun carbon nanofibers (CNFs) decorated with copper oxide nanoparticles were successfully synthesized using a one step and modified hydroxyl ion assisted alcohol reduction method. The X-ray diffraction pattern reveals the presence of (−111), (111) and (−202) crystal planes of monoclinic copper oxide (CuO). The CuO coated CNF air annealed at 250 °C exhibited an electrical conductivity of 251 S m^{-1}. The CuO coated CNFs were employed as a novel flexible matrix for a cholesterol biosensor. The biosensor exhibited a high sensitivity of 75 μA mM^{-1} cm^{-2} over the linear range (0.12 mM to 12.93 mM) of cholesterol. This coating method offers easy and inexpensive processing with a flexible and robust supporting structure for biosensing applications.

Introduction

Currently, nanostructured materials have attracted considerable attention because of their excellent efficiency for various technological applications in comparison with the bulk or micro-sized counterparts.[1,2] In particular one dimensional carbon nanostructures such as nanowires, nanofibers, nanotubes, *etc.*, possess superior chemical, electrical, and mechanical properties, which in combination with their high surface-to-volume ratios facilitate the development of various hybrid devices.[2–4] Among these carbon nanostructures, carbon nanofibers (CNFs) are very promising materials[5] for their potential applications in hydrogen energy storage,[6] lithium-ion rechargeable batteries (LIBs),[7] fuel cells,[8] and electrochemical double-layer capacitors (EDLCs)[9] and can also serve as an excellent matrix for biosensing applications.[10] Furthermore, metallization and functionalization using CNFs are effective gateways for improving the performance of biosensors. CNFs can serve as an excellent immobilization matrix for the attachment of a desired biomolecule to their surface owing to their biocompatibility as well as flexibility.[11]

Flexible substrates are light weight, robust, capable of being folded for storage, can attach to uneven surfaces and are promising for the development of implantable biosensors.[12] Carbon based materials[13] such as CNFs can be used as flexible supports for the deposition of metal oxide nanoparticles and provide an added advantage for biosensing applications. Metallic coatings on the surface of carbon based materials were obtained using chemical vapor deposition (CVD) and a wet chemical process.[3,14,15] However, coating of homogeneous and facile metals and their oxide nanoparticles directly on the surface of CNFs is very challenging.[16] Therefore, many studies have been conducted on the coating of metal or metal oxides on the CNF surface by functionalization and other techniques.[17–19] Oxidative acid treatment is one of the approaches for the generation of functional groups on the CNF surface. In the coating, the density of surface functional groups required for uniform metal deposition and interaction is severely affected using the above technique.[20–25] Conventional electroless-plating processes are widely used for the coating of metal nanoparticles[26,27] on the surface of pretreated CNFs to achieve uniform density of surface functional groups.[28,29] A few other techniques such as dip-coating in poly(furfuryl alcohol) (PFA) and tetraethylorthosilicate (TEOS) to functionalize CNF surfaces with carbon and silica nanoparticles have also been reported.[30] However, these methods have disadvantages such as severe chemical treatment, long reaction time, high temperatures, and complicated processes resulting in a decrease of the electrical, chemical and mechanical properties.[31]

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Copper Thiocyanate (CuSCN): An Efficiency Solution-Processable Hole transporting Layer In Organic Solar Cells

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Abstract

Here, we report copper(I)thiocyanate (CuSCN) as an efficient and solution-processable hole transpot layer (HTL) in bulk heterojunction solar cells. Three different combinations of most studies active layers of P3HT:PC_{61}BM, PCDTBT:PC_{71}BM and PTB7:PC_{71}BM were used for photovoltaic devices fabrication with simplest device structure of ITO/CuSCN/active layer/Al. The use of CuSCN as an HTL is improved light absorption within the active layer and thereby leads up to 5.94% and 4.60% power conversion efficiencies (PCEs) for the active layers of PCDTBT:PC_{71}BM and PTB7:PC_{71}BM respectively. These results are slightly better when compared to the devices fabricated using thermal deposition of MoO_3 and solution processed deposition of PEDOT:PSS as HTL under similar condition. We have observed that annealing temperature for HTLs in organic solar cells has significant effect on PCE specifically the fill factor (FF) and short-circuit current (J_{sc}). In this present work, the resulted HTLs were characterized by UV-vis-NIR spectroscopy, scanning electron microscope (SEM), atomic force microscope (AFM) and transmission electron microscope (TEM) for

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Design and analysis of equiangular spiral photonic crystal fiber for mid-infrared supercontinuum generation

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A design of equiangular spiral photonic crystal fiber (PCF) in As_2Se_3 chalcogenide glass is reported for mid-infrared supercontinuum generation. Supercontinuum covering the 1.2–15 μm molecular fingerprint region is achieved using only 8 mm long designed PCF pumped with 50 fs laser pulses of 500 W peak power. The structural parameters have been tailored for all-normal dispersion characteristic. Proposed structure has high nonlinearity (γ = 12474 W^{-1} km^{-1}) at 3.5 μm with very low and flat dispersion −2.9 [ps/(nm × km)]. Supercontinuum with such broadening and high coherence degree is applicable for mid-infrared spectroscopy, gas sensing, early cancer diagnostics and free space communication.

Keywords: spiral photonic crystal fiber; supercontinuum generation; all normal dispersion

1. Introduction

Mid-infrared supercontinuum generation (SCG) is one of the most exciting research topics due to its major impact on spectroscopy and molecular sensing. SCG is a process in which ultra-short pulses of laser light evolves into the light with a broadband spectrum. It happens when optical pulses pass through a highly nonlinear optical medium [1]. The spectral brightness of supercontinuum is million times brighter than the conventional light sources. The mid-infrared spectral domain ranging from 2 to 20 μm is particularly important because of not only it contains two important windows (3–5 μm and 8–13 μm spectral region) in which the earth's atmosphere is relatively transparent but also the strong characteristic vibrational transitions of most of the molecules are in this domain [2]. Mid-infrared molecular 'fingerprint region' is applicable in various important applications in different diverse fields such as medical, industry and security [3–7].

Therefore, in order to obtain broadband supercontinuum spectra in mid-infrared region, several efforts have been made during the last few years. Agrawal et al. [8,9] presented equiangular spiral (ES) photonic crystal fiber (PCF) structures in soft and tullurite glasses with high nonlinearity and expected their applications for generating supercontinuum. An ultrabroad and flat supercontinuum spectrum spanning 1.3–3.7 μm has been presented in tullurite spiral PCF [10]. Supercontinuum spectrum extending from 0.8 to 2.5 μm has been observed in a regular hexagonal lattice tellurite PCF using 150 fs long pulses at 1580 nm [11]. Shaw et al. [12] presented an experimental demonstration of SCG in the spectral range from 2.1 to 3.2 μm using hexagonal structure of As_2Se_3 based chalcogenide PCF. Recently, Hu et al. [13] gave a design procedure, which can be used to maximize the band-width of SCG in As_2Se_3 chalcogenide PCFs, for more than 4 μm band-width of SC. Kubat et al. [14] presented a numerical design optimization of ZBLAN fibers for mid-infrared SC sources using direct pumping with 10 ps pulses from mode-locked Yb and Er lasers to obtain broad spectra ranging from 1 to 4.5 μm. Saini et al. [15] reported designs of highly nonlinear triangular core PCF with all normal dispersion for SCG. Klimczak et al. [16] achieved SC broadening between 0.93 nm and 2.17 μm spectral range using all-solid soft glass microstructured optical fiber. Mid-IR SC spectra spanning 1.795–6.525 μm has been achieved using only 8 mm length of As_2Se_3 nanofiber with input pulse energy of 100 nJ [17]. In Ref. [18], the authors have experimentally demonstrated the SCG covering 0.9–9 μm with the help of commercially available ZBLAN fiber and commercially available chalcogenide PCF. Kubat et al. [19] presented numerical modelling of broadband mid-infrared SCG spanning from 3 to 12.5 μm in step-index fiber pumped at 4.5 μm with 0.75 kW pump power. Very recently, Petersen et al. [20] demonstrated broadband mid-infrared supercontinuum spectra covering the range of 1.4–13.3 μm in mid-infrared regime using ultra-high NA chalcogenide step-index fiber. As_2Se_3 based chalcogenide is most suitable material for mid-infrared SCG due to its low propagation loss and high nonlinear refractive index.

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Design and Analysis of Rectangular Core Photonic Crystal Fiber for Supercontinuum Generation

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ABSTRACT

A rectangular core photonic crystal fiber design in As_2Se_3 chalcogenide glass has been reported for mid-infrared supercontinuum generation. The structural parameters have been tailored for all normal dispersion profile. The proposed structure possesses nonlinearity (γ) as large as 20956 W^{-1} km^{-1} at 2800 nm wavelength with very low and flat dispersion of -2.38 ps/(nm×km). We have generated supercontinuum spectra spanning 1480 – 9990 nm using only 4 mm length of proposed photonic crystal fiber pumped with femtosecond optical pulses of peak power of 500 W at 2800 nm.

1. INTRODUCTION

Now-a-days the mid-infrared supercontinuum generation (SCG) is one of the most exciting research topics due to its major impact on telecommunication, optical metrology, optical coherence tomography, spectroscopy, cosmological study, ultra-short pulse generation and molecular sensing [1-7]. SCG is a process in which ultra-short pulses of laser light evolves into the light with a broadband spectrum due to the result of combined effect of the various non-linear phenomena and second and higher order dispersion effects. It happens when optical pulses pass through a highly nonlinear optical medium. The spectral brightness of supercontinuum is million times brighter than the conventional light sources.

The phenomenon of SCG was first observed in 1970 by *Alfano and Shapiro* when they focused powerful pico-second laser pulses in to glass sample [8]. After that, the SCG was obtained in a conventional step-index single-mode fiber in 1987 [9,10]. *Ranka* et al [11] demonstrated SCG first time in PCF structure. The broadening of SC spectrum is highly depends on dispersion profile of the PCF and has smooth profile when PCF has flat dispersion with small slope and a zero crossing near or at the pump wavelength [12]. Also, pumping with nearly zero dispersion wavelength (ZDW) and higher nonlinearity reduces its power requirement as well as smoothes the generated SC spectra [13]. *Foster et. al.* [14] generated an octave spanning supercontinuum using a small core tapered microstructured fiber with sub-wavelength diameter core. *Hu et. al.* [15] described a procedure of maximizing the bandwidth of the supercontinuum spectrum in As_2Se_3 based chalcogenide fibers. *Barh et. al.* [16] reported the design and numerical study of a highly non-linear photonic crystal fiber for mid-infrared light source at 4.36 μm. *Agrawal et. al.* [17 – 19] introduced the designs of spiral photonic crystal fiber structure in soft and tellurite glasses for SCG. *Baili et. al.* [20] achieved mid-infrared supercontinuum spectrum spanning 1795 – 6525 nm using 8 mm length of As_2Se_3 nanofiber with moderate pulse energy of 100 nJ. Recently, *Saini et. al.* [21-24] has reported different asymmetric designs of triangular core photonic crystal fibers in chalcogenide glasses for mid-infrared supercontinuum laser sources.

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Design and control of LCL filter interfaced grid connected solar photovoltaic (SPV) system using power balance theory

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ABSTRACT

In this paper solar photovoltaic (SPV) system connected to the utility grid is designed and simulated. The utility grid and SPV system are coupled with current controlled voltage source converter (VSC) and LCL filter. The design of LCL filter, MPPT algorithm and power quality improvements are discussed and simulation results are shown for the performance analysis of grid-coupled PV system under different load condition. The system is controlled through power balance theory method. The principle behind the control implementation is to evacuate the solar power generated during the daytime and the reactive power demand for the load should be supplied by the PV. The grid coupled system consists of SPV system, dc–dc boost converter, maximum power point tracking (MPPT), voltage source converter (VSC), LCL filter, different loads and three phase utility grid. This system is capable of eliminating harmonic and load balancing by supplying unbalanced current from the PV as a compensator. The system is simulated with 10 kW SPV array using indirect current control scheme.

Introduction

The advent of the new technologies in the different area of science and engineering gives rise in the power consumption level due to the use of various equipments which require energy to operate. But, it also provides the aspects of new energy generation technologies. In the newer aspects of energy, solar energy is one of the prominent sources. The advantage of solar energy is the possibility of uses in variety of forms and application. It can be used as solar thermal energy, solar photovoltaic system and various applications as stand-alone mode and grid connected mode. The aspects of energy generation are also related to make the individual houses, offices and societies self-sufficient in terms of energy by distributed generation. The one of the most dominant areas of distributed generation deals with the photovoltaic (PV) power generating system connected to utility grid. PV system has different characteristics with conventional power generation by fossil fuel. Therefore, the new topologies and control algorithms are implemented to couple the PV sources with utility grid [1]. Solar power generating system is a good choice for power generation because of its direct conversion capability into electrical power [2].

The solar power production is growing at very fast rate in India and world also. In India approximately 1.5 GW grid connected solar power is produced presently [3]. To cater the power demand with the increasing rate of consumption, the distributed generation in grid connected mode is mostly desirable with grid following power export control [4,5] and also it lowers the possibility of energy storage problems. The PV system can be coupled to the grid using inverter to convert the dc into ac as power generated by PV system is dc in nature. This system requires power conditioning unit for smooth operation and control algorithm for grid synchronization and power control. The LC filter can be used for reduction of ripples as power conditioner but it is expensive for medium and high power application due to the inclusion of high value inductance [6]. The LC filter is substituted by the LCL filter. The design of LCL filter is having one of the important roles in the entire system and plays vital role for stability of the system. By taking care of cost problems, the LCL filter design is used in a way that using lower value of inductance which is expensive and bulky too, higher value of capacitance which is cheaper [7]. The grid impedance is also having impact on the stability of the system and special care required in the design of LCL filter. The resonance frequency of LCL filter varies as the grid impedance varies i.e. stiffness of the grid [8]. The PV system is coupled with the grid, and the synchronization and power control strategy is required for the operation. The various control strategy is mentioned in the literature and researches based on

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Design of small core tellurite photonic crystal fiber for slow-light-based application using stimulated Brillouin scattering

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Abstract. Stimulated Brillouin scattering (SBS) performances of small core tellurite photonic crystal fibers (PCF) are rigorously studied. We propose a design of tellurite PCF that is used for slow-light-based applications. We developed a two-dimensional finite element mode solver to numerically study the acoustic and optical properties of complex refractive index profiles including tellurite PCF. Our results include the calculation of Brillouin gain spectrum, Brillouin gain coefficient (g_B) and Brillouin frequency shift by taking into account the contribution of the higher-order acoustic modes. Several simulations were run by varying the air-filling ratio of various PCF structures to enhance the SBS. The real scanning electron microscope image of a small core of highly nonlinear tellurite fiber is considered. Optimized results show a frequency shift of 8.43 GHz and a Brillouin gain of 9.48×10^{-11} m/W with a time delay between 21 and 140 ns. Such fibers have drawn much interest because of their capacity for increasing and tailoring the SBS gain. [DOI: 10.1117/1.OE.54.7.075101]

Keywords: stimulated emission; Brillouin scattering; photonic crystal fibers; tellurite glass; slow light.

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1 Introduction

Photonic crystal fibers (PCF) exhibit unique and remarkable guiding and antiguiding properties not only for optical waves but also for acoustic waves paving to create and exploit nonlinear effects.[1] Among these nonlinear effects, the nonlinear inelastic scattering effects have attracted the most notable interest. In the inelastic scattering process, the energy of a light wave is transferred to another wave that is at a higher wavelength such that the energy difference appears in the form of phonons. This process can be electrostrictively amplified and gives rise to stimulated Brillouin scattering (SBS).[2] SBS is considered as a setback to optical communications especially in wavelength-division multiplexing systems. However, it can be useful for different applications such as lasers, optical amplifiers, sensors, and slow light generation.[3–6] SBS as well as other nonlinear effects are very weak and require huge amounts of power and long fiber lengths.

Thus, it is desirable to have a large Brillouin gain in order to lower the power requirements and also to shorten the length of the fiber device.[7] Tellurite glasses offer a range of useful properties not possessed by silica, including good infrared transmittance beyond 2 μm, a higher refractive index and low-phonon energy among oxide glasses and high-optical nonlinearity.[8] These features make tellurite glass a very good candidate for microstructured fibers' fabrication, and calculations of their waveguiding properties have been already reported.[9] A tellurite fiber with a relatively large refractive index of about 2.028, which is about 40% higher than that of silica, is expected to exhibit a large SBS coefficient since it is proportional to the material refractive index raised to the power of 7.[10] Qin et al.[11] have measured the Brillouin gain coefficients of a suspended core microstructured tellurite fiber. The Brillouin gain coefficient of 1.7×10^{-10} m/W around a Brillouin shift of 7.97 GHz, which is almost 3.4 times larger than that of silica fiber, is measured.[11] In this paper, we report on full modal analysis and comparison with experimental results of the SBS in small core microstructured tellurite fibers. We will also focus on an SBS-based slow light application, which makes use of resonant effects that cause a large normal dispersion in a narrow spectral region, which, in turn, increases the group index and thus, reduces the group velocity of optical pulses. Slow light can be very helpful since it holds great promise for many potential applications in telecom including all-optical buffering to overcome data-packet contentions in switchers and routers, all-optical signal processing and quantum computing, which needs a time delay on the order of tens of nanoseconds.[12]

Our analysis is first made in a four air-hole different tellurite PCF. Such fibers have drawn much interest because of their capacity of increasing the SBS gain. A Brillouin gain coefficient, g_B, of 1×10^{-10} m/W, is found around the acoustic frequency of 8 GHz. In our study, we focus on the characterization of the SBS properties in both real [scanning electron microscope (SEM) image] and ideal (without geometrical imperfections) tellurite PCF. The variations of the Brillouin gain and Brillouin shift is evaluated for different tellurite PCF. We have exposed the simulation results of

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Design, Development and Metrological Characterization of a Force Transducer

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The present paper discusses the design and development of a force transducer. The force transducer has been developed for a nominal capacity of 5 kN and strain gauges have been applied at suitable locations over it to form a Wheatstone bridge. The force transducer has been metrologically investigated according to the standard calibration procedures based on standards ISO 376-2011.

Keywords: force transducer, ISO 376-2011, uncertainty of measurement.

Introduction

Strain gauged force transducers offers better resolution and interpolation for measurement of in-between step forces. In addition, the digital indicator helps in remote operation of force transducers also. Some commercial strain gauged force transducers are available, but they are of very complex shape and their strain gauging is a difficult task. The present work aims to demonstrate the force transducers with simple design and manufacturing considerations [1-3].

Computational Investigations

In the present paper the design and simulation of a force transducer made up of EN 24 steel for the measurement of medium forces up to 5 kN has been presented. The force sensors for medium range of forces are quite useful for Indian industry. The force is applied to the sensing element through a hardened steel ball over a hemispherical slot at the center of the diaphragm. Simulations have been carried out using an FEA software tool COMSOL Multiphysics™. Von Mises Stress as well as displacement of the diaphragm has been simulated for the forces from 0 to 5000 N at the intervals of 500 N (Figure 1). The maximum stressed areas have been determined for the optimal placement of strain gauges to get the highest sensitivity.

Metrological Characterization of Force Transducers

The force transducer has been calibrated according to the calibration procedures using the 50 kN dead weight force machines as discussed earlier. The 50 kN dead weight force machine employs dead weights with denominations from 0.5 kN to 5 kN to realize precisely known force in the range from 0.5 kN to 50 kN [4]. The dead weight force machine is able to apply the force in ascending or descending order according to the calibration procedures based on standards ISO 376-2011) [5-6]. A very high resolution digital indicator (DK 38 of HBM, Germany) of resolution 0.00001 mV/V has been used for taking the

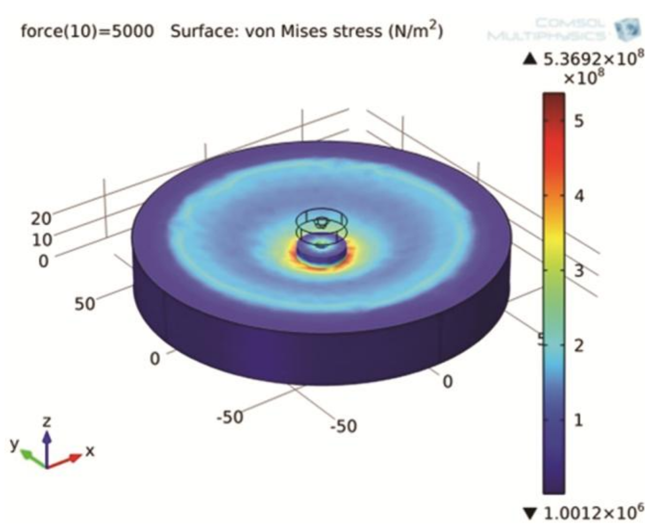

Fig. 1- Stress of the diaphragm at 5000 N force

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Dynamic response of reinforced concrete wall under blast loading

Shashank Jain, Rohit Tiwari, Tanusree Chakraborty and Vasant Matsagar

Dynamic response of reinforced concrete (RC) wall under blast loading is presented. The RC wall is modeled using shell elements in a finite element (FE) software and the steel reinforcement is modeled with the built-in rebar option. The concrete damaged plasticity constitutive model is used to simulate the stress-strain response of concrete for both strain rate independent and rate dependent modeling. Steel reinforcement is modeled using the von-Mises plasticity model for strain rate independent and Johnson-Cook (J-C) plasticity model for strain rate dependent simulations. Blast load is simulated in the form of an equivalent triangular pressure pulse calculated as per TM5-1300 and UFC 3-340-02 codes. The effect of different parameters such as (i) wall thickness, (ii) compressive strength of concrete, (iii) percentage of reinforcement, (iv) tensile yield strength of steel reinforcement, (v) reinforcing bar diameter, and (vi) strain rate dependent properties of concrete and steel are investigated. Mainly, thickness of the RC wall and grade of concrete govern the blast response predominantly as compared to the percentage of reinforcement, diameter of the rebar, and grade of steel. The RC walls with strain rate dependent material properties exhibit reduced displacement as compared to that with rate independent material properties.

Keywords : *Blast, finite element, reinforced concrete wall, strain rate dependent*

INTRODUCTION

Increase in the terrorist activities over the last few decades has highlighted the need to protect civilian and military facilities from explosive events. Especially, for life safety the civil engineering infrastructure must be built with due protective measures. In view of this, the necessity of blast-resistant design and construction of civil and military infrastructure with improved protection cannot be overemphasised. Reinforced concrete (RC) walls serve as protective structures to both civil and military facilities under blast induced impulsive loads. The design of the walls requires understanding of structural response of the walls under blast induced impulsive load. However, strategically due to the political and legal barriers present in conducting real field-scale blast experiments, it is necessary to perform rigorous numerical analysis in order to investigate structural response under the blast induced impulsive load and develop understanding their behaviour useful in routine design practice.

The Indian Concrete Journal, August 2015, Vol. 89, Issue 8, pp. 27-41.

Tanapornraweekit *et al.*, Wu *et al.*, Newberry, Ha *et al.* and others experimentally investigated the response of RC panels and slabs under blast loading [1,2,3,4]. Tanapornraweekit *et al*. used 5,000 kg (11,023 lb) Trinitrotoluene (TNT) explosive at a stand-off distance of 40 m (131 ft) from a 140 mm (5.5 in.) thick RC panel [1]. Minor cracks were observed to be developed in the slab due to the blast load. Similar observations were made by Wu *et al.* in the experiments they had conducted on concrete slab with fibre reinforced polymer (FRP) [2]. Ha *et al.* and Orton *et al.* investigated experimentally the performance of RC slabs retrofitted with carbon fibre

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Effect of insertion of low leakage polar layer on leakage current and multiferroic properties of $BiFeO_3/BaTiO_3$ multilayer structure

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Effect of ion beam irradiation on dielectric properties of $BaTiO_3$ thin film using surface plasmon resonance

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Abstract The effects of swift heavy ions on the structure, surface morphology and dielectric behaviour of barium titanate ($BaTiO_3$, known as BTO) thin films have been investigated by irradiating the films with 100 MeV Au^{+8} ions at an ion fluence of 1×10^{12} ions cm^{-2}. BTO thin films were deposited on Pt/Si substrate by pulsed laser deposition technique. The structure of the film was crystalline with tetragonal phase. Surface topography was studied by atomic force microscope. The dielectric properties of BTO have been studied using surface plasmon resonance (SPR) technique in Otto configuration. SPR is a highly sensitive technique for investigating the dielectric and optical properties of dielectrics. Gold-coated glass prisms have been utilized to excite the surface plasmon waves (SPWs) at the metal–air interface. When BTO thin film is integrated with the surface of Au thin film, a significant shift in the SPR curve has been observed due to change in the propagation constant of SPW at metal–dielectric interface. The optical and dielectric parameters of BTO thin film were obtained by fitting the experimental SPR data with the Fresnel's equations. The observed increase in the dielectric constant of BTO thin film after irradiation may be attributed to packing density.

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Introduction

Barium titanate ($BaTiO_3$) also well known as BTO is one of the most important ferroelectric materials and has attracted much attention for its remarkable properties such as high dielectric constant, good ferroelectric property and large electro-optic and nonlinear optic coefficients resulting in broad applications in the control systems [1, 2]. BTO thin films have been deposited by several methods like metal–organic chemical vapour deposition (MOCVD) [3], sol–gel method [4, 5], chemical solution deposition [6], radio frequency (RF) sputtering [7] and pulsed laser deposition [8, 9]. Among the various methods, pulsed laser deposition is an excellent method to fabricate the multi-component thin films on various substrates with good stoichiometry [10].

Irradiation of materials with high-energy ion beams or 'swift heavy ion (SHI) irradiation', is one of such techniques that effectively induce micro-structural modifications in materials [11]. Irradiation with energetic ions leads to the creation of a wide variety of defect states in the material, which changes the structural, optical and electrical transport properties of the material [12, 13]. The changes are strongly dependent on the mass of the incident ion, the irradiation energy and fluence [14]. Thus, it is essential to study the effect of irradiation on the dielectric and optical properties of materials.

SPR technique has been widely accepted as a standard tool for the optical characterisation of interfaces and thin films. When electromagnetic radiation of the appropriate frequency is incident on the metals, it gives rise to an evanescent wave, and SPR reflectance reduces to a minimum value at resonance. The phenomena of SPR were first demonstrated by Zeenack in 1907 by formulating a special surface wave solution of Maxwell's equations for radio

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Article

Efficient cellular entry of (r-x-r)-type carbamate-plasmid DNA complexes and its implication for non invasive topical DNA delivery to skin.

Manika Vij, Poornemaa Natarajan, Amit K Yadav, Kiran M Patil, Tanuja Pandey, Nidhi Gupta, Deenan Santhiya, Vaijayanti A. Kumar, Moneesha Fernandes, and Munia Ganguli

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Emerging cool white light emission from Dy^{3+} doped single phase alkaline earth niobate phosphors for indoor lighting applications

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Single-phase cool white-light emitting $BaNb_2O_6:Dy^{3+}$ phosphors have been synthesized *via* a conventional solid-state reaction method and characterized using X-ray diffraction (XRD), scanning electron microscopy (SEM) observations and spectrofluorophotometric measurements. XRD and Rietveld structural refinement studies confirm that all the samples exhibit pure orthorhombic structure [space group – $C222_1$(20)]. SEM observations reveal the dense particle packaging with irregular morphology in a micron range. The as-prepared phosphors exhibit blue (482 nm) and yellow (574 nm) emissions under 349, 364, 386 and 399 nm excitations corresponding to $^4F_{9/2} \rightarrow {}^6H_J$ (J = 15/2, 13/2) transitions of Dy^{3+} ions. The energy transfer mechanism between Dy^{3+} ions has been studied in detail and the luminescence decay lifetime for the $^4F_{9/2}$ level was found to be around 146.07 μs for the optimized phosphor composition. The calculated Commission Internationale de L'Eclairage (CIE) chromaticity coordinates for the optimized phosphor are (x = 0.322, y = 0.339), which are close to the National Television Standard Committee (NTSC) (x = 0.310, y = 0.316) coordinates. The values of CIE chromaticity coordinates and correlated color temperature (CCT) of 5907 K endorse cool white-light emission from the phosphor. The study reveals that $BaNb_2O_6:Dy^{3+}$ phosphor could be a potential candidate for near ultra-violet (NUV) excited white-LED applications.

1. Introduction

In recent years, rare earth ion doped inorganic luminescent materials have been extensively studied in the fields of materials science, physics, chemistry and life sciences due to their various potential applications in display devices (*e.g.*, cathode ray tubes, vacuum fluorescent displays, and field emission displays), lighting gadgets (*e.g.*, fluorescent tubes and white-light emitting diodes), solid-state lasers, biological labelling, X-ray, medical devices, ionization radiation and so on.[1,2] Among them, white light emitting diodes (w-LEDs) have been considered to be the next generation illumination sources in the field of solid-state lighting instead of traditional incandescent and currently implemented fluorescent lamps due to their numerous advantages such as small size, high energy efficiency, energy-saving, robustness, high brightness, fast switching, longer life time (>100 000 h) and environmental friendliness.[3–5] Currently, two approaches have been implemented to achieve white light through solid-state lighting (SSL). The first one is a phosphor-free SSL approach employing RGB-LEDs, which consist of red, green and blue monochromatic LEDs to obtain white-light. The main drawback of this approach is that every LED must be adjusted by individual power supply to balance the emission intensity of each color. However, the second approach involves phosphor integrated to the SSL device. The phosphor-converted (pc) LED uses an ultra-violet (UV)/near ultra-violet (NUV) light in combination with single/multiple phosphors that convert a part of the light emitted by the UV/NUV LED into white-light.[6,7] At present, most of the commercially available w-LEDs are based on the second approach because of the simplicity in operation. The combination of blue LED (InGaN) coated with yellow-emitting ($Y_3Al_5O_{12}:Ce^{3+}$) phosphor is one of the widely used approaches currently to produce w-LEDs. However, this approach encounters some serious issues such as the halo effect of blue/yellow color separation, color dependence on chromaticity, and poor color-rendering index (<65) due to the lack of green and red-emitting phosphor components at long wavelength regions, which limits the LED applications further.[8] On the other hand, UV/NUV LED coated with multi-

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ENERGY AND EXERGY ANALYSIS OF A DOUBLE EFFECT PARALLEL FLOW LIBR/H_2O ABSORPTION REFRIGERATION SYSTEM

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Keywords: Parallel flow, Absorption system, Exergy, Exergetic efficiency, Solution distribution ratio.
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ABSTRACT

In the present communication the analysis of a parallel flow double effect absorption refrigeration system is performed to compute the optimum solution distribution ratio (optimum distribution of strong solution masses between low and high pressure generators) from the viewpoint of maximum COP and maximum exergetic efficiency. A computational model is developed for the parametric investigation of a double effect parallel flow LiBr/H_2O absorption refrigeration system. The effect of generator, absorber and evaporator temperatures on optimum solution distribution ratio is also studied. The results show that the maximum COP and maximum exergetic efficiency is achieved corresponding to same value of optimum solution distribution ratio.

INTRODUCTION

Most absorption cooling systems adopt the double-effect cycle to increase the cooling performance of the system when the heat source available is at high temperature with water lithium bromide. However, when using series flow double effect system the range of operation comes close to the crystallization line of the LiBr solution and the absorption ability becomes weak. The parallel-flow type of double-effect cycle has been proposed to eliminate these difficulties compared with the series-flow type. Compared to the series-flow type, the range of operating conditions of the parallel-flow type is far away from the crystallization line of the LiBr solution, but the control and regulation of the flow rate of solutions are complicated. Many studies are available in literature [1-12] on the first law performance evaluation of both series and parallel flow double effect absorption refrigeration systems. Most of these studies examined the effect of operating parameters like temperatures, solution circulation ratio, and effectiveness of heat exchangers on the system performance. The maximum cop of parallel flow double effect system depends on the optimum distribution of solution, leaving the absorber, between high and low temperature generators. In some of these studies [5, 7, 9] the effect of solution distribution ratio on the cop and cooling capacity has been discussed but the analysis does not include the effect of variation in parameters on optimum value of solution distribution ratio. Lee and Sherif [13], Izquierdo et al. [14] and lee and Sherif [15] are among the earliest researchers who presented the performance analysis of absorption systems based on second law of thermodynamics. Gebreslassie et al. [16] carried out the exergy analysis, considering only unavoidable exergy destruction, for single, double, triple and half effect water-lithium bromide absorption cooling cycles. Izquierdo et al. [17] designed experimental prototype of 7 kW of cooling power. A new type of flat-sheet adiabatic absorber was used to operate at outdoor temperatures of about 45 °c without any sign of crystallization. Exergoeconomic analyses is carried out by Farshi et al. [18] for three types of double effect LiBr-water absorption cooling systems to assess the influence of

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Energy levels, lifetimes and radiative data of Ba XXVI

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HIGHLIGHTS

- Lowest 110 levels for Ba XXVI are calculated.
- Radiative data for E1, E2, M1 and M2 transitions within lowest 110 levels are presented.
- Lifetimes for lowest 110 fine structure levels are provided.

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ABSTRACT

We report an extensive and an elaborate theoretical study of atomic data for Ba XXVI by considering Singlet, Doublet and Triplet (SDT) electron excitations within N-shell and single excitations from N-shell to O-shell. We have calculated energy levels and lifetimes for lowest 110 fine structure levels by using Multi-configuration Dirac–Fock method (MCDF). We have also considered Quantum Electrodynamics (QED) and Breit corrections in our calculations. We have presented the radiative data for electric and magnetic dipole (E1, M1) and quadrupole (E2, M2) transitions among lowest 110 levels. We have made comparisons of our calculated excitation energies and EUV (Extreme Ultraviolet) transition wavelengths with experimentally observed energy levels and wavelengths and achieved good agreement. We have also computed energy levels by performing similar relativistic distorted wave calculations using Flexible Atomic Code (FAC). Additionally, we have provided new atomic data for Ba XXVI which are not published elsewhere in the literature. We believe that our results may be beneficial in fusion plasma research and astrophysical investigations and applications.

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Enhanced dielectric properties of multilayered $BiFeO_3/BaTiO_3$ capacitors deposited by pulsed laser deposition

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Abstract. We report on dielectric studies of $BiFeO_3$(BFO)/$BaTiO_3$(BTO) multilayer structure fabricated by pulsed laser deposition technique. Multilayered capacitors were prepared by increasing number of alternating individual layers from 2 to 7 while maintaining the total thickness of the layered structure as 350 nm. The dielectric constant of the BFO/BTO multilayer structure was significantly increased to 772 (at 1 kHz) and the dielectric loss decreased to 1.08 (at 1 kHz) in comparison to that of bare BFO and BTO thin films of 350 nm thickness. Further the dielectric constant increased with increasing number of individual layers. The increase in dielectric constant is related to the enhancement of ferroelectricity and reduced leakage current which is due to the induced stress at the interface of BFO and BTO layer in the multilayer capacitor. A high value of ferroelectric polarization (~ 99.80 $\mu C/cm^2$) was obtained for 6-layer BFO/BTO structure. The multilayer structure exhibited superior dielectric properties and can be undeniably used as the dielectric layer in silicon-based capacitors and tunable microwave device applications.

INTRODUCTION

Ferroelectric thin films have drawn enough consideration by displaying a wide range of dielectric, pyroelectric, piezoelectric and electro-optic properties leading to a variety of applications in dynamic random access memories (DRAM) capacitors, optoelectronics, infrared sensors, non volatile memories etc [1-4]. The crucial features for the quality and reliability of such devices include 1) low leakage current/low loss, 2) fast dielectric response, 3) long shelf life [5-6]. Wide ranging studies have been executed to enhance the dielectric properties of ferroelectric thin films. One of the encouraging methods is to use thin films in the form of multilayers or superlattices. The conventional physical properties such as, low leakage current, strong poling properties and charge effects can be modified with the presence of strain at interfaces [7-8]. Enhanced multiferroic or ferroelectric properties including improved dielectric constant can be obtained with the blend of different ferroelectric, ferromagnetic and/or multiferroic materials. Zhao et al. [8] prepared BTO/BST/STO multilayer structure, and reported that the dielectric constant was greatly enhanced. Peng et al and Xu et al. fabricated BST multilayers with varying concentration of Ba, Sr and Ti and concluded that multilayer structure was favorable towards reducing the dielectric loss while improving the tenability [9-10]. Zhou et al. [11] identified that the BTO/STO multilayered structure had an enlarged dielectric constant. Pontes et al. examined the dielectric properties of STO/BTO bilayer thin films prepared by chemical route

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Enhanced ferroelectric photovoltaic response of $BiFeO_3/BaTiO_3$ multilayered structure

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The present work is based on the photovoltaic properties of multilayered structure of Bismuth ferrite (BFO) and Barium titanate (BTO) thin films prepared by pulsed laser deposition technique on platinum coated silicon substrate. The multilayered structure possesses enhanced ferroelectric properties and shows a remarkable increase in photocurrent (from 1.56×10^{-7} A to 6.96×10^{-5} A) upon illumination with laser light of wavelength 405 nm at an intensity of 160 mW/cm^2. The values of short circuit photocurrent and open circuit voltage were found to be 0.3184 mA/cm^2 and -1.25 V, respectively, with a light-to-electricity conversion efficiency of 0.067%. A relatively high efficiency calculated at 405 nm for the developed multilayered BFO/BTO structure highlights its practical application in ferroelectric photovoltaics.
[http://dx.doi.org/10.1063/1.4928964]

I. INTRODUCTION

Over several decades, researchers have been striving to open different corridors for the production of renewable energy to curb the evolving demands for inexhaustible energy and clean fuel sources.[1–5] The exceptional advantages of ferroelectric photovoltaic effect (FE-PV) over the conventional p-n junction based photovoltaic (PV) devices, such as high output voltage and polarization controlled PV response, appear promising for the realization of efficient functional devices.[1,6–8] FE-PV effect is observed in several perovskite oxide systems, such as $Pb(Zr,Ti)O_3$ (PZT), $BaTiO_3$ (BTO), etc.,[3,7–10] but disappointingly, the photovoltaic efficiency in such materials undergoes quenching due to their small current density (of the order of 10^{-9} A/m^2) and large optical band gap (typically $\sim$ 3.5 eV). Therefore, it becomes imperative to tailor the physiochemical properties of these ferroelectric materials for possible device applications.

Most notable of the available ferroelectric materials, Bismuth ferrite (BFO) with its small optical band gap and good chemical stability, has fueled interest of the research community in past several years. Moreover, the lead free nature of BFO does not constrict its potential applications as compared to its non-environment friendly counterpart, lead zirconium Titanate (PZT).[6] BFO is a room temperature multiferroic material having high ferroelectric Curie temperature ($\sim$1120 K) and antiferromagnetic Neel temperature ($\sim$643 K).[11–13] However, the inherent high leakage current reduces its ferroelectric polarization and hence is a major concern for onward applications.[2]

Several reports are available on A-site and B-site doping for improving the ferroelectric properties of BFO thin films[13,14] as well as on the study of tip enhanced photovoltaic properties of BFO.[15] Gupta *et al*. discussed the effect of doping at "A" and "B" sites in BFO and reported a remarkable enhancement in photovoltaic properties but the efficiency was still compromised.[16] Doping may induce unwanted parasitic phase formation which restricts any enhancement of FE-PV effect. Hence, it is important to come up with strategic ideologies to fully exploit the potential material traits for obtaining an enhanced response in BFO.

On the other hand, BTO is an equally attractive perovskite ferroelectric material employed in various devices, including capacitors, ferroelectric memories, etc., due to its unique dielectric, piezoelectric, and ferroelectric properties.[5,9,17] However, BTO, being a wide band gap ($\sim$3.3 eV) semiconductor, cannot be employed for FE-PV applications, especially in the visible spectral region. Reportedly, multilayered structures possess superior ferroelectric properties compared to individual parent materials in terms of high polarization, high dielectric constant, and relatively lower losses.[14] Thus, in order to improve the ferroelectric properties of BFO while simultaneously reducing the band gap of BTO, fabrication of the multilayered structure of BFO and BTO could be beneficial.

There are several reports where band gap engineering has been demonstrated by fabricating layered thin film structure.[18,19] Some research groups have also studied BFO/BTO multilayered structures, but their photovoltaic properties are scarcely reported.[20,21] Toupet *et al*.[22] and Yang *et al*.[23] examined the multiferroic property of the BFO/BTO multilayered structure and conclusively reported an improvement in the magnetic property of the system. There exists a correlation between the phenomena of ferroelectricity and photoconductivity observed in certain materials. Ferroelectric polarization acts as a driving force for the separation of photo-generated charge carriers within a photovoltaic cell. When light with a wavelength corresponding to the energy

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Enhancement of Fuzzy Rank Aggregation Technique

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Abstract

The rankings of an object based on different criteria pose the problem of choice to give a ranking to that object at a position nearest to all the rankings. Generating a ranking list of such objects previously ranked is called rank aggregation. The aggregated ranking is analyzed by computing Spearman Footrule distance. The ranking list chosen by minimizing Spearman Footrule distance is NP-Hard problem even if number of lists is greater than four for partial lists. In the context of web, rank aggregation has been applied in meta-searching. However, the usage of prevailing search engines and meta-search engines, even though some of them being designated as successful, reveal that none of them have been effective in production of reliable and quality results, the reason being many. In order to improve the rank aggregation, we proposed the enhancement in the existing Modified Shimura technique by the introduction of a new OWA operator. It not only achieved better performance but also outperformed other similar techniques.

Keywords

Web Meta-searching Rank aggregation Spearman footrule distance Fuzzy logic

Chapter 6
Epigenesis in Colorectal Cancer: A Lethal Change in the Cell

Rashmi K. Ambasta, Dhiraj Kumar, Piyush Sawhney, Rajat Gupta, Parul Yadav, Pooja Pabari, and Pravir Kumar

6.1 Introduction

Colorectal cancer (CRC) is a heterogeneous disease characterized by progressive aggregation of genetic mutations and epigenetic alterations of the genes involved in cell cycle regulation and cell differentiation [1]. These alterations provide growth advantage for clonal expansion of these altered colons epithelial cells to transform into colon adenocarcinomas. Colorectal cancer arises as a polyp outgrowth, called an adenoma, in the colon and/or rectum lining and undergoes a malignant transformation to cause cancer [2]. It has been widely observed that colorectal cancer is initiated due to dysfunction in the signaling elements of Wingless/Wnt-signaling pathway resulting in either activation of oncogenes or silencing of tumor suppressor genes [3]. About 70–85 % of colorectal cancers are sporadic in nature, i.e. arise from somatic gene alterations. However, the heritable colorectal cancers originating from germline mutations are either familial adenomatous polyposis or hereditary nonpolyposis colorectal cancer [4, 5]. Multiple molecular pathways have been identified for the development of colorectal cancers (CRCs) that comprised of both mutations and epigenetic alterations. For instance, tubular adenomas mostly arise in response

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EventBuilder: Real-time Multimedia Event Summarization by Visualizing Social Media

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ABSTRACT

Due to the ubiquitous availability of smartphones and digital cameras, the number of photos/videos online has increased rapidly. Therefore, it is challenging to efficiently browse multimedia content and obtain a summary of an event from a large collection of photos/videos aggregated in social media sharing platforms such as Flickr and Instagram. To this end, this paper presents the EventBuilder system that enables people to automatically generate a summary for a given event in real-time by visualizing different social media such as Wikipedia and Flickr. EventBuilder has two novel characteristics: (i) leveraging Wikipedia as event background knowledge to obtain more contextual information about an input event, and (ii) visualizing an interesting event in real-time with a diverse set of social media activities. According to our initial experiments on the YFCC100M dataset from Flickr, the proposed algorithm efficiently summarizes knowledge structures based on the metadata of photos/videos and Wikipedia articles.

Categories and Subject Descriptors

H.3.1 [**Information Storage and Retrieval**]: Content Analysis and Indexing; H.5.1 [**Information Interfaces and Presentation**]: Multimedia Information Systems

Keywords

Event detection; event summarization; event visualization

1. MOTIVATION AND BACKGROUND

The EventBuilder system presented in this study is our solution to the ACM Multimedia 2015 Grand Challenge on automatic event summarization from a large collection of photos/videos. EventBuilder[1] is a real-time multimedia event summarization system which produces an event summary by visualizing social media such as Flickr. The number of photos/videos on social media sites has increased rapidly due to the advancement in smartphone and digital camera technologies and affordable network connectivity. However, obtaining an overview of an event from a large collection of photos/videos, such as the YFCC100M dataset (Ð), is still a very challenging task due to the following reasons: (i) the existence of much noise in Flickr metadata, (ii) the big size of such datasets, and (iii) the difficulty in capturing the semantics of photos/videos. EventBuilder leverages metadata such as user tags, descriptions, spatial information, *etc.*, of all photos/videos in Ð, and content of Wikipedia articles, using a feature-pivot approach to build the indices of event-datasets in Ð. Moreover, EventBuilder introduces a summarization system which considers aspects such as quality, diversity, coverage, and redundancy, during the building process. The summarization system consists of three steps: (i) the identification of important *concepts* which should be described in the event summary, (ii) the composition of a text digest which covers the maximal number of important *concepts* by selecting the minimal number of sentences from available texts, within the desired summary length, and (iii) the geo-graphical visualization of the event on Google Maps.

For efficient and fast processing, we compute scores of all multimedia contents in Ð for the given events and build indices for event datasets ($\mathcal{F}$) during pre-processing. We include only those photos/videos in $\mathcal{F}$ whose scores are above a threshold δ. Next, we formulate the problem and introduce a solution to produce text summaries of events by employing a sentence selection algorithm inspired by the greedy algorithm [3]. In the summarization process we consider a representative set of $\mathcal{M}$ photos/videos ($\mathcal{R}$) from $\mathcal{F}$ with the highest scores. In this way, the proposed EventBuilder system provides an overview of events through text summaries and improves the visualization of events by displaying only multimedia contents and their descriptions from $\mathcal{R}$.

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[1]URL: eventbuilder.geovid.org

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Regular Article

Excellent electromagnetic interference shielding effectiveness of chemically reduced graphitic oxide paper at 101 GHz*

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Abstract. Graphitic oxide (GO) was synthesized by oxidation of graphite powder using Hummer's method and the formed GO is solution processed into paper-like macroscopic form. Subsequently, chemically reduced graphitic oxide paper (CRGOP) is prepared by hydrazine vapours induced reduction of formed GO precursor based paper. The formation of GO and its successful reduction to RGO phase is confirmed by FTIR, Raman Spectroscopy and X-ray diffraction. It has been observed that due to high electrical conductivity ~200 micron thick CRGOP display excellent EMI shielding performance at very high frequency of 101 GHz frequency with total shielding effectiveness (SE) value of −35.49 dB (i.e. >99.97% blocking of incident EM radiation) which is much higher compared to pristine GO paper (−1.55 dB) or comparable to expanded graphite (EG) sheet (−35.61 dB). Due to their lightweight nature, these freestanding CRGOPs display average specific SE value of −221.8 dB cm^3/g. Besides, their excellent flexibility and makes them potential candidate for lightweight EMI gasketing material compared to other forms of flexible carbons like EG.

1 Introduction

With the rapid growth of science and technology, the usage of electronic equipments and power sources are in vogue. However, electromagnetic (EM) interference (EMI) effects due to EM radiation emitted or received by these devices, can be dangerous, as the susceptible electronic components are backbone of many critical applications like aircraft, nuclear reactors, transformers, control and communication channels, healthcare systems, etc. [1–3]. Therefore, EMI shielding is highly desirable for protecting electronic devices from malfunctioning and avoiding harmful health effects on human beings [4,5]. The conventional metal based shielding materials are bulky, costly, corrosion prone and highly reflective. Some promise has also been shown by magnetic or dielectric particulate based compositions and conducting polymer based blends, copolymers or micro- or nano-composites [6–26]. However, their processing, stability and commercial viability issues remained an open challenge [1,3]. In this context, carbon based materials have shown definite promise and considered as excellent choice for EMI shielding, due to their light weight, metallic electrical conductivity, good mechanical properties, corrosion resistance, ease of synthesis and good processability [4,6,9,14,27–33]. In particular, carbonaceous nanomaterials, including carbon nanofibers, carbon nanotubes (CNTs) and graphene have received extreme attention for EMI related applications due to excellent electrical, mechanical and thermal properties, facile processing via chemical route, high surface-to-volume ratio and very low percolation threshold in filled nanocomposites [4,9,26,34–42]. Among them graphene is considered as most promising EMI shielding material candidate due ultra-high mechanical strength (Young's modulus ~1.0 TPa), and tensile strength ~130 GPa outstanding electrical conductivity (~10^6 S/m) and excellent thermal stability/conductivity [1,14,32,35,38,41,43]. Further, ability to be chemically and morphologically manipulated provides means to regulate its shielding efficiency as well as underlying shielding mechanism. Consequently, various graphene analogues including bulk or foamed nanocomposites, graphene foams, paper-like materials, laminates, etc. [14,32,38,41,44–46] have been extensively studied for EMI shielding applications. Among them, graphene paper is considered as important EMI shielding material due to combination of good electrical properties, lightweight and flexibility. However, only few

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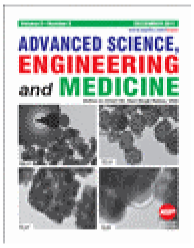

Exclusive Endothermic Oxidation of Fe_3C-Filled Multi-Walled Carbon Nanotubes

Authors: Krishnia, Lucky; Kumar, Vinay; Kumari, Reetu; Garg, Preeti; Yadav, Brajesh S.; Rath, Ashutosh; Ghosh, Arnab; Sinha, Ravindra K.; Singh, Manoj Kumar; Tyagi, Pawan K.

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In this article, thermal stability and reactivity of oxygen to Fe_3C-filled and un-filled multi-walled carbon nanotubes (MWCNTs) have been studied by using thermogravimetric analysis (TGA) and derivative thermogravimetric (DTG) analysis. Exclusively, oxidation of sample containing Fe_3C-filled MWCNTs is found to be endothermic upto 600 °C. The value of activation energy of oxidation is determined by fitting the experimentally recorded TGA/DTG curves, and both differential and integral methods have been adopted for calculation. The calculated value of activation energy for Fe_3C-filled MWCNT using Kissinger's corrected kinetic equation (integral method) is found to be 1.48 ± 0.19 eV, which is nearly equal to the reported values for highly ordered pyrolytic graphite (HOPG). Oxidation reactivity is found to follow an ascending order as amorphous carbon, thinMWCNTs, un-filled MWCNTs, and Fe_3C-filled MWCNTs.

Keywords: DERIVATIVE THERMOGRAVIMETRIC ANALYSIS (DTG); MULTI-WALLED CARBON NANOTUBES (MWCNTS); THERMOGRAVIMETRIC ANALYSIS (TGA)

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More about this publication?

Experimental Studies on Use of Karanja Biodiesel as Blend in a Compression Ignition Engine

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Abstract- Ecological system is being affected adversely by the use of diesel engines which causes harmful emissions. Alternative sources are being found to sort out this problem. Biodiesel is one of the alternative source. Nowadays, there is a focus on the non-edible oils to use it as biodiesel because of its capability to be available on waste lands. Karanja is one of the non-edible oil, which may be preferred to be used as biodiesel because of its certain advantages on diesel engine comparatively. This experimental study was aimed to find out performance characteristics and smoke emission with 10%, 20% and 30% biodiesel blend with diesel at varying loads (brake power) of 0.5 to 3.5 kW at a constant speed of 1500 rpm. Brake thermal efficiency, brake specific energy consumption, exhaust gas temperature, mechanical efficiency, volumetric efficiency, air fuel ratio and smoke opacity of biodiesel blended fuel were evaluated and compared with diesel and it has been found satisfactory. Brake thermal efficiency of 20% biodiesel blend fuel was found to be slightly higher than that of diesel with reduced smoke emissions. Brake thermal efficiency of B20 and diesel was found to be 29.04% and 29% respectively at 3.5 kW brake power. On the basis of experimental study, the B20 Karanja biodiesel blend is found more useful among all tested fuels in terms of brake thermal efficiency. Smoke opacity was also found to be reduced with Karanja biodiesel blends. Hence Karanja biodiesel is proved to be an environmentally friendly alternative to diesel.

Keywords Biodiesel, Blends, Karanja, Brake Thermal Efficiency, Smoke Emissions.

1. Introduction

In the world, 80% of primary energy is consumed by fossil fuel and out of which, 58% is consumed by the transport sector. There was a 23 % increase in the consumption of diesel while the increase in the consumption of other petroleum products was 7% from 2000 to 2008 according to reports of International Energy Agency [1]. Ecological system is being affected adversely by the use of diesel engines which causes harmful emissions. Alternative sources are being found to sort out this problem. Biodiesel is one of the alternative source. Biodiesel has calorific value, cetane number and flash point which are comparable with diesel [2].Biodiesel is an ester of vegetable oil. Ester is obtained by transesterification process which reduces the viscosity of vegetable oil with the conversion of triglyceride into ester. Biodiesel is safe to handle due to its high flash point and low volatility. Biodiesel may be used as a substitute for diesel due to its similar combustion behaviour and performance [3]. Transesterification process decreases the viscosity of vegetable oils causing biodiesel to be easily miscible with diesel in any ratio of blends. Biodiesel has density, viscosity and calorific value which is nearer to that of diesel [4]. Biodiesel is renewable, energy efficient, non-toxic, biodegradable and can be used suitably for sensitive environments. At present, Edible oil contributes to the 95% of biodiesel production, which means the conversion of food into fuel leading to food starvation problem. So non-edible feedstocks are being focused in the biodiesel production to get rid of food starvation problem [5].

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Fe_3C-filled carbon nanotubes: permanent cylindrical nanomagnets possess exotic magnetic properties

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Abstract

The present study aims to deduce the confinement effect on the magnetic properties of iron carbide (Fe_3C) nanorod filled inside carbon nanotube (CNT) and to document any structural phase transitions that can be induced by compressive/tensile stress generated within the nanorod. Enhancement in the magnetic properties of nanorods is attributed to tensile stress as well as compression present in radial direction and along the nanotube axis, respectively. Finally, growth of permanent cylindrical nanomagnets has been optimized by applying field gradient. Besides presenting the growth model of *in situ* filling we have also proposed the mechanism of magnetization of the nanotubes. Magnetization along the tube axis has been probed by confirming the pole formation. Fe_3C has been selected because of easy formation, low T_C and incompressibility.

1. Introduction

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Finite Abelian Group Labeling

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(Dedicated to the memories of Dr. B.D. Acharya)

Abstract

In this paper, we introduce an abelian group labeling (shortly, AGL) over finite abelian groups. We have shown that every finite graph admits an abelian group labeling. In the course of investigation, we found that representation labeling can be obtained from *abelian group* labeling for certain graphs. Several new directions for further research are also indicated through problems.

Keywords: Abelian group labeling, abelian group labeling index.

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Recent Advances In Nano Science And Technology 2015 (RAINSAT2015)

First principles study of Li terminated armchair graphene nanoribbons

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Abstract

We have investigated the consequences of Li termination on the electronic and structural properties of armchair graphene nanoribbons (AGNR) by employing first-principles calculations. We considered the effect of Li termination on one edge as well as on both the edges of ribbons and revealed their potential applications. It is observed that Li termination has a profound effect on the electronic structure of AGNR. The analysis of binding energy suggests that all the structures are energetically feasible to obtain. Further, AGNR with larger widths are comparatively more stable than the narrow width nanoribbons. A semiconducting to metallic transition can be observed depending upon the ribbon width. Our results indicate that Li termination could be a potential way to tailor the electronic and transport properties of AGNR.

Selection and Peer-review under responsibility of [Conference Committee Members of Recent Advances In Nano Science and Technology 2015.].

Keywords: Graphene nanoribbon electronic structure binding energy Fermi level

1. Introduction

Graphene, the first atomically thick material observed by the scientific community, has proven its potential for variety of applications [1-5]. Patterned strips of graphene, formally known as graphene nanoribbons (GNR) can be

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Flexible carbon nanofiber electrodes for a lead zirconate titanate nanogenerator†

Bharat Bajaj,[a] Seonghwan Hong,[a] Seong Mu Jo,[bc] Sungho Lee[bc] and Hyun Jae Kim*[a]

The performance and stability of flexible carbon nanofiber (CNF) electrodes were investigated for a lead zirconate titanate (PZT) nanogenerator. A comparative study was carried out with indium tin oxide coated polyethylene 2,6-naphthalate (ITOP) electrodes. The piezo voltage generated for CNF/PZT/CNF was almost 2 V which is ~10% higher than ITOP/PZT/ITOP after the bending test. The increase in voltage shows a good contact probability between PZT nanofibers and CNF electrodes and demonstrates the feasibility of CNFs as flexible and stable electrodes for nanogenerators.

Recently, carbon nanomaterials have attracted great attention due to their diverse applications as high strength as well as conductive materials for nanoscale-electronics. Among them, carbon nanofibers (CNFs) have been recognized as an exclusive form due to their exceptionally good electrical, thermal, optical, and mechanical properties.[1,2] As examples, CNF-based supercapacitors,[3] biosensors,[4] lithium-ion batteries,[5] and dye-sensitized solar cells[6] have been developed with exceptional performance. This leads to a rapid increase in commercial demand for CNFs as an electrode material for flexible organic electronics. Until now, indium tin oxide (ITO) films have been commonly used as flexible electrodes in electronic devices.[7] However, their certain technical limitations such as low flexibility, inherent brittleness of the oxides under tension, and initiation of cracks[8] on over-flexing have restricted their use for stable flexible devices.[9] ITO electrodes have lower electrical and mechanical stability that significantly affects the lifetime of nanogenerators.[10] Also, the flat surface of ITO used as top and bottom electrode leads to a low contact probability (*i.e.*, small number of active sites and high series resistance) between lead zirconate titanate (PZT) nanofibers and top electrode during pushing or bending, thereby reducing the output current density.[10] Therefore, there is a strong need to develop alternate electrodes which are highly flexible, defect free, robust and highly conductive. CNFs can serve as an excellent electrode materials and now being considered as a potential alternative for conventional ITO based electrodes. Recently, our group reported application of CNF as an effective flexible electrode for cholesterol sensor.[11] Over the last few years, ZnO,[12,13] InN,[14–16] ZnS,[17] PZT,[18,19] $BaTiO_3$, and PVDF[20,21] based piezoelectric materials have been widely employed for fabricating nanogenerators. However, there are some or other types of technical challenges associated with most of these materials, for instance, ZnO-based nanogenerators, suffer low piezoelectric coefficient and electromechanical conversion efficiency,[22,23] whereas, high piezoelectric coefficient ceramics such as PZT[24] and $BaTiO_3$ [25] films made by conventional methods are brittle and are infeasible for fabricating the flexible nanogenerators. On the other hand, PZT nanofibers fabricated by electrospinning possess considerable higher flexibility as compared to those prepared by other conventional methods and may offer significant decrease in device dimensions and better tolerance to bending stresses.[26] Electrospinning is a low cost and scalable technique to fabricate CNFs and PZT with tunable nanostructures. However, there are still many challenges such as charge carriers, low flexibility, irregular surface morphology and Schottky contact for a generated current output and efficiency that need to be well addressed.[27] In this work, we report application of a CNF network sheet as the top cathode electrode of PZT nanogenerators. The nanofiberous morphology of CNF helps to improve the energy performance and stability. Particularly, nanofiberous morphology of CNF electrode and PZT is highly suitable to each other in enhancing the contact probability. In this communication, morphological effect and the electrical stability of CNF films for PZT nanogenerators are investigated.

It is found that CNF films have a nanosized network surface with fiber size larger than PZT fiber size which favors nanofibers

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Holmium doped Lead Tungsten Tellurite glasses for green luminescent applications

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Luminescence

ABSTRACT

Lead Tungsten Tellurite (LTT) glasses doped with different concentrations of Ho^{3+} ions have been synthesized using the melt quenching method and characterized to understand their visible emission characteristic features using optical absorption and photoluminescence spectral studies. The Judd–Ofelt (JO) parameters measured from the absorption spectral features were used to evaluate radiative properties such as transition probability (A_R), branching ratio (β_R) and radiative lifetimes (τ_R) for the prominent fluorescent levels of Ho^{3+} ions in LTT glasses. The photoluminescence spectra recorded for all the Ho^{3+} doped LTT glasses at an excitation wavelength 452 nm gives three prominent emission transitions $^5F_4 \rightarrow {}^5I_8$, $^5F_5 \rightarrow {}^5I_8$ and $^5F_4 \rightarrow {}^5I_7$, of which $^5F_4 \rightarrow {}^5I_8$ observed in visible green region (546 nm) is relatively more intense than the other two transitions. The intensity of $^5F_4 \rightarrow {}^5I_8$ emission transition in these glasses increases up to 1 mol% of Ho^{3+} ions and beyond concentration quenching is observed. Branching ratios (β_R) and emission cross-sections (σ_{se}) were evaluated for the intense emission transition $^5F_4 \rightarrow {}^5I_8$ in these glasses to understand the luminescence efficiency in visible green region (546 nm). The CIE chromaticity coordinates were also evaluated in order to understand the suitability of these glasses for visible luminescence. From the measured emission cross-sections and CIE coordinates, it was found that 1 mol% of Ho^{3+} ions in LTT glasses are most suitable for visible green luminescence in principle.

1. Introduction

Glasses doped with transition metal and rare earth ions have attracted a great deal of attention because of their applications in visible and mid-infrared regions of the electromagnetic spectrum such as lasers, optical fibers, sensors, biomedical diagnostics, infrared detectors, marine optical communications, up-conversion lasers, optical data storage, atmospheric probing and high density memory storage devices [1–5]. Recently research work on tellurium based glasses is increasing because of their promising technological applications in diversified fields [6–11]. Tellurium oxide (TeO_2) being a semiconductor in both crystalline and amorphous forms, with its superior physical and chemical properties, is aptly suitable for various technological devices such as γ-ray detectors, nonlinear optoelectronic devices and optical recording systems [12–16]. In addition to this, tellurite glasses possesses wide transmission range from 0.4 to 5 μm, high linear and non-linear refractive indices, low phonon energies (~750 cm^{-1}) and high rare earth ions solubility [17]. Tellurium oxide besides being a conditional glass former can form a stable glass in the presence of certain glass modifiers like tungsten trioxide (WO_3). Moreover these oxides show high thermal stability and mechanical strengths relative to other glass forming oxides and fluorides [16–21].

Tungsten based glasses can be prepared at relatively low temperatures (~750 °C) and also show low phonon energies (~800 cm^{-1}) [22,23] when compared with phosphate (~1300 cm^{-1}) borate (~1400 cm^{-1}) and silicate glasses (~1000 cm^{-1}) [24–26]. It is well known that the glasses with low phonon energies offer less non-radiative relaxation rates and increases the luminescent quantum efficiencies. The relatively slow crystallization rate, good transparency in a wide spectral region from visible to NIR, good mechanical strength, chemical stability and high refractive indices makes tungsten tellurium glasses the best choice as an efficient host [27–29]. It is well known that heavy metal fluoride compounds such as PbF_2 having very less phonon energies (~340 cm^{-1}) when added to a host glass can reduce phonon

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Research article

Identification of chebulinic acid as potent natural inhibitor of *M. tuberculosis* DNA gyrase and molecular insights into its binding mode of action

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ABSTRACT

Drug resistant tuberculosis has threatened all the advances that have been made in TB control at the global stage in the last few decades. DNA gyrase enzymes are an excellent target for antibacterial drug discovery as they are involved in essential functions like DNA replication. Here we report, a successful application of high throughput virtual screening (HTVS) to identify an inhibitor of *Mycobacterium* DNA gyrase targeting the wild type and the most prevalent three double mutants of quinolone resistant DNA gyrase namely A90V + D94G, A74S + D94G and A90V + S91P. HTVS of 179.299 compounds gave five compounds with significant binding affinity. Extra presicion (XP) docking and MD simulations gave a clear view of their interaction pattern. Among them, chebulinic acid (CA), a phytocompound obtained from *Terminalia chebula* was the most potent inhibitor with significantly high XP docking score, −14.63, −16.46, −15.94 and −15.11 against wild type and three variants respectively. Simulation studies for a period of 16 ns indicated stable DNA gyrA–CA complex formation. This stable binding would result in inhibition of the enzyme by two mechanisms. Firstly, binding of CA causes displacement of catalytic Tyr129 away from its target DNA-phosphate molecule from 1.6 Å to 3.8–7.3 Å and secondly, by causing steric hindrance to the binding of DNA strand at DNA binding site of enzyme. The combined effect would result in loss of cleavage and religation activity of enzyme leading to bactericidal effect on tuberculosis. This phytocompound displays desirable quality for carrying forward as a lead compound for anti-tuberculosis drug development. The results presented here are solely based on computations and need to be validated experimentally in order to assert the proposed mechanism of action.

1. Introduction

Mycobacterium tuberculosis causes one of the most severely affecting human diseases called tuberculosis. With present scenario of time-taking, inappropriate use of the first line of tuberculosis therapeutics led to emergence of multiple-drug resistant *M. tuberculosis* (MDR-TB) and has threatened the TB control programme at global stage (World Health Organization, 2013a). According to WHO report of 2012, 750,000 cases of MDR-TB cases of MDR-TB have been reported and near about 170,000 deaths have been attributed to MDR-TB. Along with this, 92 countries have reported cases of extensively-drug-resistant (XDR) TB with half of the cases coming from China, India, and the Russian Federation (World Health Organization, 2013a,b). In case of MDR-TB, WHO advocates fluoroquinolone drugs like ofloxacin when predisposition to the first line drug's report are not available in the continuation period (18 months) before changing the course of treatment or if resistance to at least two drugs rifampicin and isoniazid is proven (Walwaikar et al., 2003). However, in light of emergence drug resistance cases, key for controlling both wild type and MDR-TB is the search of a common inhibitor of tuberculosis DNA gyrase and its drug resistant mutant gyrase.

Type II topoisomerases are crucial enzymes involved in controlling, modifying DNA's topology and regulating supercoiling

Abbreviations: HTVS, high throughput virtual screening; CA, chebulinic acid; XP, extra precision; MDR-TB, multiple-drug resistant tuberculosis; XDR-TB, extensively-drug resistant tuberculosis; QRDR, quinolone resistance determining region; CTD, C-terminal domain; PSVS, protein structure validation suite; MD, molecular dynamics.

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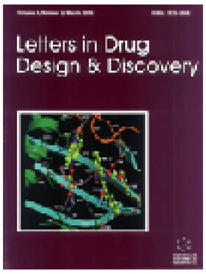

In silico Analysis of Plasmodium falciparum Actin and Profilin Interaction at the Interface Region for Antimalarial Drug Designing

Authors: Alam, Asrar; Kamal, Zahid; Fatima, Atiya
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Malaria parasite Plasmodium falciparum actively invades its host cells utilizing its actin/ myosin-based motor machinery. Actin-profilin interaction is essential for actin filament dynamics in eukaryotic cells. P.falciparum profilin (PfPRF) is highly divergent from other eukaryotic profilins and possesses unique structural properties. In this study, we attempted to identify region(s) of P.falciparum actins (PfACT1 and PfACT2) that interact with unique region(s) of PfPRF at the binding interface. We identified nine-residue peptides from PfACT1 (PLNPKGNRE) and PfACT2 (PLNPKTNRE) that interacted with a unique region of PfPRF. This interaction was largely absent from docked human beta actin-human profilin 1 complex. By molecular docking, the peptide derived from PfACT1 bound at the unique region of the PfPRF interface. Virtual screening based on the peptide-binding region of PfPRF identified a number of drug-like molecules. Our study demonstrated that the unique region of PfPRF could be specifically targeted. Since actin polymerization is essential for parasite motility and invasion, inhibitors specifically targeting parasite actin-profilin interaction could be potential antimalarials.

Keywords: Actin; Antimalarial; Molecular Docking; Plasmodium falciparum; Profilin; Virtual Screening

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Influence of laser repetition rate on the structural and optical properties of GaN layers grown on sapphire (0001) by laser molecular beam epitaxy

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High-quality GaN layers were grown on sapphire (0001) substrates using laser molecular beam epitaxy (LMBE) by laser ablating a solid GaN target at different laser repetition rates (10–40 Hz) under a constant supply of r.f. nitrogen plasma. The effect of laser repetition rate on the structural and optical properties of GaN layers was systematically studied using high-resolution X-ray diffraction (HRXRD), field emission scanning electron microscopy, atomic force microscopy, Raman spectroscopy and photoluminescence (PL) spectroscopy. High-resolution X-ray rocking curve measurements revealed highly *c*-axis oriented GaN layers on sapphire grown at 30 Hz with a calculated screw dislocation density of ~1.42×10^7 cm^{-2}, whereas the GaN layers grown at 10 or 40 Hz consisted the screw dislocation density in the range of 10^8–10^9 cm^{-2}. Surface morphological analysis revealed a change in grain size as well as surface roughness as a function of laser repetition rate and is explained on the basis of growth kinetics. Vibrational Raman spectroscopy revealed that the GaN layer grown at 10 Hz shows an in-plane compressive stress of ~1 GPa, while the film grown at 30 Hz exhibits a minimum stress of ~0.3 GPa. The PL measurements show a highly luminescent band-to-band emission of GaN at 3.44 eV for the 10 Hz grown highly strained GaN layer and at 3.41 eV for the less strained film grown at 30 Hz along with a broad defect band emission centered around 2.28 eV. It is found that the GaN layers grown at 30 Hz have excellent structural and optical properties. We expect that the less strained thin and highly oriented GaN film grown by LMBE can further be utilized for developing prodigious low-temperature-grown nitride-based multilayer structures and devices.

1. Introduction

Group III nitride direct band gap semiconductors have demonstrated superior physical and electronic properties and thus have attracted much attention in the field of optoelectronic devices such as laser diodes (LDs), solar cells and full color or white light-emitting diodes (LEDs).[1–5] For group III nitride-based devices, GaN layers are utilized as a buffer or base layer as they can be employed for the emission of visible and ultraviolet light through proper alloying with other group III metals.[4] Due to the high cost and lack of commercial GaN single crystal substrates, GaN layers are fabricated mostly on different lattice-mismatched foreign substrates in which GaN layers contain a high dislocation density.[6] The threading dislocations present in the GaN layers limit the performance of the devices as the high dislocation density causes a current leakage pathway, non-radiative recombination, and charge scattering centers and also deteriorates the optical and structural properties of the GaN epitaxial layers.[7,8] Several epitaxial growth techniques such as metal organic chemical vapor deposition (MOCVD), plasma assisted molecular beam epitaxy (PA-MBE), hydride vapor phase epitaxy (HVPE) and laser MBE (LMBE, also known as ultra-high vacuum pulsed laser deposition – UHV PLD) have been employed to grow high-quality GaN layers.[5,9–17] Among these conventional GaN growth techniques, LMBE is a relatively less explored technique in spite of its several advantages such as low-temperature growth, tuning of growth rate by laser energy density and repetition rates, freedom from usage of any hazard/poisonous gases and flexibility to use metals, compounds and alloy targets for the growth.

A variety of substrates such as SiC (0001),[12,16] Si (111)[18] and sapphire (0001)[14,15] have been used to grow high-quality *c*-axis wurtzite GaN layers for better performance of GaN devices. Among these substrates, *c*-plane sapphire has been used extensively due to the cost-effectiveness and availability of large sized wafers.[15] The LMBE growth of GaN on sapphire

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Interfacial encapsulation of bio-based benzoxazines in epoxy shells for temperature triggered healing

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ABSTRACT: Successful application of interfacial engineering for the preparation of cross-linked epoxy microspheres containing thermally polymerizable cardanol-based benzoxazine (Bz-C) monomer in the core is demonstrated. Bz-C is facilely synthesized by Mannich type condensation of cardanol (a by-product of cashew nut industry) and aniline with formaldehyde under solventless conditions. **The encapsulation process relies on the preferential reaction of polydimethylsiloxane immiscible epoxy resin and amine-based hardener to form a cross-linked spherical shell at the interface.** The microcapsule dimensions and core content could be tailored by modulating the operating parameters, particularly stirring speed and Bz-C: epoxy ratio. Spherical microcapsules with a core content of ~37% were obtained when the reaction was carried out at 600 rpm, while maintaining the reaction medium at 70°C with Bz-C: epoxy ratio of 2.3 : 1. The simplicity and versatility of the present methodology are the forte of this technique, which widens the scope for large-scale application of benzoxazines in the field of temperature triggered healing. © 2015 Wiley Periodicals, Inc. J. Appl. Polym. Sci. **2015**, *132*, 42832.

KEYWORDS: differential scanning calorimetry; microscopy; ring-opening polymerization; surfaces and interfaces; thermal properties

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INTRODUCTION

Polybenzoxazines belong to a class of addition cure phenolic systems which possess excellent mechanical, thermal, and flame retardant properties. The flexibility in designing the structure of benzoxazine monomers allows enormous scope in tailoring the properties of polymers for a wide range of applications in the field of polymer technology.[1] In addition, polybenzoxazines exhibit high glass transition temperature (T_g), long shelf life, chemical resistance, low water absorption, release of no by-products which translates to negligible volumetric change upon curing. Most interestingly, benzoxazines do not require any catalyst for their curing, a feature which bestow them interesting candidature as far as healing agents in mendable compositions is concerned,[2] provided they can be encapsulated in fragile microcapsules.

Currently, conventional healing agents are restricted to a class of monomers which undergo catalytic ring opening polymerization, e.g., epoxy, dicyclopentadiene (DCPD), etc., which in turn are encapsulated in the polymeric shells of melamine–formaldehyde, urea–formaldehyde (UF), and gelatin-gum arabic coacervate.[3] Conformist micro-encapsulation procedures involve *in situ* emulsion polymerization of urea or melamine with formaldehyde on the surface of the hydrophobic dispersed phase of the precursor. The condensation process necessitate acidic environment (pH <3),[4,5] conditions which can induce curing in benzoxazines.[6,7] This imposes a restriction on the technique used for the encapsulation of benzoxazines in commonly used shell walls. To circumvent these issues, we have previously reported the encapsulation of benzoxazines in polystyrene shell with a core content of the order of 37%.[8]

In this article, we adopt an interfacial engineering approach to prepare epoxy microcapsules containing core of liquid benzoxazine. The potential of liquid–liquid interface toward the preparation of nanocrystals, thin films[9–11], and microcapsules[12,13] has been well reported. We believe that this concept could very well be extended to prepare microcapsules with interesting morphologies. Our aim is to elaborate this conceptually, and to elucidate this approach, we disperse epoxy–benzoxazine solution in silicone medium followed by addition of a polyamine which reacts selectively with the epoxy. In view of the preferential reaction of oxirane with amine, we engender that the reaction would be

Additional Supporting Information may be found in the online version of this article.

CHAPTER THREE

Ion Channels in Neurological Disorders

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Contents

Abstract

The convergent endeavors of the neuroscientist to establish a link between clinical neurology, genetics, loss of function of an important protein, and channelopathies behind neurological disorders are quite intriguing. Growing evidence reveals the impact of ion channels dysfunctioning in neurodegenerative disorders (NDDs). Many neurological/neuromuscular disorders, viz, Alzheimer's disease, Parkinson's disease, Huntington's disease, multiple sclerosis, amyotrophic lateral sclerosis, and age-related disorders are caused due to altered function or mutation in ion channels. To maintain cell homeostasis, ion channels are playing a crucial role which is a large transmembrane protein. Further, these channels are important as it determines the membrane potential and playing

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Large-Scale Computational Screening Identifies First in Class Multitarget Inhibitor of EGFR Kinase and BRD4

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Inhibition of cancer-promoting kinases is an established therapeutic strategy for the treatment of many cancers, although resistance to kinase inhibitors is common. One way to overcome resistance is to target orthogonal cancer-promoting pathways. Bromo and Extra-Terminal (BET) domain proteins, which belong to the family of epigenetic readers, have recently emerged as promising therapeutic targets in multiple cancers. The development of multitarget drugs that inhibit kinase and BET proteins therefore may be a promising strategy to overcome tumor resistance and prolong therapeutic efficacy in the clinic. We developed a general computational screening approach to identify novel dual kinase/bromodomain inhibitors from millions of commercially available small molecules. Our method integrated machine learning using big datasets of kinase inhibitors and structure-based drug design. Here we describe the computational methodology, including validation and characterization of our models and their application and integration into a scalable virtual screening pipeline. We screened over 6 million commercially available compounds and selected 24 for testing in BRD4 and EGFR biochemical assays. We identified several novel BRD4 inhibitors, among them a first in class dual EGFR-BRD4 inhibitor. Our studies suggest that this computational screening approach may be broadly applicable for identifying dual kinase/BET inhibitors with potential for treating various cancers.

Kinase inhibitors have been identified for the treatment of various cancers[1,2]. However, compensatory mechanisms diminish the long-term efficacy of these inhibitors[3]. Drug resistance is often observed in the clinic as rapidly dividing cancer cells are able to avoid inhibition by a single targeted therapy through a variety of mechanisms[4]. The resistance of tumors toward kinase-directed therapeutics is often accompanied by a distinct change in signaling network composition through adaptive kinome reprogramming, allowing the tumor to elude effects of the drug and manifest resistance[5]. An established strategy to improve the durability of clinical responses to targeted therapies is to simultaneously inhibit multiple cancer-driving kinases. However, discovering kinase inhibitors with an appropriate multitarget profile has been challenging and necessitated the application of combination therapies, which can pose major clinical development challenges[6–9]. We therefore sought a strategy to identify single agent polypharmacological

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Research article

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Luminescence and advanced mass spectroscopic characterization of sodium zinc orthophosphate phosphor for low-cost light-emitting diodes

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ABSTRACT: A new rare-earth-free $NaZnPO_4$:Mn^{2+} (NZP:Mn) phosphor powder has been developed by our group and investigated meticulously for the first time using secondary ion mass spectroscopy and chemical imaging techniques. The studies confirmed the effective incorporation of Mn^{2+} into the host lattice, resulting in an enhancement of photoluminescence intensity. Phase purity has been verified and structure parameters have been determined successfully by Rietveld refinement studies. The NZP:Mn phosphor powder exhibits strong absorption bands in the ultraviolet and visible (300–470 nm) regions with a significant broad yellow-green (~543 nm) emission due to the characteristic spin forbidden d–d transition ($^4T_1 \rightarrow {}^6A_1$) of Mn^{2+} ions, indicating weak crystal field strength at the zinc-replaced manganese site. The decay constants are a few milliseconds, which is a pre-requisite for applications in many display devices. The results obtained suggest that this new phosphor powder will find many interesting applications in semiconductor physics, as cost-effective light-emitting diodes (LEDs), as solar cells and in photo-physics.

Keywords: luminescence; orthophosphates; ToF SIMS

Introduction

White light-emitting diodes (WLEDs) are gaining wide popularity as promising substitutes for next generation lighting sources. They have attracted much attention due to their unique properties such as low-power consumption, high luminescence efficiency and longer lifetimes, when compared with the traditional incandescent and fluorescent lamps (1–4). For phosphor-based WLEDs, rare-earth activated inorganic compounds have been reported extensively in the literature (5,6). Among the many host lattices recognized to date, such as aluminates, sulfides, borates and phosphates, the orthophosphates ($ABPO_4$ family) have captivated researchers' interests the most because of reports stating that they give brighter luminescence using transition metal ions as activators (7,8). Apart from being chemically and thermally stable, these phosphate group-based $ABPO_4$ phosphors have low phonon energy (9,10). They also display excellent optical and ferroelectric properties (11,12). For the orthophosphates, it has been reported that its phases crystallize into three basic shapes depending upon cation sizes (13,14). Apart from the usual trend of using rare-earth (RE) ions as activators, transition metal ions (such as Mn^{2+}) are also gaining popularity in the field of eco-friendly lighting and display devices (15–17). The emission wavelength of Mn^{2+} depends on the crystal field environment provided by the host framework. It gives strong green emission in a weak crystal field, i.e. when it is tetrahedrally coordinated. It also exhibits an orange-to-deep red emission in a strong crystal field site, i.e. when it is placed on an octahedral site (18). It has been reported that zinc orthophosphate (zincophosphate) host matrices show bright and uniform luminescence due to co-ordination flexibility and strong Zn–O–Zn linkages (7).

In this paper, we report the results from structure, luminescence and dopant distribution studies using mass spectroscopic and photoluminescence techniques on Mn^{2+}-doped sodium zinc orthophosphate phosphor. Time decay curves at different concentrations of Mn^{2+} have also been studied. This new phosphor could find many applications in the realm of efficient lighting technologies.

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Abbreviations: AcSIR, Academy of Scientific and Innovative Research; CSIR, Council of Scientific and Industrial Research; DFT, Density functional theory; GGA, generalized gradient approximation; IBZ, Irreducible Brillouin Zone; IPCC, Intergovernmental Panel on Climate Change; LED, light-emitting diodes; OLED, organic light-emitting diodes; QY, quantum yield; RE, rare earth; SEM, scanning electron microscope; UGC, University Grants Commission; WLED, white light-emitting diodes; XRD, X-ray diffraction.

Luminescence Spectral Studies of Tm^{3+} ions doped Lead Tungsten Tellurite Glasses For Visible Red and NIR applications

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Abstract

Lead Tungsten Tellurite (LTT) glasses doped with different concentrations of Tm^{3+} ions of composition (60-x) TeO_2 + 25 WO_3 + 15 PbF_2 + x Tm_2O_3 (Here x=0.1, 0.5, 1.0, 1.5, 2.0, 2.5 mol %) were prepared by using melt quenching technique and characterized through optical absorption, photoluminescence and decay spectral studies to know the feasibility of using these glasses as luminescent devices in visible Red and NIR regions. Judd-Ofelt (J-O) theory has been applied to the optical absorption spectral profiles to calculate the J-O intensity parameters Ω_λ (λ=2, 4 and 6) and consecutively used to evaluate various radiative properties such as radiative transition probability (A_R), radiative lifetimes (τ_R) and branching ratios (β_R) for the prominent luminescent levels. The luminescence spectra for all the LTT glass samples have two intense peaks in bright red and near Infrared regions at 650 nm ($^1G_4 \rightarrow {}^3F_4$) and 800 nm ($^3H_4 \rightarrow {}^3H_6$) respectively for which effective band widths ($\Delta\lambda_P$), experimental branching ratios (β_{exp}) and stimulated emission cross-sections (σ_{se}) are evaluated. The decay profiles for all the glasses are recorded to measure the quantum efficiency by coupling the radiative with experimental lifetimes. From the measured emission cross-sections, quantum efficiency and CIE chromaticity co-ordinates, it was found that 0.5 mol% of Tm^{3+} ions doped LTT glass is most suitable for generating bright visible red and NIR lasers to operate at 650 and 800 nm respectively.

Keywords: *Thulium, Glasses, JO parameters, Optical materials, Luminescence, Optical properties*

Mechanical properties and microstructure of spark plasma sintered nanostructured p-type SiGe thermoelectric alloys

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Abstract

SiGe based thermoelectric (TE) materials have been employed for the past four decades for power generation in Radio-isotope thermoelectric generators (RTG). Recently "nanostructuring" has resulted in significantly increasing the figure-of-merit (ZT) of both n and p-type of SiGe and thus nanostructured $Si_{80}Ge_{20}$ alloys are evolving as a potential replacement for their conventional bulk counterparts in designing efficient RTGs. However, apart from ZT, their mechanical properties are equally important for the long term reliability of their TE modules. Thus, we report the mechanical properties of p-type nanostructured $Si_{80}Ge_{20}$ alloys, which were synthesized employing spark plasma sintering of mechanically alloyed nanopowders of its constituent elements with 1.2% boron doping. Nanostructured p-type $Si_{80}Ge_{20}$ alloys exhibited a hardness of ~9 ± 0.1 GPa, an elastic modulus of ~135 ± 1.9 GPa, a compressive strength of 108 ± 0.2 MPa, fracture toughness of ~1.66 ± 0.04 MPa√m with a thermal shock resistance value of 391 ± 21 Wm^{-1}. This combination of good mechanical properties coupled with higher reported ZT of nanostructured p-type $Si_{80}Ge_{20}$ alloys are render it to be a potential material for power generation applications, compared to its bulk counterpart.

Keywords: Nanostructured p-type $Si_{80}Ge_{20}$ alloy, Thermal Shock Resistance, Fracture Toughness, Spark Plasma Sintering, Compressive Strength, Hardness, Elastic Modulus.

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Metabolic Imbalance Associated Mitophagy in Tumor Cells: Genesis and Implications

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Abstract: Emerging knowledge supports the notion that metabolic reprogramming facilitates the progression of many cancers and in some it could be initiated by mutations in genes related to mitochondrial function. While dysfunctional mitochondria plays a pivotal role in driving metabolic reprogramming, mitophagy that recycles damaged mitochondria by selective and organized degradation appears to be vital for sustaining carcinogenesis. Although the potential of targeting mitophagy as a therapeutic strategy has still remained elusive, poor prognosis and therapeutic resistance of highly glycolytic tumors suggest that inhibitors of mitophagy could be potential adjuvant in radio- and chemotherapy of tumors. We briefly review the current status of knowledge on the interrelationship between mitophagy and metabolic reprogramming during carcinogenesis and examine mitophagy as a potential target for developing anticancer therapeutics and adjuvant.

Keywords: Warburg, PARKIN, Oxidative stress, Metabolic Reprogramming, Calcium.

Mitochondria are considered to be the energy house of eukaryotic cells. To ensure functionality of this crucial requirement under a variety of stress conditions, cells have evolved a highly structured mechanism for recycling damaged mitochondria known as Mitophagy [1, 2]. Mitophagy aids in selective degradation of damaged/dysfunctional and old mitochondria produced in response to certain deleterious stresses such as hypoxia and starvation, thereby helping in the maintenance of cellular homeostasis [1, 2]. Accumulating evidences suggest that dysfunctional mitochondrion has a pivotal role in modulating the metabolic reprogramming thus contributing to the process of tumorigenesis [3]. Variations in the status of Warburg phenotype linked to the differences in mitochondrial status in cancer cells and/or tumor micro milieu (reverse Warburg phenotype) appear to be dependent on mitophagic potential of cells as well as the type and extent of stress [4]. Poor prognosis and therapeutic resistance of highly glycolytic tumors suggest that mitophagy could be one of the contributing factors. Although the potential of targeting mitophagy as a therapeutic strategy has so far remained elusive, emerging evidences suggest the potential of targeting this phenomenon for developing inhibitors of mitophagy as adjuvant in radio- and chemotherapy of tumors [5]. This review will discuss the relationship between metabolic disturbance leading to calcium imbalance and mitophagy in both malignant as well as untransformed cells and critically examine the direct and collateral evidences for developing inhibitors of mitophagy as adjuvant in cancer therapy.

METABOLIC REPROGRAMMING AND TUMORIGENESIS

Metabolic reprogramming or altered bioenergetics has emerged as an important hallmark of cancer. The source of cancer initiation and maintenance which was earlier only restricted to genetic mutations is now gradually being attributed to metabolic reprogramming also. Glucose and ATP have been identified as key players in altered bioenergetics. Metabolic alternations in cancer cells were recognized as early as 1920, when Otto Warburg gave his hypothesis of “Warburg effect” stating that ‘‘*Cancer, above all other diseases, has countless secondary causes”.*

Warburg postulated that unlike normal cells, cancer cells produce lactate from glycolysis even in the presence of abundant oxygen. He termed it as aerobic glycolysis. Warburg attributed this phenomenon to dysfunctional mitochondria that impairs oxidative phosphorylation [3, 6]. High glycolytic rate might also result from a decreased mitochondrial mass in tumor cells [7]. The constant glycolysis in these cells is maintained by up regulation of glucose transporters (Glut1-4) that help in glucose uptake [8-11].

In addition to providing ATP, increased glucose uptake also provides cancer cells with building blocks of the cell i.e. macromolecules like nucleotides, amino

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Sustainable Chemistry

Microwave-Assisted Sustainable Synthesis of Telechelic Poly(ethylene glycol)s with Benzoxazine End Groups

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A microwave assisted synthetic route was explored as a sustainable tool for the preparation of cross-linkable telechelic poly(ethylene glycol)s endcapped with benzoxazine functionality. In comparison to the conventional methodology, the reaction completion time could be significantly reduced using MAS technique and the sustainability of the procedure was improved. Microwave active bifunctional amines were prepared by the condensation reaction of p-aminobenzoic acid and poly (ethylene glycol)s of different chain lengths to yield amine terminated poly(ethylene glycol)s (ATPEGs). Cardanol, an agro-waste was chosen as the phenolic source, which was reacted with ATPEG to undergo Mannich like condensation resulting in reactive thermoplastic of telechelic nature. The structure of the resulting polymer was confirmed through FT-IR and ^{1}H-NMR spectroscopy. Benzoxazine moieties present at the terminals undergo thermally accelerated ring opening polymerization to form cross-linked networks which was studied using non-isothermal differential scanning calorimetry (DSC). The rheological behavior of the resulting polymer suggests that the viscosity of the benzoxazine-endcapped telechelic poly (ethylene glycol)s is sufficiently low to permit solventless processing which can be credited to the presence of flexible polyether linkages. The adhesive properties of the cross-linked benzoxazine endcapped telechelic poly(ethylene glycol)s have also been studied.

1. Introduction

Microwave assisted synthesis (MAS) has emerged as a sustainable tool for organic synthesis which offers a simple, efficient and economic route towards the preparation of industrially important chemicals.[1]Microwave assisted heating is a rather rapid process, which does not mandate any contact between the energy source and the reaction vessel. The acceleration in the rate of reaction is primarily due to thermal effects, which is essentially due to rapid heating of the reactants.[2] Possible existence of “non-thermal microwave effects” that could rationalize the difference in ′thermal′ and ′microwave assisted′ heating has always been a topic of much debate.[2]In general, the essential criterion behind the success of MAS technique is the polarity of the reaction media. In the field of polymers, the application of microwaves for process development has led to apt solutions for several intriguing technical problems.[3] For example, MAS has been adopted for the synthesis of several industrially important polymeric resins like unsaturated polyesters,[4] polyamides,[5] polyethers,[6] polyimides[7] etc. and microwave radiation has also been reported to facilitate the curing process of various polymeric systems.[8]

Several benzoxazine derivatives have also been prepared using MAS,[9] which are generally used in the field of pharmacological sciences. Inan et. al.[10] reported the microwave synthesis of polybenzoxazine precursor using humic acid as a source of phenol from coal. However, literature on the exploration of MAS technique towards synthesis of polymeric benzoxazine resins is relatively scarce, the reason probably being the low microwave activity of the reactants involved, i.e. amine, formaldehyde and phenol. 1,3-benzoxazine monomer is synthesized by Mannich like condensation of these reactants in solution or through melt processing. Polybenzoxazines, formed by the thermal curing of this monomer, exhibit interesting properties, particularly negligible volume shrinkage during curing,[11] low water absorption[12] and excellent thermal stability in combination with excellent mechanical performance.[13]As is clear, there is enormous design flexibility in benzoxazine synthesis, due to the large library of precursors available. In view of the potential of benzoxazines in different areas, all endeavors towards reduction in the reaction time for the preparation of these resins are highly desirable.

Development of benzoxazines, especially those based on renewable raw materials using alternative sustainable processes, has been receiving the attention of academicians and industrialists.[14]In the context of sustainable benzoxazines, there is enormous literature to support the candidature of agro-waste cardanol as a phenolic source. Cardanol possess a long alkyl chain which can lead to intramolecular plasticization,[15] resulting in the lowering of glass transition temperature (T_g) of the cured specimen[16] but higher polymerisation temperatures.[17]What makes cardanol particularly interesting in the context of benzoxazine preparation, is its ability to render the synthetic process solventless. The Mannich like condensa-

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Nanoparticle Synthesis and Oxygen Anion Diffusion in Double Perovskite $GdBaCo_{2-x}Fe_xO_{5+\delta}$ Electrodes for SOFC

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Development of an intermediate temperature solid oxide fuel cell essentially require the synthesis of electrocatalytically active nanostructured cathode materials with fast oxygen anion transport and surface exchange properties. Double perovskite structured $GaBaCo_2O_{5+\delta}$ (GBCO) electrode showing an average particle size of less than 20 nm was synthesized by a bio-milling approach. In parallel, molecular dynamics (MD) simulations were utilised to calculate the effect of Fe doping at the B-site on the oxygen anion diffusivity of $GdBaFe_xCo_{2-x}O_{5.5}$ double perovskites. The oxygen diffusion was observed to be preferential in the *a-b* plane of $GBCO_{5.5}$ with a value of D=2.8 x 10^{-7} cm^2 s^{-1}, calculated at 1173 K. The change in diffusion coefficient (D=1.95 x 10^{-7} cm^2 s^{-1} at 1173 K) was negligible on doping 50% Fe in the structure. However, in 100% Fe substituted structure, $GdBaFe_2O_{5.5}$ ($GBFO_{5.5}$), the diffusivity was significantly reduced (D=2 x 10^{-8} cm^2 s^{-1} at 1173 K).

Introduction

Solid oxide fuel cells (SOFC) have shown considerable promises as compared to other types of fuel cells in terms of fuel flexibility and energy efficiency for providing direct conversion of chemical to electrical energy. In general, SOFC operates at high temperatures (>1173K) which requires materials to be thermally stable and non-reactive. In addition the SOFC components have to match with their thermal expansion coefficient for high temperature operations. Therefore, research in the development of SOFC technology is directed towards lowering the operating temperature to an intermediate (773-973 K) regime, wherein the oxygen reduction reaction (ORR) at the cathode was found to be sluggish, as compared to the processes on the other components of the cell [1]. Traditionally, electronic conductors of simple

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Nanostructured SnO_2 encapsulated guar-gum hybrid nanocomposites for electrocatalytic determination of hydrazine

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The present article deals with synthesis of sol–gel derived tin dioxide (SnO_2) nanoparticles encapsulated in to guar gum (GG) biopolymer as the organic–inorganic hybrid materials for the determination of hydrazine. The organic–inorganic hybrid combines the perfunctory strength offered by the inorganic SnO_2 nanoparticles with flexible binding sites provided by the organic biopolymer (GG) solution by the ultrasonication. The phase identification, crystalline size, surface morphology and optical properties of prepared SnO_2 and SnO_2-GG nanocomposites has been investigated through FT-IR, XRD, SEM, AFM, TEM, UV–Vis, and PL techniques. The colloidal solution of SnO_2 and GG is electrophoretically deposited (EPD) onto the indium tin-oxide (ITO) glass substrate and studied for the electrooxidation of hydrazine. Under the optimized experimental conditions, the linearity between the current response and the hydrazine concentration has been obtained in the range of 2–22 mM, with a low detection limit of 2.76 mM and a high sensitivity of 5.72 μA cm^{-2}. Based on the linear increase in amperometric current, a sensitive hydrazine electrochemical sensor is constructed. The proposed SnO_2-GG/ITO electrode shows a good response time (35 s), reproducibility, and long-term stability. The obtained results suggest that SnO_2-GG nanocomposites electrode provides a favorable sensing platform for the electrochemical studies. In addition, the cyclic voltammetry (CV) studies are used to evaluate the kinetic parameters.

1. Introduction

Development of various non-enzymatic electrochemical sensors using innovatively designed electrocatalytic materials of optimum efficiency has gained a great deal of interest in recent years [1–3]. Over the last few decades, nanosctructured metal oxide and polymer based organic- inorganic hybrids materials has evolved greatly [4–6], and lead to the construction and improvement of many electrochemical sensors [7–10]. Numerous electrochemical sensors have been developed based on the electrocatalytic properties of nanostructured materials such as Au, Pt, and TiO_2, SnO_2, by incorporating in different organic and inorganic matrices [11–14]. Among them, SnO_2 as a n-type semiconductor with direct band gap of 3.6 eV has paid much attention because of its applications in different fields such as designing of transparent conducting electrode [15], gas sensors [16], solar cells [17], and catalyst [18]. Several methods have been introduced to synthesize various types of nano/microstructures SnO_2, including size controllable, template free, hydrothermal, sonochemical, facile one-pot and sol–gel methods [19–23]. Biopolymers have number of attractive features and therefore, these materials are gaining interest to design the multifunctional materials [24–27]. These features include biocompatibility, nontoxicity, biodegradability, adjustable hydrophobic/hydrophilic nature, as well as metal ion chelating ability [28]. Biopolymer, such as GG is a natural polysaccharide consisting of galactose and mannose units [29]. Because of its unique properties such as strong hydrogen bonding, film forming ability, excellent thickening, emulsion and stabilizing agent, it has gained popularity for the development of advanced materials [30]. In addition, GG is soluble in hot and cold water, having high viscosity over a broad range of pH which is compatible with a variety of inorganic and organic substances. Organic–inorganic hybrid nanostructures can provide an efficient and effective electrochemical sensing platform which gives superior response to the analytes in aqueous solution. It is expected that the inorganic component (SnO_2) provides good charge transfer ability, large surface area, high catalytic activity and high adsorption ability. On the other hand, organic polymer matrix (GG) is advantageous due to good film forming ability, fascinating electron transfer ability, large surface area and biocompatibility. Exploiting the properties of SnO_2 and GG, the (SnO_2-GG) hybrid nanocomposites based electrode having tunable mechanical, thermal, electrical and optical properties can be prepared with a low production cost which can be further used for the construction of an electrochemical device.

Hydrazine and its derivatives have wide range of applications such as pharmaceutical intermediates, antioxidants, blowing agents, pesticides,

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Non-invasive topical delivery of plasmid DNA to the skin using a peptide carrier

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Topical delivery to skin is an essential step in non-invasive application of nucleic acid therapeutics for cutaneous disorders. The barrier posed by different layers of the skin – stratum corneum on top followed by the viable epidermis below – makes it extremely challenging for large hydrophilic molecules like nucleic acids to efficiently enter the uncompromised skin. We report an amphipathic peptide Mgpe9 (CRRLRHLRHHYRRRWHRFRC) that can penetrate the uncompromised skin, enter skin cells and deliver plasmid DNA efficiently as nanocomplexes *in vitro* and *in vivo* without any additional physical or chemical interventions prevalent currently. We observe efficient gene expression up to the highly proliferating basal layer of the skin without observable adverse reactions or toxic effects after delivery of reporter plasmids. The entry mechanism of nanocomplexes possibly involves reversible modulation of junction proteins accompanied by transient changes in skin structure. This peptide holds potential to be used as an efficient transporter of therapeutic nucleic acids to the skin.

1. Introduction

Skin, by virtue of its large size and easy accessibility, can be explored for therapeutic interventions. It has been shown to be a favorable target for both topical as well as transdermal delivery of different small molecule drugs [1–3]. Usually substances that are small in size (<500 Da) with high or moderate lipid solubility penetrate/permeate the skin more easily as compared to large hydrophilic molecules whose diffusion is slow and inefficient. The stratum corneum containing dead keratinocytes, tight junctions called desmosomes and different cellular barriers pose difficulty for facile delivery of such molecules to skin. Strategies have been designed to aid delivery of macromolecules like proteins, nucleic acids and glycosaminoglycans to the skin [4–6]. Delivery methods usually involve harsh physical procedures e.g. electroporation and microneedle injections, treatments with chemical enhancers or use of vesicles like liposomes, ethosomes and transfersomes [7–11]. These methods other than ethosomes which have been used for dermal and transdermal delivery in clinic [4] compromise the integrity of the skin structure to an extent and may have other side effects if intended to be used in a diseased condition where the structure of the skin could be even more fragile. In recent times, natural and synthetic peptides have emerged as potential transporters of large biomolecules like proteins and plasmid DNA to cells [12–14]. Peptides are easy to synthesize, diverse in chemistry and can be modified for cellular targeting. Peptides like TAT, polyarginine, magainin and penetratin can penetrate the stratum corneum and have been used for efficient transdermal delivery of small molecules in the skin [15,16]. Recently TD-1, a cyclic peptide, has been shown to enhance transdermal delivery of hydrophilic macromolecular proteins like insulin [17]. Another phage display derived peptide SPACE has been used for siRNA delivery across intact skin [18]. Peptide mediated HIFαODD plasmid DNA delivery has been successful in stimulating wound healing in integrity compromised skin [19]. In another report cysteine flanked arginine-rich peptide has been shown to deliver luciferase plasmid through intradermal injection in the skin [20]. Also many fusion proteins such as TAT-epidermal growth factor, Chaperon-epidermal growth factor, TAT and R9 fused anti-oxidative enzymes, and non-covalently associated cargo such as TAT-EGFP have been shown to enter the skin in an efficient manner

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Ontologies for Software Engineering: Past, Present and Future

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Abstract

Background/Objectives: Research in recent years has probed integration amongst research field of Software Engineering and Semantic Web technology, addressing the advantages of applying Semantic techniques to the field of Software Engineering. Prolifically published studies have further substantiated the benefits of ontologies to the field of Software Engineering, which clearly motivate us to explore further opportunities available in this collaborated field. This paper is a survey expounding such opportunities while discussing the role of ontologies as a Software Life-Cycle support technology. **Method/Statistical Analysis:** Survey centred on providing an overview of the state-of-art of all the ontologies available for Software Engineering followed by their categorization based on software life cycle phases and their application scope. **Findings:** Characterization of ontologies as a Software Life-cycle support technology, instigated by the increasing need to investigate the interplay between Semantic Web & Software Engineering with the ultimate goal of enabling & improving Software Engineering capabilities.**Application/Improvements:** This paper discusses the practical and potential applications of ontologies in the field of Software Engineering followed by the issues and challenges that will keep this field dynamic and lively for years to come.

Keywords: Life Cycle, Ontologies, Semantic Web, Semantic Web Enabled Software Engineering, Software Engineering, Support Technology

1. Introduction

"Semantic Web provides a common framework that allows data to be shared and reused across application, enterprise, and community boundaries "[1]. It is a machine processable "Web of Data"[2]. It is well recognized as an effective means of improving visibility of knowledge on the Web. At the core of Semantic Web is ontology that is used to explicitly represent our conceptualizations. Ontologies are built to model a domain and support reasoning over the concepts. Ontology engineering in Semantic Web is primarily supported by languages such as RDF, RDFS and OWL[3].

Software Engineering is "the application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software, and the study of these approaches; that is, the application of engineering to software"[4]. Software development is a multifaceted task with new challenges being imposed frequently. The problem manifolds owing to overwhelming demands of the customers, numerous participants, shorter time frames, different geographical and virtual locations of software development teams, information overload and related issues. Sharing and reusing available information saves the effort in development and maintenance of software systems. As a major operative challenge this fosters the need to explore strategic and supporting technologies.

Recent studies have publicized the collaboration among research fields of Software Engineering (SE) and Semantic Web Technology (SW), which demonstrate the benefits of integrating semantic techniques with Software Engineering[5-9]. Ontologies have emerged as a key player in this direction[7,8,10,11]. A rising trend to exploit ontologies to exchange and interconnect Software Engineering knowledge across Web has been recognized and accepted

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Ontology based Framework for DetectingAmbiguities in Software Requirements Specification

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***Abstract*— Research in recent years has shown integration amongst the prominent & dynamic areas of software engineering and semantic web technologies. Prolifically published studies have explored the advantages of applying semantic web techniques to the field of software engineering. The motivation to further probe opportunities available in this collaborated field is ample with many issues and challenges.Among such issues, one is to detect ambiguities in Software Requirements Specification using ontology. This research paper presents a framework and discusses the implementation approach to resolve this issue.**

Keyword*— *Ambiguity Detection, Ontology, Semantic Web, Software Engineering, Software Requirements Specification

NOMENCLATURE

SE- Software Engineering
SW- Semantic Web
SRS- Software Requirements Specification
RDF- Resource Description Framework
RDFS- Resource Description Framework Schema
SDD- Software Design Document
NLP- Natural Language Processing

I. INTRODUCTION

Software development is a multifaceted and complex task that involves a lot of effort from numerous participants and produces large amount of information [1]. Reusing already available information saves this effort in development and maintenance of software systems [2]. Also, when software development teams are present at different geographical and virtual locations, it may lead to the generation of inconsistent information due to lack of proper knowledge sharing mechanism. Thus, for large software system development, reusing and sharing software engineering knowledge turns out to be a major operative challenge, which motivates researchers to explore possible supporting technologies [3].

Integration among research fields of Semantic Web Technology (SW)& Software Engineering (SE) have been shown by recent studies, illustrating the advantages of collaborating semantic techniques with Software Engineering. Ontologies, which are “formal and explicit specification of shared conceptualization” [4], and Semantic Web techniques such as RDF, RDFS, SPARQL, etc. have been used to improve various software engineering processes [5],[6],[7],[8]. Hence, ontologies have emerged as a vital player in this direction. A rising trend to utilize ontologies to exchange and interconnect Software Engineering knowledge across Web has been identified by the Software Engineering community.

“However, this integration still possesses various issues and challenges that ought to be addressed. Issues and challenges, which will keep this integrated field dynamic and lively for years to come” [7],[8],[9],[10]. Among such issues, one is to detect ambiguities in Software Requirements Specification (SRS) using ontology.

SRS is usually the first deliverable for any software project. It serves as the "parent" document because all successive project management documents, such as Software Design Document (SDD), software architecture specifications, testing & validation plans, and documentation manual, are related to it [11]. A good SRS has some desirable characteristics, i.e., it is expected to be correct, complete, verifiable,unambiguous, consistent, ranked for importance and/or stability. Usually SRS is written in natural language which is inherently ambiguous. The literal meaning of the word unambiguous is: "not having two or more possible meanings". This implies that each requirement is expected to have one and only one interpretation.One way to get rid of ambiguities is also to use formal language, but it is very complex, time consuming and expensive [12].

In ontology based software development, application domain ontology can be used to capture all requirements specification. It describes various relationships that exist between different concepts relating to the domain [6],[13]. This research paper presents a framework as well as an implementation approach for detecting ambiguities in SRS document using an application domain ontology assisted by Natural Language Processing (NLP) and Semantic Web techniques.

The rest of the paper is organised as follows: section II elaborates the related work followed by section III which discusses the proposed framework. Section IV expounds the

Ontology Based Framework for Reverse Engineering of Conventional Softwares

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Abstract— **Incontemporary years, integration among research areas of semantic web technologies and software engineering took place due to the reason of developers being present at different virtual, cultural, and geographical locations. Due to this amalgamation, a new collaborated field has emerged known as Semantic Web Enabled Software Engineering. This field presents researchers ample opportunities to probe issues and challenges, which are originated due to their amalgamation.Among such issues, one is the reverse engineering of conventional softwares using ontologies. This research paper presents a framework and discusses the implementation approach to resolve to the above issue.**

Keyword— Conventional Software,Ontology, Reverse Engineering, Semantic Web, Software Engineering

NOMENCLATURE

API- Application Programming Interface
IT- Information Technology
N3- Notation 3
OWL- Web Ontology Language
SE- Software Engineering
SW- Semantic Web
RDF- Resource Description Framework
SPARQL- SimpleProtocol and RDF Query Language
RDFS- Resource Description Framework Schema
UML- Unified Modified Language

I. INTRODUCTION

Nowadays, due to global competitiveness, every organization wants to reduce it expenditure on Information Technology (IT)operations.Therefore, offshoring IT services is a very common phenomenon.Also, in offshore projectsthere is high probability that thedevelopment, support & maintenance teams are located at different geographical, virtual, and cultural locations. For example, when Merck (the UnitedStates of America based pharmaceutical company) hasoffshored its IT work to HCL Technologies (an Indian based IT services company) to look after for various development, support & maintenance activities, the HCL Technologies gottheir teams distributed geographically and virtually at various locations of India and United States of America to support their day to day IT activities and eachsuch team belongs to different cultural background.Consider another similar example where British Airways (the United Kingdom based flag carrier airline organization)has also offshored its IT operations to NIIT Technologies (an Indian based global IT solutions organization) to handle their complex and expensive business, the NIIT Technologies has deployed its several teams across various locations of United Kingdom and India to support their all IT activities. Again these teams belong to different culture and geographical locations.Therefore, in situations where IT workingteams belong to different locations, they possessdiversified information,knowledge & skills and sharing them becomes a key challenge. In the absence of any proper sharing mechanism, the developmentleads to generation of inconsistent information.This inconsistency further results into the development of undesired software [1],[2].

Also, when various development, support & maintenance activitiestook place, itgenerates a lot of information involving numerous participants [3]. Reusing already available information further saves the human effort in various development, support & maintenance activities [4]. Due to this overall scenario, reusing and sharing IT information turns out to be a key operative challenge.

The above challenge leads to the integration between research fields of Semantic Web (SW) technologies & Software Engineering (SE)[5],[6],[7] because “Semantic Web provides a common framework that allows data to be shared and reused across application, enterprise, and community boundaries” [8]. On the other hand Software Engineering is “the application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software, and the study of these approaches; that is, the application of engineering to software” [9]. This integration opened new avenues for researchers to look after various issues & challenges that got generated due to amalgamation of SW & SE. Among such issues, one is reverse engineering of conventional softwares using ontologies.

“Reverse engineering, also called back engineering, is the processes of extracting knowledge or design information from anything man-made and re-producing it or reproducing anything based on the extracted information” [10]. Hence, reverse engineering plays a crucial role in understanding the software system during various support & maintenance activities in the absence of any updated documentation. Ontologies, which are “formal and explicit specification of

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Oxygen anion diffusion in double perovskite $GdBaCo_2O_{5+\delta}$ and $LnBa_{0.5}Sr_{0.5}Co_{2-x}Fe_xO_{5+\delta}$ (Ln = Gd, Pr, Nd) electrodes

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ABSTRACT

Simulations utilizing molecular dynamics (MD) were applied to study the anisotropic diffusion in the *a–b* plane of double perovskite structure, $GdBaCo_2O_{5.5}$ ($GBCO_{5.5}$). Diffusion coefficient of $GBCO_{5.5}$ was calculated to be 5×10^{-8} cm^2 s^{-1} at 873 K. The calculated diffusion coefficient was observed to increase on increasing temperature with an activation energy of 50.8 kJ/mol. Similar MD simulations were employed to study the effect of the level of Fe doping at the B-site of the co-doped $GdBa_{0.5}Sr_{0.5}Co_{2-x}Fe_xO_{5+\delta}$. In the co-doped structure, increasing diffusion was observed on increasing the Fe doping to x = 1 (D = 7.5×10^{-8} cm^2 s^{-1} at 923 K). This was contrary to the Pr or Nd based co-doped materials, $LnBa_{1-y}Sr_yCo_{2-x}Fe_xO_{5+\delta}$ (Ln = Pr, Nd), where maximum diffusion was calculated for Fe doping level at x = 0.5 (D = 5.16×10^{-8} cm^2 s^{-1} for Ln = Pr and D = 1.18×10^{-7} cm^2 s^{-1} for Ln = Nd at 873 K). The trend in diffusivity correlates well with the trends in the measured peak power density of a solid oxide fuel cell fabricated with these electrode materials.

Introduction

Solid Oxide Fuel cell (SOFC) technology has a promising case for efficient conversion of chemical energy into electrical energy, with a prospect to achieve sustainability, in terms of fuel flexibility [1]. In general, SOFCs are operated at high temperatures (>973 K) where the applied materials are required to be stable and non-reactive with a desirable thermal expansion coefficient (TEC) match between the components [2,3]. These conditions offer a limited choice in materials development. Thus, it is imperative to reduce the operating temperature to an intermediate (773–973 K) or even to a lower (<773 K) regime [4], which constitute the state of the art research. While operating a SOFC at an intermediate temperature [5], significant increase in the

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Particle Swarm Based Evolution and Generation of Test Data Using Mutation Testing

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Abstract. Adequate test data generation is a vital task involved in the process software testing. Process of mutation testing, a fault-based testing technique, generates mutants of the program under test (PUT) by applying mutation operators. These mutants can assist in finding test cases that have the potential to detect faults in the PUT. Particle Swarm Optimisation (PSO) share similar working characteristics with Genetic Algorithm (GA) which has already been applied to test data generation using mutation testing. In this paper, applicability of PSO for the generation of test data with mutation testing is explored. The results obtained by empirical evaluation of the proposed approach on benchmark C programs are presented. The evaluated results show that the test cases generated from the technique proposed kills substantial number of mutants and therefore, has a scope of exploring its performance in the area of search based test case generation.

Keywords: Particle Swarm Optimization · Mutation testing · Genetic Algorithm · Software-artifact Infrastructure Repository

1 Introduction

Mutation testing is a fault-based testing technique that was originally proposed by DeMillo and Hamlet [1,2]. The underlying principle of mutation testing is to emulate the faults in software that a proficient programmer may make during the software development phase. Jia and Harman presented a detailed survey [3] on the analysis and developments in the field of mutation testing up to the year 2009. Mutation testing was initially proposed to measure the quality of the test cases that uses 'mutation score' for evaluating the effectiveness of the test suite. The researchers later began to use it as a technique for generation of test data [3]. A recent study [4] identified various approaches used by researchers for test data generation using mutation testing.

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Passive Islanding Detection Technique for Multi-DG Power System

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***Abstract*— The use of distributed generators including solar photovoltaic, wind, small hydro, biomass etc. are playing an important role in the restructured power system. However, there are certain issues related to grid integration of DGs including islanding detection. Hence, it becomes an important area of research nowadays for power engineers. There are various islanding detection techniques including passive, active, hybrid, utility, communication based etc. In this paper, a passive islanding detection technique for multi-DGs including solar photovoltaic is presented. Three DGs including solar photovoltaic have been considered in this study. The performance is evaluated on the basis of four parameters i.e. voltage, frequency, positive sequence voltage and negative sequence voltage at the point of common coupling (PCC). This paper considered two practical scenarios for isolation of grid, one due to occurrence of fault and other is intentional disconnection of grid for schedule maintenance of the system. The test system is simulated in DigSILENT Power factory software for detecting the islanding.**

Keywords—distributed generator; islanding; passive islanding detection; non detection zone; power quality factor

I. Introduction

Over the past decade, with the increase in worldwide consumption of electricity and increasing loads, the traditional model of the grid is no longer sufficient to fulfill the load demands. This gives rise to the concept of distribute generation. Distributed generators or DGs are secondary power sources, renewable in nature that may be connected to the grid at various places and essentially fulfil the load demand that is required. DGs are usually wind powered turbines, hydroelectric dams or array of PV cells acting as a solar power producing unit.

However the advent of integrating DGs in the grid also gives rise to the problems associated with it, most notable of which is islanding. Islanding is a potentially hazardous phenomenon in which the DG continues to supply power to the connected load despite the grid tripping and despite the absence of supply from other power sources. When islanding occurs, the utility protection devices such as isolator or circuit breaker get opened while the DG remains connected and continuously injects power actively to the local load. The condition occurs when the grid suffers from a sudden and hazardous disruption of abnormality, such as short-circuit, voltage shut-down, or failure of equipments. The point of common coupling is the point or the node on the grid where distributed generator is connected to the main grid [1]. The point of common coupling can be one or more than one in the system depending on the distributed generators connected in the system.

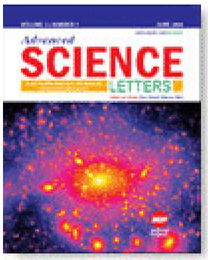
Islanding presents us with some hazards like safety risks of linesmen and maintenance personnel as well as problems in grid synchronization. To correct this, anti islanding methods have been proposed, whose role is to alert the DG about grid tripping, thereby deactivating and disconnecting it from the grid. Various islanding algorithms and detection methods have been developed. The detection techniques can broadly be classified into local islanding detection techniques and remote islanding detection techniques. The first technique is based on the measurement of fundamental system parameters at the interconnected point of DG and grid while remote islanding detection is based on the active communication between the DG and the grid [5]. None of the islanding systems is perfect due to the following limitations – large non detection zone (NDZ), deterioration of system power quality, false operation in multiple DG, requirement of additional circuitry and of course rising costs.

Therefore, an effective islanding method is required to minimize the pitfall of the existing techniques and to make them faster and more accurate. Some researchers are working on the hybrid islanding detection to enhance the effectiveness of the islanding detection techniques [9-11].

This paper presents the passive islanding detection method for the multi-distributed generators (Multi-DGs) system. Four parameters that is voltage, frequency, positive sequence voltage and negative sequence voltage at the point of common coupling have been analyzed. Two practical situations are considered, one with fault and other with forced shut down of the grid for maintenance purpose. The simulation is done under the test system having three DGs, out of which one is solar photovoltaic power plant.

II. Islanding Detection Techniques

Mainly the islanding detection techniques are classified into two groups, one is Local detection technique and other is remote detection technique [6]. Local detection method can further be classified into Active and Passive methods. The classification for islanding detection technique is shown in figure 1.



Peculiar Structural, Optical, Paramagnetic, Electronic and Electrical Behavior in Bulk Tin Telluride Grown via Physical Route

Authors: Tanwar, Praveen; Srivastava, A. K.; Singh, Sukhvir; Panwar, A. K.
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Abstract | References | Citations | Supplementary Data | Article Media | Metrics | Suggestions

P-type SnTe ingot was prepared by the vertical directional solidification technique via physical route. XRD, SEM, EDS, HRTEM, FTIR, micro-Raman and EPR techniques were used to characterize the bulk SnTe compound. XRD results revealed about the polycrystalline features of the material, which agrees with the SAED pattern and HRTEM investigations. A peak obtained at 3645 cm^{-1} in FTIR spectra confirms about the narrow band gap property of the material and beneficial in IR applications. Longitudinal-optical phonon scattering due to the (222) orientation was observed in the micro-Raman spectra which corresponds to a peak at 125.3 Raman shift/cm^{-1}. EPR measurements exhibited the presence of paramagnetic centre holes and the formation of voids in the SnTe ingot and revealed free electron g-factor with a value of $g = 2.14424$. Electrical measurement confirms that the material is semi-metallic and resistivity is temperature dependent in the warming cycle after cooling the sample to ~9 K.

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More about this publication?

Performing target specific band reduction using Artificial Neural Networks and assessment of its efficacy using various Target Detection algorithms

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ABSTRACT

Hyperspectral imaging is a powerful tool in the field of remote sensing and has been used for many applications like mineral detection, detection of landmines, target detection *etc.* Major issues in target detection using HSI are spectral variability, noise, small size of the target, huge data dimensions, high computation cost, complex backgrounds *etc*. Many of the popular detection algorithms do not work for difficult targets like small, camouflaged *etc.* and may result in high false alarms. Thus, target/background discrimination is a key issue and therefore analyzing target's behaviour in realistic environments is crucial for the accurate interpretation of hyperspectral imagery. Use of standard libraries for studying target's spectral behaviour has limitation that targets are measured in different environmental conditions than application. This study uses the spectral data of the same target which is used during collection of the HSI image. This paper analyze spectrums of targets in a way that each target can be spectrally distinguished from a mixture of spectral data. Artificial neural network (ANN) has been used to identify the spectral range for reducing data and further its efficacy for improving target detection is verified. The results of ANN proposes discriminating band range for targets; these ranges were further used to perform target detection using four popular spectral matching target detection algorithm. Further, the results of algorithms were analyzed using ROC curves to evaluate the effectiveness of the ranges suggested by ANN over full spectrum for detection of desired targets. In addition, comparative assessment of algorithms is also performed using ROC.

Keywords: dimensionality reduction, ANN, target detection, ROC.

1. INTRODUCTION

Hyperspectral sensors remotely capture reflectance of areas of interests in several hundreds of EM bands and thus HSI data is characterized with very high spectral resolution. This richness of spectral data in HSI enables algorithms to correctly identify unique materials contained in the image and thus making it very suitable for many military and surveillance applications that demands high accuracy. Generally, target detection using HSI data is performed in two steps. Firstly, high dimensionality of HSI data is reduced to lower dimensions. Next, detection algorithms are implemented on the reduced dataset for faster and accurate detection of desired targets.

Huge spectral resolution of HSI data makes it ideal for target detection applications. However, the high spectral resolution may also generate many problems such as redundancy, highly correlated bands and Hughes phenomenon (Hughes 1968) and high computational cost[1] *etc*. In addition, the literature suggests that many algorithms used for processing HSI data use covariance based analysis but higher dimensions of HSI may result in inaccurate estimation of the covariance matrix and thus may give unreliable results[2]. Therefore for processing HSI data, it is advantageous to reduce the dimensions of data for faster processing. Some of the popular dimensionality reduction techniques are principal component analysis (PCA) and minimum noise fraction (MNF) *etc.* However, most of these data reduction techniques have some drawbacks such as these doesn't improve class separability significantly and also the extracted dimensions are not very reliable when the targets of interest have similar statistical means or when a target has a very different statistical mean from other targets or backgrounds[3,4]. Although most of the dimensional reduction techniques achieve good data reduction but these may result in loss of significant information contained in data. Though HSI data has the capability to capture the peaks and valleys of the spectral signature of targets. But methods like MNF, PCA often

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Photovoltaic effect in $BiFeO_3/BaTiO_3$ multilayer structure fabricated by Chemical solution deposition technique

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ABSTRACT

Photovoltaic (PV) properties of bismuth ferrite (BFO) and barium titanate (BTO) multilayered ferroelectric BFO/BTO/BFO/BTO thin film structure deposited on $Pt/Ti/SiO_2/Si$ substrates using chemical solution deposition technique are presented. X-ray diffraction analysis confirms pure phase polycrystalline nature of deposited perovskite multilayered structures. Simultaneously both distorted rhombohedral (R3c) and tetragonal phases (P4mm) of the respective BFO and BTO components are also well retained. The ferroelectric sandwiched structures grown on fused quartz substrates exhibit high optical transmittance (~70%) with an energy band gap 2.62 eV. Current-voltage characteristics and PV response of multilayered structures is determined in metal-ferroelectric-metal (MFM) capacitor configuration. Considerably low magnitude of dark current density 1.53×10^{-7} A at applied bias of 5 V establish the resistive nature of semi-transparent multilayered structure. Enhanced PV response with 40 nm thin semitransparent Au as top electrode is observed under solid-state violet laser illumination (λ - 405nm, 160 mW/cm^2).

Photovoltaic Power Forecasting Methods in Smart Power Grid

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Abstract
Due to increasing global warming and depletion of conventional resources it is important to think of new types of energy sources to have clean and sufficient energy for sustainable growth. Photo-voltaic (PV) power generation is playing important role in minimizing the shortage of power demand and providing clean energy to smart power grid. PV energy is growing and getting connected in distributed manner to the smart power grid. Forecasting of PV generation would play a vital role in the interconnection of the PV generators to smart power grid as this is intermittent in nature, depend on weather conditions and distributed throughout the grid. A comprehensive review of the PV forecasting methods in terms of their performances has been done in this paper. This paper presents a broad spectrum of the issues related to forecasting of PV generation at centralized as well as distributed level and also discusses its importance in smart power grid.

Index Terms-Photovoltaic power generation, Renewable energy, PV Forecasting, Neural network.

I.INTRODUCTION

From 1991, CO_2 emission mitigation is becoming a public concern and green energy generation has become alternative solution to increasing energy demand. Renewable energy (Solar and wind energy) is free and abundant in nature. It is growing rapidly to fulfill the energy demand of the world. Photo-voltaic (PV) for electricity generation is the fastest-growing energy technology since 2002, experiencing an average annual increase of 48% [1]. Many countries of the world are making policies and providing incentives to promote the green energy, like feed-in- tariff and renewable purchase obligation (RPO) etc.

Due to uncertainty of the solar radiation on the earth and changing weather conditions, forecasting has become a key tool for the optimum utilization of the existing and new coming PV power plant. Forecasting will also help in integrating the PV plant to the smart power grid by providing prior information about the availability of the PV power [1]. Forecasting is playing important role in interconnection of the PV system to the grid. Security of the grid is also improved with the help of forecasting, because of the prediction of available PV power in advance.

Based on the literature available in the area of forecasting related to the renewable energy, researchers are focusing mainly in the forecasting of solar radiation. Apart from this some authors also directly forecast the power generation from PV system [2] with the help maximum power point tracking (MPPT) algorithm. In this case the forecasting will be done by selecting output power of PV system directly as an input to the tracking system and track the optimum power output.

In this paper an extensive survey has been presented in the field of forecasting of PV power generation to identify the problem associated with it. Various methods used in PV forecasting have some advantage and disadvantage depending upon their uses [3]-[10]. It is found that in some cases statistical method give more accurate and reliable result as compared to the physical method, and vice versa. In most of the cases artificial intelligence and hybrid methods give more accurate and reliable forecasting as compared to the conventional forecasting methods.

A comparative analysis of forecasting between statistical approach and artificial intelligence technique are presented in the year 2008 [11]. It has been found that artificial intelligence techniques are more flexible as compared to the conventional forecasting method [12]-[17]. The main disadvantage of the artificial intelligence methods is that, it requires large data set for training and validation.

Section II of this paper presents the classification of forecasting models. Satellite based forecasting models are discussed in section III. Section IV introduces wavelet based forecasting model. Performance evaluation is presented in section V and conclusion is discussed in section VI.

II. Classification of PV forecasting methods

There are no fixed criteria to classify the methods of PV forecasting. Different researchers use their own classification depending upon the historical data of solar irradiance, forecasting horizon, technique used to forecast etc. An extensive review has been done on the methodologies and based on that classification of PV forecasting methods are presented below in detail.

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Platinum nanoparticles-single-walled carbon nanotubes hybrid based chemiresistive sensor array for myoglobin detection

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Keywords: carbon nanotubes, sensor, protein antigen, source–drain current

Abstract

We examined the potential of platinum nanoparticles (PtNP) modified single-walled carbon nanotube (SWNT) hybrid chemiresistive sensor for detection of antigen myoglobin (Mb) in phosphate buffer saline. Protein antibody, Ab-Mb, was covalently immobilized through site specific binding on PtNP attached over SWNT. A concentration-dependent change in the source–drain current of the hybrid device was observed in the range of 0.1–1000 ng ml^{-1}. The hybrid device response fitted well with the Hill–Langmuir equation with a maximum response of 111.14% and low dissociation constant value ($K_d = 19.98$ ng ml^{-1}), indicating high protein antigen binding affinity at hybrid nanostructure.

1. Introduction

In recent years, the detection of biomolecules is of prime importance in the field of environmental pollution control, safety of food, water and medical diagnostics. Cardiac vascular diseases (CVD) are considered to be one of the most serious threats to global health [1]. Therefore the determination of cardiac biomarkers plays an important role in screening and diagnosis of CVD. Cardiac myoglobin (Mb), a heme-containing protein, although not a very specific marker, but is the first marker that is released in circulation after the myocardial damage (as early as 1–3 h upon symptom onset) due to its small size of 17.8 kDa as compared to other cardiac specific biomarkers viz. C-reactive protein (CRP) (23 kDa) and Troponin I (29 kDa), which makes it highly sensitive and valuable marker for the early diagnosis of myocardial infarction (MI) [2–4]. Its normal level is 30–90 ng ml^{-1} in human blood, which gets elevated to 200 ng ml^{-1} in the first 1 h of onset of MI and can reach as high as 900 ng ml^{-1} during the peak hour. Several detection methods have been proposed for cardiac biomarkers sensing based on label based techniques including enzyme-linked immunosorbent assay [5], radioimmunoassay [6], fluorescence and chemiluminescence techniques [7]. However, these methods have many disadvantages such as time consuming, complicated multistage process and difficulty to realize automation with the aim of rapid screening [8, 9] and therefore, demand for more sensitive and rapid technology platform for the diagnosis of CVD. One dimensional (1D) nanostructures has been studied extensively as a transducer in biosensors that provided a better alternative to planar structure devices due to their large surface conducting channel volume and facilitated device miniaturization with low power operations [10]. Among different 1D materials, single-walled carbon nanotubes (SWNTs) possess great potential in nanoelectronic devices due to their exceptional electrical, mechanical and optical properties [11, 12]. The SWNTs are exploited to create high sensitive sensor owing to its high charge carrier mobility along the axis with a direct contact of the surface current to the analyte of interest [13]. The CNTs can also be easily configured as field-effect transistors (FETs) which are based on the modulation of the electrical conductivity/resistivity of 1D nanostructures between micro electrodes and can be potentially integrated with conventional devices and miniaturized device fabrication techniques [14]. The random array of SWNTs functioning as the conducting channel has much larger surface area than individual nanotubes, and the sensor fabricated from array of SWNTs average the properties of the large number of random individual SWNTs [15]. Furthermore recently studies

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Polyurea coatings for enhanced blast-mitigation: a review

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Elastomeric coatings are being advocated as excellent retrofit materials for strategic applications, particularly for blast mitigation and ballistic protection. Polyurea, an elastomer formed by the reaction of isocyanate and amine, possesses hard domains dispersed randomly within the soft domains, forming a heterogeneous landscape with a nano-segregated microstructure, with each domain exhibiting its own characteristic glass transition temperature. Commercialised in the late eighties, this relatively new entrant in the field of elastomers has received enormous attention in view of its excellent blast mitigation properties and ballistic protection. Although the literature is abundant with studies demonstrating the potential of polyurea for retrofitting applications, the underlying mechanism behind its exceptional properties has not yet been fully comprehended. The ballistic protection ability is attributed to the dynamic transition from "rubber to glass", which occurs when the material is subjected to extremely high strain rates, while the blast mitigation potential is attributed to a phenomenon more commonly referred to as "shock wave capture and neutralization". Since the blast mitigation and ballistic protection ability is decided by the hard and soft domains of polyurea, respectively, the polymer needs to be tuned for a particular application through judicious choice of the raw materials. The current article reviews the relevant publications in the field of polyurea-based retrofits including their preparation, characterization, properties and applications in the context of blast mitigation and ballistic protection.

1. Introduction

In the wake of terrorist threats, enormous attention is nowadays being directed towards designing of strategic buildings, where such a possibility is even remotely envisioned. Unfortunately, the majority of the structures existing today were not originally designed to endure dynamic loads, which are characterized by their impulsive nature, transmitting extremely high-pressures *ca.* 10 to 10^3 kPa. On the other hand, static loads are time independent, presumably acting on the structure for infinitely extended time durations (*e.g.* gravity loads). Time dependent dynamic loads are classified on the basis of their relative intensity and frequency. Natural dynamic loads like those

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Manorama Tripathi completed her MSc (chemistry) from Banaras Hindu University, India in the year 2003. She joined Defence Research and Development Organization, Ministry of Defence, India as a research scientist. She is presently in the final year of his PhD programme under the supervision of Prof. D. Kumar and Dr P. K. Roy. Her research interests involve exploration of alternative healing agents for polymer coatings with an emphasis on autonomic healing system.

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Potential application of carbon nanotube core as nanocontainer and nanoreactor for the encapsulated nanomaterial

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ABSTRACT

Fe_3C nanorod filled inside carbon nanotube has been irradiated inside transmission electron microscope at both room and high temperature. *In-situ* response of Fe_3C nanorod as well as CNT walls has been studied. It has been found that when electron irradiation is performed at room temperature (RT), nanorod first bends and then tip makes at the end whereas at high temperature (~490 °C) nanorod slides along the tube axis and then transforms into a faceting particle. Extrusion of solid particle filled in the core of CNT has also been demonstrated. It is suggested that these morphological changes in nanorod may have happened due to the compression which was generated either by shrinkage of tube or by local electron beam heating. Presented results demonstrate that CNT core could be used as nano-container or reactor.

1. Introduction

Concave geometry of hollow core of carbon nanotube (CNT) with confined space offers the tremendous possibility to generate the nanomaterial of superior physical, chemical or electronic properties [1]. In previous reports [2–15], CNT filled with ferromagnetic material has been proposed as a novel material and their myriad potential applications such as magnetic recording media [16], magnetic force microscopy (MFM) [17], biomedicine [18,19] and spintronics [20] have been demonstrated. This has been attributed to the fact that in filled-CNT, tube-walls not only protect the filled nanomagnets against harsh environment but also prohibit coalescence. Filling of CNT core with different materials have facilitated the fabrication of nanostructures in a controlled fashion and has introduced the interesting applications of CNT such as containers, conduits, pipettes, and coaxial cables. In order to further expand the applications of filled-CNT key aspect will be post-growth modification techniques which can modify shape as well as position of the filled materials in a controlled manner. In recent reports, electron irradiation performed inside high-resolution transmission electron microscopy (HRTEM) demonstrated that when post-growth modification is performed in a controlled manner, it is possible to control the shape, size and properties of the CNTs as well as encapsulated metal by producing defects, at both room [21,22] and high [23] temperatures. Under the energetic electron beam, extrusion of filled material has been demonstrated [24,25]. This evidenced that electron beam might be a tool which has post-synthesis alteration capability on CNT [23,26–30]. Hence, we envision that CNTs either fully or partially filled have many prospective applications. Some of them have been already demonstrated where CNT was used as nanopipette [31], high pressure nanoextruder [24], diagnostic tool [18] and preservative nanocell [18].

Another interesting applications of ferromagnetic nanoparticles, and nanorod of sharp tip filled inside CNT has been reported in the area of high-density magnetic recording media and medicinal imaging [32–34]. Hence, being motivated with the approach adopted in references, [24,25] we performed electron irradiation on Fe_3C-filled CNT at both room and high temperature. *In-situ* response of Fe_3C nanorod as well as CNT was monitored and irradiation induced structure related phenomena such as: shrinkage, thinning, sharpening of tip and shape transformation of nanorod were studied.

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Power system restructuring models in the Indian context

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ABSTRACT

A range of new models is available for power system restructuring in India to meet the requirements of state and central government policies as well as the social and market needs of the state. Uttar Pradesh Power Corporation Limited provides a useful case study of these possibilities.

1. Introduction

The Electricity Act of 2003 ("the Act") came into effect on June 10, 2003, to replace earlier laws governing the Indian power sector, namely, the Indian Electricity Act 1910, the Electricity (Supply) Act of 1948 and the Electricity Regulatory Commissions Act of 1998.[1] The Act sought to create a liberal framework for the development of the power industry, promoting competition, protecting the interests of consumers and the supply of electricity to all areas, rationalization of the electricity tariff and ensuring transparent policies and the promotion of efficiency, among others. The Act came out with the National Electricity policy, mandatory creation of state electricity regulatory commissions (SERCs), emphasis on rural electrification, open access in transmission distribution, and some other provisions. It mandated that the regulatory commissions regulate tariffs and issues of license. It focused on laws relating to generation, transmission, distribution, trading and the uses of electricity. The objectives of the 2003 act are as follows:

- To consolidate the laws relating to generation, transmission, distribution, trading and the use of electricity.
- Promote competition.
- Protect the interest of consumers.
- Insure the supply of electricity to all areas.
- Rationalize electricity tariffs.
- Ensure transparent policies regarding subsidies.
- Promote efficient and environmentally benign policies.
- Guide the constitution of the Central Electricity Authority (CEA) and regulatory commissions.
- Establish an Appellate Tribunal.

The Act was amended on May 28, 2007, with stronger power and clarity and with greater emphasis on assessments, fines and the legal framework to check commercial losses due to theft and unauthorized use of electricity.[2]

With the enactment of the Electricity Act of 2003 and the implementation of open access, the market structure in the power sector changed from a single-buyer structure to a multi-buyer model. The generator could sell power to any buyer using the open access provision in transmission and users were given a choice of supplier: Since the Act was introduced, there has been increased competition among generators and suppliers, thereby improving the sector's performance. Currently many states, which have unbundled the state electricity boards (SEBs), have reported improvements in their operational efficiency and are able to ensure a reliable power supply to consumers.

Reforms in the power sector in India are underway to create more generation to foster greater competition among producers

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[1] http://www.cea.nic.in/reports/electricity_act2003.pdf.

[2] http://www.mserc.gov.in/acts/no5_electricity_act_2007.pdf.

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Recent advances on multicue object tracking: a survey

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Abstract The performance of single cue object tracking algorithms may degrade due to complex nature of visual world and environment challenges. In recent past, multicue object tracking methods using single or multiple sensors such as vision, thermal, infrared, laser, radar, audio, and RFID are explored to a great extent. It was acknowledged that combining multiple orthogonal cues enhance tracking performance over single cue methods. The aim of this paper is to categorize multicue tracking methods into single-modal and multi-modal and to list out new trends in this field via investigation of representative work. The categorized works are also tabulated in order to give detailed overview of latest advancement. The person tracking datasets are analyzed and their statistical parameters are tabulated. The tracking performance measures are also categorized depending upon availability of ground truth data. Our review gauges the gap between reported work and future demands for object tracking.

Keywords Object tracking · Multicue · Data set · Tracking evaluation · Computer vision

1 Introduction

The object tracking aims at analysis of video sequences for localization of object in sub sequences frames. It is foremost important due to its myriad of applications in field of computer vision such as driver assistance systems, video surveillance, man-machine interaction, autonomous robot, medical imaging, activity analysis, augmented reality, video indexing, traffic control and much more. However, object tracking in video is very challenging due to: dynamic environment conditions, conversions from 3D to 2D world, real time requirements, full or partial occlusion, clutter background, pose variations, abrupt object motion, appear-

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Reduced graphene oxide modified smart conducting paper for cancer biosensor

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ABSTRACT

We report results of the studies relating to the fabrication of a paper based sensor comprising of poly(3,4-ethylenedioxythiophene):poly(styrenesulfonate) (PEDOT:PSS) and reduced graphene oxide (RGO) composite. The effect of various solvents like methanol, ethylene glycol and H_2SO_4 on the electrical conductivity of PEDOT:PSS coated Whatman paper has been investigated. The conductivity of this solution processed conducting paper significantly increases from $\sim 1.16 \times 10^{-4}$ S cm^{-1} up to $\sim 3.57 \times 10^{-2}$ S cm^{-1} ($\sim$300 times) on treatment with ethylene glycol. The observed significant increase in electrical conductivity is due to conformational rearrangement in the polymer and is due to strong non-covalent cooperative interaction between PEDOT and the cellulose molecules. Further, incorporation of RGO into the conducting paper results in improved electrochemical performance and signal stability. This paper electrode is a promising alternative over the expensive conventional electrodes (ITO, gold and glassy carbon), that are known to have limited application in smart point-of-care (POC) devices. This low cost, flexible and environment friendly conducting paper based biosensor utilized for cancer biomarker (carcinoembryonic antigen, CEA) detection reveals high sensitivity of 25.8 μA ng^{-1} mL cm^{-2} in the physiological range, 1–10 ng mL^{-1}.

1. Introduction

Paper based point-of-care (POC) devices are rapidly evolving for desired analytical and clinical applications since these are predicted to be simple, cost-effective, portable, consume low power and are disposable. These devices have potential applications in healthcare, detection of toxicants, explosives and environmental studies. Compared to conventional laboratory assays, these devices are found to be very helpful for making speedy decision for therapeutics. Besides this, the testing can be performed near the vicinity of a patient and hence these devices have recently gained considerable attention in health care (Gervais et al., 2011; Kumar et al., 2013a, 2013b; Luppa et al., 2011).

Electrochemical sensors are known to play an important role in on-going transition towards the paper based POC diagnostic devices. The electrochemical techniques offer high sensitivity, high signal-to-noise ratio, portability and fast response time (Wang, 2006). Therefore, its integration with the paper may be advantageous. To ensure the application of paper in an electrochemical sensor, it is essential to make it conducting. In this context, many methods such as screen printing, inkjet printing etc. have been used to incorporate conducting ink on a paper substrate (Jagadeesan et al., 2012; Tobjörk and Österbacka, 2011). These methods require complex fabrication steps, additional instrumentation, skilled personnel and are time-consuming. Conducting polymers (CPs) have been considered a promising candidate to obtain conducting paper due to delocalization of π electrons since they are known to facilitate rapid electron transfer, mechanical flexibility and solution processability. Doping of a conducting polymer has been found to enhance its electronic, optical, physical, chemical and electrochemical properties (Dhand et al., 2011). CPs have been predicted to have enough potential for the development of a low cost and high performance biosensor materials that offer high permeability biocompatibility, and rapid electron transfer (Li et al., 2015; Zhai et al., 2013). Among the various conducting polymers, poly(3,4ethylenedioxythiophene):poly(styrenesulfonate) (PEDOT:PSS) has been considered to be a interesting candidate for development of a conducting paper due to its homogeneous entrapment in/on a paper using a simple dip coating method with

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Refractive index dispersion of swift heavy ion irradiated BFO thin films using Surface Plasmon Resonance technique

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ABSTRACT

Swift heavy ion irradiation (SHI) is an effective technique to induce defects for possible modifications in the material properties. There is growing interest in studying the optical properties of multiferroic $BiFeO_3$ (BFO) thin films for optoelectronic applications. In the present work, BFO thin films were prepared by sol–gel spin coating technique and were irradiated using the 15 UD Pelletron accelerator with 100 MeV Au^{9+} ions at a fluence of 1×10^{12} ions cm^{-2}. The as-grown films became rough and porous on ion irradiation. Surface Plasmon Resonance (SPR) technique has been identified as a highly sensitive and powerful technique for studying the optical properties of a dielectric material. Optical properties of BFO thin films, before and after irradiation were studied using SPR technique in Otto configuration. Refractive index is found to be decreasing from 2.27 to 2.14 on ion irradiation at a wavelength of 633 nm. Refractive index dispersion of BFO thin film (from 405 nm to 633 nm) before and after ion radiation was examined.

1. Introduction

Swift heavy ion (SHI) irradiation has been realized as an effective method for material modifications from the past research studies [1–3]. The material response to the incident SHI irradiation has a crucial dependence upon the characteristics of the ions, the fabrication parameters, stoichiometry and the type of the material [4]. The bombardment of these ions can create disorder in the form of point defects, cluster defects or a perturbed atomic distribution along its path as they pass through the material [4]. There is continuing research going on in studying the interaction of ion beam irradiation with low-dimensional structures [5,6]. The impact of ion beam irradiation on the bulk materials has been extensively studied. Huang et al. have investigated the light- and heavy-ion radiation damage in single-crystal $LiNbO_3$ in terms of defect clusters, elastic strain, surface deformation, as well as change in elemental composition [7]. Olivares et al. have exploited heavy mass ions like Kr and Xe, having energies in the ~10 MeV/amu range to produce thick planar optical waveguides at the surface of lithium niobate ($LiNbO_3$) [8]. The impact of these heavy ions leads to partial amorphization and refractive index change at the surface [8]. Amorphization and disordering has been observed in single crystalline Al_2O_3 by swift heavy ions [9]. Recently, Park et al. have observed an increase in the amorphous fraction as a function of fluence for polycrystalline $La_2Ti_2O_7$ powders [10]. The concept of ion beam irradiation effect on nanostructures has become a captivating field of research. This aroused interest in the use of ion beams to synthesize and modify physical and chemical properties of the nanostructures for various applications [11–13]. The mass of the incident ion, irradiation energy and fluence greatly affect the induced modifications due to irradiation [14].

Interest has been growing in bismuth ferrite (BFO) due to its room temperature multiferroic properties. Both magnetic and ferroelectric properties have been simultaneously observed with high ferroelectric Curie temperature (T_C = 1100 K) and antiferromagnetic temperature (T_N = 643 K) [15,16]. BFO has several potential applications in data storage, spin valves, spintronics and sensors [17–19]. There is growing interest in the study of its optical properties making it useful for the development of optoelectronic devices. Recently, several research groups have studied the optical properties of BFO thin films including its optical band gap, photoconductivity, and linear and nonlinear optical properties [20–22]. There is recent paper on theoretical investigation of optical properties of BFO using first principle calculations [23]. The relation between SHI created structural defects and ferroelectric ordering in BFO thin films has been of considerable interest underlying their optical, multiferroic, magneto-dielectric, and magnetoelectric

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Scope and sustainability of hybrid solar–biomass power plant with cooling, desalination in polygeneration process in India

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ABSTRACT

The term "polygeneration" is referred to as "an energy supply system, which delivers more than one form of energy to the final user", for example: electricity, heating/cooling, desalination can be delivered from polygeneration process. The polygeneration demonstrates unique integration of energy efficiency and renewable energy. It is the next generation energy production technique with a potential to overcome intermittence of renewable energy, reduce cost of power generation and greenhouse gas emissions. The feasibility study of this paper is divided in three sections: In first section of this study, solar and biomass have been arranged to produce steam for power generation. In the second section, cooling is produced by vapor absorption refrigeration (VAR; LiBr-H_2O) system as per demand load requirement using steam, extracted from pass-out turbine. In the last section of this paper, multi effect dehumidification (MED) water desalination is produced by using limited amount of heat from water vapor (refrigerant; H_2O) through HE1 of VAR cooling system.

Contents

1. Introduction

The energy scene in India is a complex picture of variety of energy sources being used to meet the growing energy needs. However there is a gap in the demand and supply position. It is recognized that decentralize generation based on the various renewable energy technology can, to some extent, help in meeting the growing energy needs. Renewable energy landscape in India, during the last few years, has witnessed tremendous changes in the policy framework with accelerated and ambitious plans to increase the contribution of renewable energy such as solar, wind, bio-power etc. The present installed capacity of power generation in energy sector of India is 272.50 GW as on May 2015. This includes, 189.31 GW (69.4%) from thermal power, 41.63 GW (15.27%) from hydro, 35.77 GW (13.12%) from renewable energy sources and 5.78 GW (2.12%) from nuclear. Out of 35.77 GW renewable energy, wind energy continues to dominate India's

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Scuffing behaviour of EN31 steel under dry sliding condition using pin-on-disc machine

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Abstract

The focus of the present study is to investigate the scuffing phenomenon of EN 31(Pin) against EN 19(Disc) steel under dry running condition using pin-on-disc machine. Coefficient of friction (COF) and pin wear are experimentally measured for different combination of loads (10N-70N) and rotational speeds (200 rpm-2000 rpm). The speed and load at which transition to scuffing occur are also examined. It is observed that the wear resistance increases with sliding velocity for lower load, while at higher load it increases initially and then becomes stable at higher speed. The COF increases with sliding velocity at lower loads and then becomes steady, while at higher loads, the COF first increases with increase in speed and then decreases considerably. This abrupt decrease in friction coefficient is due to intense heat generation between the disc and the pin and the experiment is stopped due to higher noise and vibration. Archard's wear model is also used to validate the wear of pin at different loads and speeds. Experimentally measured pin wear shows higher value probably due to decreases in material hardness with increase in interface temperature.

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Keywords: Wear; Wear resistance; Coefficient of friction; Scuffing; sliding velocity; Archard's wear model

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Slow light generated via Brillouin scattering in small core chalcogenide photonic crystal fiber

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ABSTRACT

In this paper, we have calculated the highly efficient generation of the slow light based on the Stimulated Brillouin scattering (SBS) in a small core As_2Se_3 chalcogenide PCF. A Brillouin gain coefficient, g_B, of 9.05 10^{-9} $m.W^{-1}$ is found around the acoustic frequency of 8.08 GHz in small core diameter of 1.69 µm with 1.5 μm^2 effective mode area at 1550 nm. A Brillouin gain of 77.3 dB was achieved with only 10 mW pump power in a 10-m fiber length, which leads to the optical time delay of 94 ns. In terms of the proposed figure of merit, it shows 2.77 dB/mW/m which is about 110 times more efficient than conventional single-mode fibers. These fibers are expected to have potential applications in realization of compact slow light devices.

Keywords: Photonic crystal fibers, nonlinear optics, chalcogenide glass, stimulated Brillouin scattering, acoustic waves, acousto-optic effects, slow light**.**

1. INTRODUCTION

Stimulated Brillouin scattering (SBS) is a third-order nonlinear process arising from the interaction between propagating optical and acoustic waves [1][2]. Nonlinear coupling between traveling-wave photons and phonons through SBS has been widely exploited in many applications, such as optical frequency conversion, radio frequency signal processing, fiber amplifiers and lasers, distributed fiber sensors and slow light [3][4][5][6].

Slowing down the group velocity of light based on SBS in optical fibers has been recognized as a key technology in future optical communication and microwave photonics systems for its potential applications such as optical delay, data synchronization, all-optical-buffers or regenerators for optical telecommunications, pattern correlation, interferometers with novel properties, and phased and synchronized arrays for beam steering [7][8][9][10]. Slow light via SBS has many advantages, such as operating at room temperature, tunability, compatibleness with optical communication systems, and sensitivity to temperature or strain [11][12]. This technique, based on SBS in optical fibers, has recently attracted interest of many researchers.

Slow-light via SBS was first proposed by *Gauthier et al*. in 2004 [14][13]. *Okawashi et al*.[14] and *Song et al*.[15]demonstrated slow light in optical fiber SBS amplifier independently in 2005. In recent years, the optical pulse dependence of SBS slow light in fibers was demonstrated: *Stenner et al***.** [16] presented techniques for designing pulses for linear slow-light delay systems and *Chin et al*.[17]experimentally demonstrated the effect of the proper shaping of the temporal envelope of isolated pulses in slow-light systems based on stimulated Brillouin scattering in optical fibers. Using a highly nonlinear microstructured silica fiber, up to 14 ns time delay is achieved experimentally by *Wang et al*. under relative low pump power (~200 mW) and short fiber length (~25m) [18]. *Herraez et al*. were the first to increase the SBS slow-light bandwidth and achieved a bandwidth of about 325 MHz by broadening the spectrum of the SBS pump field [19]. *Zhu et al*. extended this work to achieve a SBS slow light bandwidth as large as 12.6 GHz, thereby supporting a data rate of over 10 Gb/s [20].

Recently, higher nonlinearity compound glass fibers, such as Bismuth Oxide [21]tellurite and chalcogenide glass fibers [22][22], were used to improve the delay efficiency of the SBS slow light, showing their potential in improving the

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ARTICLE TYPE

SnO_2 quantum dots decorated on RGO: A superior sensitive, selective and reproducible performance for H_2 and LPG sensor

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We report the H_2 and LPG gas sensing behavior of RGO/SnO_2 QDs synthesized by surfactant assisted hydrothermal method. The RGO/SnO_2 QDs based sensor shows high response ~89.3% to H_2 and ~92.4% to LPG for 500 ppm test gas concentration at operating temperatures 200 °C and 250 °C, respectively. Further, the RGO/SnO_2 QDs based sensor shows good selectivity to H_2 and LPG in the presence of other interfering gases such as ammonia, chloroform, toluene, benzene, acetone, n-butylacetate, acetic acid and formic acid. We observed that the gas response to H_2 is 29.8 times higher than that of acetic acid whereas gas response to LPG is 17.8 times higher than that of formic acid. The long-term analyses have also been performed to demonstrate the reproducible nature of RGO/SnO_2 QDs based sensor over passing time which shows excellent reproducibility.

Introduction

Solid state gas sensors are well known for their high sensitivity, good selectivity and stability, which in combination with inexpensive production, simplest nature, power efficient and miniature sizes have made them ubiquitous and extensively used in various applications.[1-4] Recently, new generation of gas sensors have been reported using graphene and graphene/metal oxide nanocomposites.[5-9] Among metal oxide semiconductors (MOS), tin oxide (SnO_2) is particularly important, as an intrinsic n-type wide band gap (3.6 eV at 300 K) semiconductor[10] and drawn much attention because of good optical and electrical properties. It exhibits n-type conductivity due to its interstitial Sn atoms and oxygen vacancies, which act as donor in the host matrix.[11] SnO_2 nanostructures have shown potential applications in various e.g. field effect transistors,[12] light emitting diodes,[13] dye-sensitized solar cells,[14] supercapacitor,[15] lithium ion batteries[16] and gas sensors.[17]

Graphene, a two dimensional counterpart of three-dimensional graphite, comprises a single layer of carbon atoms is a rising star in the horizon of nano-materials & technology, solid-state physics, materials science, and nanoelectronics devices.[18] In addition, graphene possess outstanding physical properties such as quantum electronic transport, extremely high mobility and high surface to volume ratio. Graphene based nanostructure materials have attracted a great interest of researchers due to enormous applications in organic light emitting diodes, solar cells, chemical and biological gas sensors,[19] transistors, photovoltaics, and photosensors. The commonly used methods for the preparation of graphene and reduced graphene oxide (RGO) are micromechanical cleavage of graphite,[20] chemical vapor deposition (CVD),[21] epitaxial growth,[22] organic precursors,[23] chemical reduction of exfoliated graphene oxide[24] and electrochemical reduction.[25] Since, graphene possess a monatomic layer structure and excellent electrical properties, it could be a fascinating material for gas sensing application. In principle, charge carriers in an individual graphene sheet delocalize over the entire sheet and can travel thousands of interatomic distances without scattering because of its zero band gap semiconducting nature, very high in-plane conductivities and very high Fermi velocity.[26] However, its poor interactions with the gas molecules and restricted diffusion in the boundaries result in low sensitivity and poor selectivity for target gases. To resolve this critical problem, different types of MOS/RGO based nanocomposites have been developed. Decoration of RGO with metal oxide nanocrystals promote charge transfer between specific gas species, which have proven to be an effective way to improve the sensitivity, faster response/recovery and better selectivity of the specific gas at a particular operating temperature.

Hydrogen (H_2) is invisible, odorless and flammable gas where safety becomes primary concerns, since the presence of H_2 concentration in excess of 4 vol% in the environment is potentially explosive.[27] On the other hand, liquefied petroleum gas (LPG), mainly a mixture of propane and butane is a highly inflammable gas which is regularly used in automobiles, industries and other domestic purposes.[28] LPG is most commonly used in kitchen as cooking fuel but bears high possibility of explosion accidents due to leakages/human error or bursting of LPG filled cylinders. A small leakage may be more dangerous for living bodies as well as domestic and industrial properties.

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Stancu–Kantorovich operators based on inverse Pólya–Eggenberger distribution

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ABSTRACT

The purpose of this paper is to investigate approximation properties of Stancu–Kantorovich operators based on inverse Pólya–Eggenberger distribution. For these new operators we establish some approximation properties including uniform convergence, asymptotic formula and degree of approximation.

1. Introduction

In 1923, Eggenberger and Pólya [5] considered an urn model contains w white balls and b black balls. A ball is drawn at random and then replaced together with s balls of the same color. This procedure is repeated n times and noting the distribution of the random variable X representing the number of times a white ball is drawn. The distribution of X is given by

$$Pr(X=k)=\binom{n}{k}\frac{w(w+s)\cdot\ldots\cdot(w+\overline{k-1}s)b(b+s)\cdot\ldots\cdot(b+\overline{n-k-1}s)}{(w+b)(w+b+s)\cdot\ldots\cdot(w+b+\overline{n-1}s)}, \tag{1.1}$$

for $k=0,1,\ldots,n$ and $\overline{k-1}s=(k-1)s$. The distribution (1.1) is known as Pólya–Eggenberger distribution with parameters (n,w,b,s) and contains binomial, respectively hypergeometric distribution as particular cases.

The inverse Pólya–Eggenberger distribution is defined by

$$Pr(N=n+k)=\binom{n+k-1}{k}\frac{w(w+s)\cdot\ldots\cdot(w+\overline{n-1}s)b(b+s)\cdot\ldots\cdot(b+\overline{k-1}s)}{(w+b)(w+b+s)\cdot\ldots\cdot(w+b+\overline{n+k-1}s)}, \tag{1.2}$$

for $k=0,1,\ldots$ and is the distribution of the number N of drawings needed to obtain n white balls. More details about Pólya–Eggenberger distributions (1.1) and (1.2) can be found in [10].

Based on Pólya–Eggenberger distribution (1.1), Stancu [15] introduced a new class of positive linear operators associated to a real-valued function $f:[0,1]\to\mathbb{R}$, given by

$$P_n^{[\alpha]}(f;x)=\sum_{k=0}^{n}p_{n,k}(x,\alpha)f\left(\frac{k}{n}\right)=\sum_{k=0}^{n}\binom{n}{k}\frac{x^{[k,-\alpha]}(1-x)^{[n-k,-\alpha]}}{1^{[n,-\alpha]}}f\left(\frac{k}{n}\right), \tag{1.3}$$

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ORIGINAL PAPER

Strain rate sensitivity of toughened epoxy

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Abstract The high strain rate behaviour of toughened epoxy is explored under compressive loadings. A cycloaliphatic epoxy was toughened using different types of preformed fillers: epoxy-coated elastomeric poly(dimethylsiloxane) (CSR) and thermoplastic polystyrene microspheres. The toughening ability of the fillers was quantified in terms of improvement in izod impact strength. Our studies revealed that the disadvantages associated with liquid rubber toughening, especially lowering of the glass transition temperature (T_g) and storage modulus, could be overcome by using poly(dimethylsiloxane) (PDMS) microspheres. The izod impact strength increased by 33 % upon addition of 3 % w/w amino-polystyrene microspheres, and ~125 % upon introduction of CSR (5 % w/w). High strain rate studies performed using split Hopkinson pressure bar revealed that the compressive strength of epoxy and the toughened compositions were significantly enhanced at high strain rates (~10^3 s^{-1}) compared with that at quasi-static loading conditions (~10^{-1} s^{-1}). The effect of filler type on the strain rate sensitivity of the base polymer was established by comparing the property enhancement factor (PEF). Although introduction of elastomeric microspheres led to a lower compressive strength of epoxy, the PEF associated with the rubber-toughened composites was substantially higher than that with the thermoplastic-toughened analogous compositions, which was attributed to the viscous energy absorption in PDMS resulting from the dynamic rubber to glass transition at high strain rates.

Keywords High strain rate · Split Hopkinson pressure bar · Epoxy

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Introduction

Polymeric composite materials are finding increasing usage in engineering applications, primarily because of their low specific weight and production costs. In this context, epoxy resins constitute the most common matrix material for preparation of polymeric composites. Unfortunately, conventional polyepoxides are extremely vulnerable to impact-induced damage because of their inherently cross-linked structure, thereby limiting their use in highly demanding applications. Physical toughening techniques like blending with elastomers [1–3], thermoplastics [4] and rigid particulates [5, 6] have been attempted to improve the dynamic properties of the base resin. However, the increase in toughness is usually associated with a concomitant decrease in modulus, strength and very often the resultant blends exhibit low glass transition temperatures [7].

It is to be noted that irrespective of the material employed for epoxy toughening, it is the thermodynamically and kinetically controlled process of phase separation which governs the morphology of the resultant blend and in turn defines its final properties and applications [8]. Curing of epoxy in the presence of another polymer results in the formation of phase-separated blends, a process difficult to control in fast curing compositions. Researchers worldwide are exploring techniques towards developing ways and means of controlling the blend morphology [9–11]. In this

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Stress induced enhanced polarization in multilayer $BiFeO_3/BaTiO_3$ structure with improved energy storage properties

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Present work reports the fabrication of a multilayer (5-layer) structure of $BiFeO_3$(BFO)/$BaTiO_3$(BTO) using spin-coating technique. The crystallographic structure, surface morphology and ferroelectric behavior of multilayer structure in metal-ferroelectric-metal capacitor have been studied. Le-Bail refinement of X-ray diffraction data revealed the formation of polycrystalline pure perovskite phase with induced stress. The values of remnant (P_r) and saturation polarization (P_s) for BFO/BTO multilayer structure are found to be 38.14 $\mu C/cm^2$ and 71.54 $\mu C/cm^2$ respectively, which are much higher than the corresponding values reported for bare BFO thin film. A large value of dielectric constant of 187 has been obtained for multilayer structure with a low leakage current density of 1.09×10^{-7} A/cm^2 at applied bias of 10 V. The BFO/BTO multilayer structure favors the enhanced energy storage capacity as compared to bare BFO thin film with improved values of energy-density and charge-discharge efficiency as 121 mJ/cm^3 and 59% respectively, suggesting futuristic energy storage applications. [http://dx.doi.org/10.1063/1.4934578]

INTRODUCTION

The atomic scale combination of dissimilar materials is expected to produce not only striking control but also ample scope of enhancement in new combinations of functional properties. In recent years, novel multilayers comprising of different ferroelectric/multiferroic materials have been intensively studied to find better system with superior electrical and ferroelectric properties having strong coupling and interaction among its layers.[1–4] The interfacial strain due to the lattice mismatch can lead to modulation of ferromagnetic anisotropy and improvement in electrical properties. Also, the ferroelectric switching affects the interface magnetization due to the change in collection of spin-polarized electrons at the ferromagnetic/ferroelectric (FM/FE) interface, as was discussed by many workers for $Fe/BaTiO_3$,[5] $Co_2MnSi/BaTiO_3$[6] and $Fe_3O_4/BaTiO_3$[7] hetrostructures. Reddy *et al*. reported improved ferroelectric as well as ferromagnetic properties for four-layered thin films over two-layered BLFCO-BFO thin films due to the interface coupling and interaction between the thin layers.[8] Pintilie *et al*. studied the capacitance of PZO–PZT (80/20) multilayers with enhanced polarization with increase in number of interfaces due to the presence of some interfacial polarization, trapped charges at the multilayer interfaces.[9] Lee *et al*. studied the enhancement of polarization by strain in superlattices of $BaTiO_3$, $SrTiO_3$ and $CaTiO_3$.[10] Wu *et al*. observed the high saturation polarization in a $(BaTiO_3)_8/(SrTiO_3)_3$ superlattice film.[11] Bao discussed that constructing multilayers or superlattices is an effective way to improve properties of ferroelectric/dielectric thin films.[12]

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Tailpipe emission from petrol driven passenger cars ☆

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ABSTRACT

Realizing the dominance of petrol-driven passenger cars of MUL over the fleet of cars in India, a case study of different models of petrol-driven passenger cars of Maruti reporting at an authorized service station of M/s R.K.B.K. Automobiles, Gorakhpur was taken up and the tailpipe emissions along with individual vehicle-related parameters were monitored for idle and fast idle test conditions. The outcome of the study relating to the effect of various vehicle-related parameters on CO and HC emissions of petrol-driven passenger cars of Maruti has led to the useful inferences, which can be used not only for predicting the emission of vehicles with respect to vehicle age and mileage, but also for automobile manufacturing sector to help them produce such environmentally benign petrol-driven passenger cars having long-lasting compliance of pollution control systems with respect to vehicle age and mileage of the petrol-driven passenger cars in the country.

Introduction

Most of the Indian Cities are experiencing rapid urbanization and the majority of the country's population is expected to be living in cities within a span of next two decades. The rapid urbanization in India has also resulted in a tremendous increase the number of motor vehicles imposing a serious effect on human life and its environment in recent years – what is being referred to as Urban Air Pollution (UAP) in the context of ever-expanding urban areas.

According to Census reports, the urban population has increased from 10% in 1901 to 28% in 2001. And ever-increasing, the urban growth rate is running at 31.8% i.e., almost three times higher than rural areas in 2011 (Census, 2011). The World Health Organization (WHO) has estimated that in developing countries, increasing UAP has resulted in more than 2 million deaths per annum along with various cases of respiratory illnesses (WHO, 2005, 2014). It is reported that over 70–80% of air pollution in mega cities in developing nations is attributed to vehicular emissions caused by a large number of older vehicles coupled with poor vehicle maintenance, inadequate road infrastructure and low fuel quality (Auto Fuel Policy, 2002; Badami, 2005; Singh et al., 2007; Wang et al., 2010). Among the criteria pollutants, CO is the major pollutant coming from the transport sector, contributing 90% of total emission. Hydrocarbons are next to CO. It is indeed interesting to observe that the contribution of transport sector to the particulate pollution is as less as 3–5%, most of the SPM (Suspended Particulate Matter) are generated due to re-suspension of dust out of which PM_{10} is the most prominent air pollutant.

☆ *Capsule:* The study finds that vehicle age & mileage parameters are directly proportional to tailpipe emission from petrol driven passenger cars.

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The role of photo-electric properties of silk cocoon membrane in pupal metamorphosis: A natural solar cell

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Silkworm metamorphosis is governed by the intrinsic and extrinsic factors. One key intrinsic factor is the temporal electrical firing of the neuro-secretory cells of the dormant pupae residing inside the silk cocoon membrane (SCM). Extrinsic factors are environmental like temperature, humidity and light. The firing pattern of the cells is a function of the environmental factors that eventually controls the pupal development. How does the nervous organization of the dormant pupae sense the environment even while enclosed inside the cocoon shell? We propose that the SCM does this by capturing the incident light and converting it to electricity in addition to translating the variation in temperature and humidity as an electrical signal. The light to electricity conversion is more pronounced with ultraviolet (UV) frequency. We discovered that a UV sensitive fluorescent quercetin derivative that is present on the SCM and pupal body surface is responsible for generating the observed photo current. Based on these results, we propose an equivalent circuit model of the SCM where an overall electrical output transfers the weather information to pupae, directing its growth. We further discuss the implication of this electrical energy conversion and its utility for consumable electricity.

Silkworm has a typical four-stage lifecycle viz., egg, larvae, pupae and adult moth[1–11]. An adult moth lay the eggs and upon hatching the larvae emerges. The larvae voraciously eats on the plant leaves and copiously secretes a viscous salivary fluid rich in protein, which eventually forms a selectively permeable[11], thermoregulatory[11–13], UV-protecting[10,14,15], waterproof shell[9,16] around its own body, termed as silk cocoon. Entering of the larvae in this self-enclosed chamber, mark the beginning of pupal phase or commonly called dormant or diapause phase in silkworm's life. This phase varies from 21 days to as long as 9 months in certain species of silkworm found in the temperate regions of the world[11]. Once this self-induced dormancy is completed, an adult moth emerges out of the silk cocoon. This whole process is termed as metamorphosis.

The transformation of the pupae to an adult moth is a tightly regulated neuro-electrical event under the control of intrinsic (neuro-secretory brain cells of the pupae) and extrinsic (seasonal parameters namely temperature, relative humidity, moisture and light) factors[1–8]. Intrinsic control is exerted by the spontaneous periodic electrical firing of the brain cells regulating the activity of the prothoracic gland[5–8]. Further it has been shown that the pupal dormancy could be terminated by external electrical stimulation of the pupal brain[7], thus mimicking the spontaneous electrical signaling of the brain cells. Neuro-electrical firing pattern of the pupal brain cells is influenced by the extrinsic seasonal factors. That is the reason why metamorphosis is a season dependent event[17].

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TRACE: Linguistic-based Approach for Automatic Lecture Video Segmentation Leveraging Wikipedia Texts

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***Abstract*—In multimedia-based e–learning systems, the accessibility and searchability of most lecture video content is still insufficient due to the unscripted and spontaneous speech of the speakers. Moreover, this problem becomes even more challenging when the quality of such lecture videos is not sufficiently high. To extract the structural knowledge of a multi-topic lecture video and thus make it easily accessible it is very desirable to divide each video into shorter clips by performing an automatic topic-wise video segmentation. To this end, this paper presents the TRACE system to automatically perform such a segmentation based on a linguistic approach using Wikipedia texts. TRACE has two main contributions: (i) the extraction of a novel linguistic-based Wikipedia feature to segment lecture videos efficiently, and (ii) the investigation of the late fusion of video segmentation results derived from state-of-the-art algorithms. Specifically for the late fusion, we combine confidence scores produced by the models constructed from visual, transcriptional, and Wikipedia features. According to our experiments on lecture videos from VideoLectures.NET and NPTEL[1], the proposed algorithm segments knowledge structures more accurately compared to existing state-of-the-art algorithms. The evaluation results are very encouraging and thus confirm the effectiveness of TRACE.**

***Keywords*-Lecture video segmentation; e–learning systems; multimodal analysis; Wikipedia; late fusion; linguistic features**

I. Introduction

A large volume of digital lecture videos has accumulated on the web due to the ubiquitous availability of cameras and affordable network infrastructures. However, a significant number of old (but important) videos with low visual quality from well known speakers are also commonly part of such databases. Because a specific topic of interest is often discussed in only a few minutes of a long video recording, it is essential to perform an efficient and fast topic boundary detection that also works robustly with lower quality videos. Moreover, such topic-wise segmentation of a lecture video into smaller cohesive intervals is advantageous to enable an easy search of the desired pieces of information. However, an automatic segmentation, indexing, and content-based retrieval of appropriate information from a large collection of lecture videos is very challenging because: (i) SRT (subtitle resource tracks) of lecture videos contain repetitions, mistakes, and rephrasings, (ii) the low visual quality of such videos may be challenging for topic boundary detection, and (iii) the camera may in many parts of a video focus on the speaker instead of the, *e.g.*, whiteboard.

State-of-the-art methods for automatic lecture video segmentation are based on the analysis of visual content, speech signals, and transcripts/SRT. However, none of the prior approaches consistently yields the best segmentation results for all lecture videos due to unclear topic boundaries, varying video qualities, and the subjectiveness inherent in transcripts. Since multimodal information augments multimedia based applications and services [6], [8], we postulate that a crowd-sourced knowledge base such as Wikipedia can be very helpful in the automatic lecture video segmentation because it provides several semantic contexts to analyze and segment videos more accurately. Empirical results in Section IV confirm our intuition. Thus, segment boundaries computed from SRT using state-of-the-art methods are further improved by refining these results using Wikipedia features. Our proposed TRACE system also works well for the detection of topic boundaries when only Wikipedia texts and SRT of lecture videos are available. Generally, the length of lecture videos ranges from 30 minutes to 2 hours, and computing the visual and audio features is a very time consuming process. Since TRACE is based on a linguistic approach, it does not require to compute such features from video content and

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Two-phase anticipatory system design based on extended species abundance model of biogeography for intelligent battlefield preparation

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ABSTRACT

This paper presents an extended model of biogeography based optimization (BBO) as opposed to the classical BBO wherein the HSI value of a habitat is not solely dependent upon the emigration and immigration rates of species but the HSI value is a function of different combinations of SIVs depending upon the characteristics of the habitat under consideration. The extended model also introduces a new concept of efforts required in migration from a low HSI solution to a high HSI solution for optimization in BBO. Hence, the proposed extended model of BBO presents an advanced optimization technique that was originally proposed by Dan Simon as BBO in December, 2008. Based on the concepts introduced in our extended model of BBO and its mathematics, we design a two – phase anticipatory system architecture for intelligent preparation of the battlefield which is the targeted optimization problem in our case. The proposed anticipatory system serves a dual purpose by predicting the deployment strategies of enemy troops in the battlefield and also finding the shortest and the best feasible path for attack on the enemy base station. Hence, the proposed anticipatory system can be used to improve the traditional approaches, since they lack the ability to predict the destination and can only find a suitable path to the given destination, leading to coordination problems and target misidentification which can lead to severe casualties. The designed system can be of major use for the commanders in the battlefield who have been using traditional decision making techniques of limited accuracy for predicting the destination. Using the above natural computation technique can help in enabling the commanders in the battlefield for intelligent preparation of the battlefield by automating the process of assessing the likely base stations of the enemy and the ways in which these can be attacked, given the environment and the terrain considerations. The results on two natural terrain scenarios that of plain/desert region of Alwar and hilly region of Mussourie are taken to demonstrate the performance of the technique where the proposed technique clearly outperforms the traditional methods and the other EAs like ACO, PSO, SGA, SOFM, FI, GA, etc. that have been used till date for path planning applications on satellite images with the smallest pixel count of 351 and 310 respectively. For location prediction application, the highest prediction efficiencies of the traditional method on Alwar and Mussourie was only 13% and 8% respectively as compared to the proposed method.

1. Introduction

In this modern warfare era, it has become necessary to have the ability to anticipate the likely actions of the enemy's maneuver and the troop mobilization strategies. The ability to accurately predict the deployment strategy of the enemy troops –to identify the most likely location for the enemy to position their forces and finding a feasible route is of critical importance to the commanders in the battlefield [38]. To understand and simulate the best available routes for attacking the enemy forces and to predict the ability of the enemy to position forces and mount attack, this paper has put forward natural computation algorithm. Natural computing refers to computational processes observed in nature and human designed computing inspired by nature.

ACO, PSO, BBO, Swarm intelligence, and artificial neural networks are some of the techniques under natural computation. For our military application, we have used the combination of

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Ultraviolet radiation detection by barium titanate thin films grown by sol–gel hydrothermal method[☆]

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Ultraviolet (UV) photodetector using ferroelectric barium titanate, $BaTiO_3$ thin film has been prepared successfully. $BaTiO_3$ (BTO) this film is deposited by sol–gel hydrothermal (SG-HT) method. The deposited BTO films were found to be polycrystalline having a band gap of about 3.51 eV. The photoconductive gain ($K = I_{on}/I_{off}$) of bare BTO based photodetector was found to be 8.36×10^2 for UV radiation ($\lambda = 365$ nm and intensity = 24 μW/cm^2). The modifier, tungsten (W) in the form of both thin overlayer and uniformly distributed circular dotted structures (600 μm diameter) were integrated with the surface of BTO thin film by rf-magnetron sputtering technique to improve the photoresponse characteristics. The photoconductive gain was enhanced to about two orders of magnitude (1.84×10^4) after integration of W modifier in the form of circular dots. The significant enhancement in photoresponse for W(dots)/BTO photodetector is related to the twin effect of (1) reduction in dark current (I_{off}) due to formation of schottky junction between the oxide (BTO) and metal (W), and (2) enhancement in photocurrent (I_{on}) due to high absorption of UV radiation on the detector surface.

1. Introduction

Ferroelectric materials have potential applications, for high dielectric-constant capacitors, ferroelectric memories, sensor, transducers, etc. Ferroelectric thin films were also important for tunable microwave devices, acoustic and pressure sensors, surface acoustic wave devices, MEMS and actuator applications [1]. Few reports are also available on realization of UV photodetectors using ferroelectric thin films by combining their unique optical and piezoelectric properties [2–9]. In the last two decades, there has been increasing demand for reliable photodetectors for detection of UV radiation due to its harmful effects [10]. The development of UV photodetectors is important because of its potential applications in the various fields of science and technology, including space science, aircraft science, defense and other industries [11]. Lead zirconate titanate (PZT) having very high piezoelectric coefficient has been widely used for the realization of UV photodetectors [2,3]. However, there is urgent need for identification of suitable green materials, which must be lead free, for these applications.

Barium titanate, $BaTiO_3$ is a well known lead free ferroelectric material with high dielectric constant and promising ferroelectric properties which is being exploited in a number of applications like gas sensors, capacitors, memory devices, etc. [12,13]. However, the material properties of $BaTiO_3$ (BTO) need to be tailored for photonic device applications [8] including photo-detectors. Thus, BTO after desired modifications in structural property has also been used for the photovoltaic applications [14]. A number of physical and chemical deposition techniques have been utilized for the growth of BTO thin films, including pulsed laser deposition (PLD), magnetron sputtering, thermal evaporation, chemical vapor deposition, co-precipitation, sol–gel, chemical bath deposition, etc. [13,15–18]. Amongst them, Sol–gel-hydrothermal (SG-HT) technique is a promising chemical method for low cost, low temperature fabrication of BTO thin films with large surface area and hence may be useful for sensing applications [11]. Although, there are few reports on the fabrication of BTO thin film using sol–gel hydrothermal method, but have not been explored for the sensing applications [18,19]. Further it is reported that incorporation of various metals in different forms including dopants, overlayer and dispersal of nanoparticles may be useful in improving the photoconducting properties of compound semiconductors [20,21] and hence results in development of UV photodetector with improved response due to formation of schottky junction [22,23]. However no such study has been made towards the influence of suitable

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Urban roadside monitoring and prediction of CO, NO_2 and SO_2 dispersion from on-road vehicles in megacity Delhi

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ABSTRACT

The study inspects the traffic-induced gaseous emission dispersion characteristics from the urban roadside sites in Delhi, India. The concentration of pollutants viz. CO, NO_2 and SO_2 along with traffic and ambient atmospheric conditions at five selected local urban road sites were simultaneously measured. A developed General Finite Line Source Model (GFLSM) was used to predict the local roadside CO, NO_2 and SO_2 concentrations. A comparison of the observed and predicted values emission parameters using GFLS model has shown that the predicted values for SO_2, CO and NO_2 at all the selected local urban roadside locations are found to lie within the error bands of 5%, 6%, and 7% respectively. A high level of agreement was found between the monitored and estimated CO, NO_2 and SO_2 concentration data. From the study, it has also been established that the developed model exhibits the capability of reasonably predicting the characteristics of gaseous pollutants dispersion from on-road vehicles for the urban city air quality.

Introduction

The environmental impacts are particularly severe in urban environment due to high population, traffic levels, intense motor vehicle use, driving patterns, vehicle characteristics and complex urban geometry (Allen et al., 2009; Beelen et al., 2009; Davies et al., 2009; Gurjar et al., 2008; Weber et al., 2008). In Delhi, the total number of vehicles has increased from 3.62 million in 2001-02 to 8.83 million in 2014-15 (Table 1).

The rapidly increasing number of motor vehicles has resulted in alarming levels of traffic congestion, air pollution, noise, and traffic danger. Transportation sector is accountable for about 50% of the emissions of nitrogen oxide and 90% of the carbon monoxide (Nagurney, 2000). As a result, urban environmental quality has been deteriorated in most of the cities of developing countries. Different models have been developed and used to investigate the source of emission from the vehicles in urban cities. Dispersion modelling is a common technique for inferring a quantitative deterministic correlation amid pollutant release and ambient concentrations. Various review studies on vehicular emission models have been carried out by different researchers across the country (Gokhale and Khare, 2004; Nagendra and Khare, 2002; Sharma and Khare, 2001).

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White Light Emission and Color Tunability of Dysprosium doped Barium Silicate Glasses

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Abstract

The present work elucidates the synthesis of Dy^{3+} doped barium silicate glasses, along with subsequent studies performed to evaluate its viability in solid state lighting applications. The synthesized photonic glasses were investigated via X-ray diffraction, scanning electron microscopy and fourier transform infrared spectroscopy. The photoluminescence properties were examined under ultraviolet (UV)/near UV (NUV) excitation. Photoluminescence spectrum exhibited characteristic emission bands at λ_{em}= 483 nm (blue) and λ_{em}= 576 nm (yellow) which are ascribed to the $^4F_{9/2}\rightarrow{}^6H_{15/2}$ and $^4F_{9/2}\rightarrow{}^6H_{13/2}$ transitions of Dy^{3+} ion, respectively. The chromaticity coordinates under excitation of λ_{ex}= 348 nm are (0.31, 0.34), which lies in the white region of CIE 1931 chromaticity diagram and are in excellent proximity with the standard equal energy white illuminant (0.333, 0.333). The calculated correlated color temperature and the yellow to blue (Y/B) ratio are found to be 6602 K and 1.12, respectively for the optimized sample. The synthesized photonic glass also offered the possibility of tuning the color as exemplified through the variation in CIE coordinates, correlated color temperature and the Y/B ratio. The results confirm the possibility of color tunability from the proposed glass and may be useful for various photonic device applications.

Keywords: Photoluminescence, Silicate glass, FT-IR, w-LEDs

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Zero Ring Labeling of Graphs

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Abstract

This paper introduces the notion of zero ring labeling of a graph and its empirical study demonstrates that every graph admits a zero ring labeling with respect to some zero ring. The zero ring graph $\Gamma(R^0)$ turns out to be maximal with respect to an injective zero ring labeling. In particular, we determine the optimal zero ring index for some well-known graphs.

Keywords: labeling, zero ring.

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ZVS-ZCS High Voltage Gain Integrated Boost Converter For DC Microgrid

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***Abstract*—A non-isolated soft switched integrated boost converter having high voltage gain is proposed for the module integrated PV systems, fuel cells and other low voltage energy sources. Here a bidirectional boost converter is integrated with a resonant voltage quadrupler cell to obtain higher voltage gain. The auxiliary switch of the converter, which is connected to the output port acts as an active clamp circuit. Hence ZVS (zero voltage switching) turn on of the MOSFET switches are achieved. Coupled inductor's leakage energy is recycled to the output port through this auxiliary switch. In the proposed converter, all the diodes of the quadrupler cell are turned off with ZCS (zero current switching). This considerably reduces the high frequency turn off losses and reverse recovery losses of the diodes. ZCS turn off of the diodes also remove the diode voltage ringing caused due to the interaction of the parasitic capacitance of the diodes and the leakage inductance of the coupled inductor. Hence to protect the diodes from the voltage spikes, snubbers are not required. The voltage stress on all the MOSFETs and diodes are lower. This helps to choose switches of low voltage rating (low $R_{DS}(ON)$) and thus improve the efficiency. Design and mathematical analysis of the proposed converter are made. A 250W prototype of the converter is built to verify the performance.**

***Index Terms*—DC-DC Converter, Zero voltage switching, Zero current switching, High voltage gain.**

I. Introduction

EFFICIENT utilization of the different renewable energy sources is one of the main challenge of power and energy sector. In order to interconnect the renewable sources to the grid, power electronics interface are necessary [1]. Solar PV systems are the most sought after renewable energy source due to the universal availability of the solar irradiation and the flexibility to install the PV panel at the consumer end. In order to improve the efficiency of the PV system by overcoming the losses due to the partial shading and module mismatches, modular PV systems are preferred for low power applications [2], [3]. Here a highly efficient, high voltage gain dc-dc converter is required to step up the low voltage output of the PV to that of the dc bus voltage. High voltage gain dc-dc converters are also required for various applications like UPS systems, fuel cells systems, battery bank, high intensity discharge (HID) lamps and server power supply etc. [4], [5].

In a conventional boost converter obtaining a high voltage gain is limited by the poor efficiency operation caused due to the conduction losses and diodes's reverese recovery losses [6]. Isolated converters can be used to achieve high voltage gain. However, for low power applications, nonisolated converters are preferred due to their higher efficiency, good power density and lower cost [7], [8]. Changes in electric codes also favours the use of nonisolated converters for low power solar PV systems. Among the various nonisolated high gain dc-dc converters, coupled inductor based converters are attractive due to the freedom of increasing the voltage conversion gain by simply changing the turn's ratio. Voltage spike on the switches due to the coupled inductor's leakage energy is the main concern of these converters. Lossless passive clamp [4], [9] or active clamp [10], [11] technique is used to limit this voltage spike on the switches. In [9], a boost converter is integrated with a flyback converter (Integrated boost converter) to obtain high voltage gain. Here the boost converter is acting as a passive clamp circuit which recycle the leakage energy. However, these converters suffer from high voltage stress on the output diode and thus necessary to use snubber circuit or high voltage rated diodes.

In isolated high voltage gain converters, different voltage multipliers like conventional full wave doubler, Greinacher multiplier and voltage tripler are used to reduce the turn's ratio of the transformer [12]. In [13], by connecting two Greinacher multipliers a voltage quadrupler circuit is proposed for high voltage step up applications. Natural voltage balancing of the output capacitor and lower device stress are the advantage of this voltage multiplier. In nonisolated coupled inductor converters, to reduce the voltage stress on the output diode and also to improve the voltage gain, voltage multipliers which are used in the isolated converters are introduced at the secondary side of the coupled inductor [3], [5], [14]–[21]. These converters achieve higher voltage gain without extreme

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Fault Prediction Using Statistical and Machine Learning Methods for Improving Software Quality

Ruchika Malhotra* and Ankita Jain**

Abstract—An understanding of quality attributes is relevant for the software organization to deliver high software reliability. An empirical assessment of metrics to predict the quality attributes is essential in order to gain insight about the quality of software in the early phases of software development and to ensure corrective actions. In this paper, we predict a model to estimate fault proneness using Object Oriented CK metrics and QMOOD metrics. We apply one statistical method and six machine learning methods to predict the models. The proposed models are validated using dataset collected from Open Source software. The results are analyzed using Area Under the Curve (AUC) obtained from Receiver Operating Characteristics (ROC) analysis. The results show that the model predicted using the random forest and bagging methods outperformed all the other models. Hence, based on these results it is reasonable to claim that quality models have a significant relevance with Object Oriented metrics and that machine learning methods have a comparable performance with statistical methods

Keywords—Empirical Validation, Object Oriented, Receiver Operating Characteristics, Statistical Methods, Machine Learning, Fault Prediction

1. Introduction

Software reliability is a critical field in software engineering and an important facet of software quality. Every organization wants to assess the quality of the software product as early as possible so that poor software design leading to lower quality product can be detected and hence be improved or redesigned. This would lead to significant savings in the development costs, decrease the development time, and make the software more reliable. The quality of the software can be measured in terms of various attributes such as fault proneness, maintenance effort, testing effort, etc. In this study, we have used fault proneness as the quality predictor. Fault proneness is defined as the probability of fault detection in a class [1-4]. Due to high complexity and constraints involved in the software development process, it is difficult to develop and produce software without faults. High cost is involved in finding and correcting faults in software projects. Thus, we need to identify or locate the areas where more attention is needed in order to find as many faults as possible within a specified time and budget. To address this issue, we predict fault proneness model using statistical and machine learning methods in this paper. One of the approaches to identify faulty classes early in the development cycle is to predict models by using software metrics. In the realm of an object oriented environment, object oriented soft-

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A comparative study on ultrasonic cavitation and mechanical stirring method towards efficient production of biodiesel from non-edible oils and performance testing on a CI engine

Ashok Kumar Yadav , M. Emran Khan , Amit Pal , Alok Manas Dubey

Abstract PDF

Abstract

This paper presents the biodiesel production processes using low frequency ultrasonic energy (24 kHz) and conventional mechanical stirrer method. For this purpose, three different non-edible oils namely kusum, yellow oleander and bitter groundnut oil were used as the biodiesel feedstock. The experiments have been performed for molar ratio (alcohol/oil) 6:1 and 4.5:1, with three different catalyst percentages (0.5%, 0.75% and 1%) of potassium hydroxide. Further an experimental investigation has been carried out on a diesel engine with diesel and biodiesel blends [B10, B20, and B30]. The most significant conclusions are: 1) biodiesel production through ultrasound energy appears to be efficient and time saving; 2) BTE of engine slightly increases when operating on lower blends of biodiesel (up to B10) than that operating on neat diesel. It may be concluded from the experimental investigations that up to 30% of biodiesel blends can be used as a fuel in engine without modification.

Keywords: biodiesel production, ultrasonic cavitation, mechanical stirring, CI engines, non-edible oils, performance evaluation, biofuels, kusum, yellow oleander, bitter groundnut oil, biodiesel feedstock, potassium hydroxide, ultrasound energy, biodiesel blends, diesel engines

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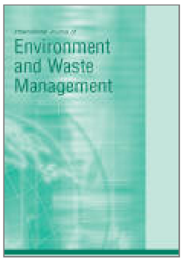

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A Hybrid Approach for Promoting Low Carbon Technologies in Distributed Generation Planning

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***Abstract*—The greatest challenge for power utilities is to meet exponentially increasing energy demand subjected to the constraints of sustainable development with clean energy apart from economic viability. Renewable DGs, in spite of high investment cost and intermittent generation, are compulsive choice for environment friendly planning and sustainable growth. Clean energy DG technologies can provide solution to ever increasing power demand in sustainable and cost effective manner by adopting appropriate incentive mechanism. Clean energy technologies can also be encouraged by penalizing the conventional resources for harmful emissions. The proposed method minimizes the annual cost by maximizing the emission reduction and carbon credit revenue. The proposed formulation yields solution in terms of type, optimal size and location while fulfilling the criterion in terms of economic, technical or techno-economic. The objective function comprises of energy purchase, losses, capital, operational and GHG emission costs. Importance of each objective is mapped with optimal weight allocation, thereby maintaining the consistency among all objectives. A hybrid optimization technique based on Harmony Search integrated with Teaching-Learning is used to enhance the search process. The merit of the proposed algorithm is dynamic tuning of control parameters which enhances the convergence property of the solution algorithm. Results indicate that renewable DG technologies can become financially viable with appropriate price mechanism depending on planner's objective.**

Keywords- Clean energy planning, Harmony search Teaching-learning Optimization, Distributed generation

Nomenclature

$\lvert V_i\rvert_{\min}, \lvert V_i\rvert_{\max}$	Minimum and maximum bus voltages
$N_{DG}, N_{DG}^{\max}$	Number of DG units
$C_{tc}, C_{en}^{SS}, C_{Loss}$	Total, substation energy, loss, emission cost
$C_{cpt}^{DG}, C_{op}^{DG}, C_{o\&m}^{DG}$	Annual capital, operational, O&M costs of DG
$C_{emi}, C_{inc\_emi}^{DG}, C_{cce}^{DG}$	Annual emission, emission-offset, and carbon credit earned by DG
$Cf^{bmg}, Cf^{wg}, Cf^{spv}$	Capacity factor of biomass, wind, & SPV DG
$P_n^{bmg}, P_n^{wg}, P_n^{spv}$	Power output of biomass, wind & SPV DG
$S_n^{bmg}, S_n^{wg}, S_n^{spv}$	Installed capacity of biomass, wind &SPV DG
$E_n^{bmg}, E_n^{wg}, E_n^{spv}$	Annual energy biomass, wind & SPV DG

I. Introduction

Power system planning is generally viewed as cost minimization problem for meeting load requirement subjected to the network constraint. In modern power system environmental sanctions such as GHG emission reduction, low carbon energy inclusion have gained equal importance in addition to the economical factor. Snoring load demand, deregulated market approach, and environmental considerations have led to the distributed generation (DG) resources. DGs comprise of dispatchable resources namely gas turbine driven synchronous generator, fuel cells, etc.) and non-dispatchable sources namely solar, wind, biomass, etc.). Both the DGs have benefits and drawbacks.. Non-dispachable DGs are suitable for sustainable energy planning, though sources are intermittent in nature, poor utilization factor and large installation cost. Dispatchable resources provide low cost efficient solution, but still pose threat to sustainable growth. DG sources improve the network performance by many ways. Research Studies have reiterated that planners can exploit the benefits in terms of reduced losses, improved voltage profile, and reduced line flows by the optimal placement of DG resources. Inadequate site and size of DG resources can result in higher losses and violation in network parameters. In addition, DG can be considered as a viable option to ease out problems such as network congestion, power quality and deferral network expansion.

Researchers have explored DG planning from different objectives [1]. Cost benefit analysis with DG integration is proposed by khattam et. al[2].Algorithm for Single and multi period modeling in deregulated environment is proposed for minimizing installation operational and loss cost [3].Multi-

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A hybrid impedance control scheme for underwater welding robots with a passive foundation in the controller domain

Sunil Kumar[1], Vikas Rastogi[2] and Pardeep Gupta[1]

Abstract
A hybrid impedance control scheme for the force and position control of an end-effector is presented in this paper. The interaction of the end-effector is controlled using a passive foundation with compensation gain. For obtaining the steady state, a proportional–integral–derivative controller is tuned with an impedance controller. The hybrid impedance controller is implemented on a terrestrial (ground) single-arm robot manipulator. The modeling is done by creating a bond graph model and efficacy is substantiated through simulation results. Further, the hybrid impedance control scheme is applied on a two-link flexible arm underwater robot manipulator for welding applications. Underwater conditions, such as hydrodynamic forces, buoyancy forces, and other disturbances, are considered in the modeling. During interaction, the minimum distance from the virtual wall is maintained. A simulation study is carried out, which reveals some effective stability of the system.

Keywords
Underwater robot, proportional–integral–derivative controller, bond graph, impedance control, flexible link

1. Introduction

The interaction of underwater robot manipulators with objects is a very important aspect for completing autonomous missions. For a number of applications performed in underwater conditions, the robot end-effector has to make contact or keep a constant distance with the environment, as in the case of welding. The interaction of the underwater robot with such nonlinear environmental conditions is of great interest. The underwater robot manipulators should have reliable communication with the underwater environment conditions in their work space when subjected to interaction forces while performing tasks. From this point of view, control of the position and constant force between the robot end-effector and environment is necessary.

There are several interaction control schemes related to robot force control[1] in friction-less environments.[2] Stiffness control, direct force control, hybrid force/position control, parallel force/position control, and impedance control are some of the examples.[3] By applying the designated impedance between the robot end-effector position and constant force, a controlled interaction can be achieved.[4] Hogen[5–7] developed an approach to facilitate the application of robots involving static and dynamic interaction between the manipulator and its environment considering impedance components of the manipulator behavior using a bond graph. Krishnan et al.[8] dealt with the issue of interaction between the hopping robot toe and the physical ground by controlling the driving point stiffness (impedance) using bond graph modeling software. Using a pneumatic actuator with passive properties of the impact and force control, the desired interaction force can be achieved for stable and dissipative contact tasks with an arbitrary environment.[9] Wang and Xie[10] investigated the force/position track control of a free flying space manipulator kinematic and dynamics using multiple impedance control (MIC). In the more practical case of contact

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A novel approach of multi-stage tracking for precise localization of target in video sequences

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ABSTRACT

Visual tracking methods are mostly based on single stage state estimation that limitedly caters to precise localization of target under dynamic environment such as occlusion, object deformation, rotation, scaling and cluttered background. In order to address these issues, we introduce a novel multi-stage coarse-to-fine tracking framework with quick adaptation to environment dynamics. The key idea of our work is to propose two-stage estimation of object state and to develop an adaptive fusion model. Coarse estimation of object state is achieved using optical flow and multiple fragments are generated around this approximation. Precise localization of object is obtained through evaluation of these fragments using three complementary cues. Adaptation of proposed tracker to dynamic environment changes is quick due to incorporation of context sensitive cue reliability, which encompass its direct application for development of expert system for video surveillance. In addition, proposed framework caters to object rotation and scaling through a random walk state model and rotation invariant features. The proposed tracker is evaluated over eight- benchmarked color video sequences and competitive results are obtained. As an average of the outcomes, we achieved mean center location error (in pixels) of 6.791 and F-measure of 0.78. Results demonstrate that proposed tracker not only outperforms various state-of-the-art trackers but also effectively caters to various dynamic environments.

1. Introduction

Precise localization of an object in video sequences is imperative due to its wide range of applications in the field of video surveillance and security, traffic monitoring, human-computer interaction, video-indexing, vehicle navigation and many more. However, dynamic environments such as partial or full occlusion, illumination changes, scale changes, rotation, and deformation of object etc. make object tracking in video sequences a challenging task. Time complexity of the tracking algorithm is another indispensable factor for real time applications. The features with high dimensions require high computational power and real time tracking using these features under dynamic environments is a challenge. In the last two decades, object tracking has been explored extensively considering one or more dynamic environment challenges. An extensive review of object tracking methods was reported (Yilmaz, Javed, & Shah, 2006). Further, an experimental survey comparing nineteen state-of-the-art trackers was reported (Smeulders et al., 2014). A review on multicue based object tracking methods was carried out by Walia and Kapoor (2016a). Despite these advances in object tracking methods from single cue based solutions to more robust multicue based solutions, most of object tracking solutions based upon only single cue fail to accurately localize objects in real time under dynamic environments (Smeulders et al., 2014; Walia & Kapoor, 2016b; Yang & Nevatia, 2014; Yilmaz et al., 2006).

Generally, object tracking methods can be categorized on the basis of modalities and features used. Multicue based tracking solutions where multiple features are extracted from single-modal (single sensor) were extensively investigated. Under dynamic environment, cues performing better at one instance of time may get deteriorated at other instance of time. The color cue is invariant to object scaling and can handle partial occlusion, but it gets deteriorated with change in illumination and full occlusion. Inability of color cue to provide spatial information was overcome by considering semi overlapping regions in color space (Maggio & Cavallaro, 2005). Motion feature can be easily extracted but it does not provide any information about the shape of the object. Spatial-temporal motion energy was considered for embed-

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A robust algorithm for analysis of intercepted HF traffic under noisy environment

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Abstract PDF

Abstract

The aim of this paper is to introduce a novel algorithm for retrieval of information from noisy intercepted traffic. The design considerations for HF protocol along with its simulation are elaborated. The main contribution of our research work is proposal for novel method for recovery information from a partially decoded noisy bit stream for HF protocols. Statistical properties of language such as unigram, bigram, trigram frequency have been exploited for design of cost function. Also, histogram analysis along with mean and variance statistics of language are extracted and used for design of another cost function. In our proposed analysis algorithm these cost functions are used for automatic analysis of recorded baseband protocols. The algorithm for automatic estimation of non-standard parameters such as baud rate, data format is proposed. The results and analysis of proposed algorithms are discussed for simulated HF protocol recordings.

Keywords: frequency shift keying, autocorrelation, centre frequency, baud rate, information retrieval, intercepted HF traffic, simulation, noisy bit streams, high frequency protocols

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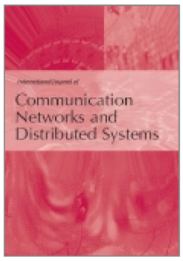

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Abnormal Temperature dependent luminescence behavior of $CaSrSiO_4:Eu^{2+}$ phosphors synthesized via sol-gel strategy

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Abstract

A silicate based crystal doped with Eu^{2+} phosphors have been synthesized by sol-gel method using propylene glycol modified silane (PGMS). The structural and luminescence properties of the as-prepared samples were well characterized by using x-ray diffractometer (XRD) & photoluminescence spectroscopy. Thermal stability of the prepared phosphors was also measured and analyzed in detail. The results revealed a new fact that longer wavelength emission band position is relatively more sensitive to the sample temperature for higher dopant concentrations when compared to the other emission bands. Such observations were not found in the samples prepared by solid phase reaction method. The $CaSrSiO_4$ phosphor doped with 3 mol % of Eu^{2+} showed unique optical properties that consist of a shift in emission spectrum towards shorter wavelength along with a decreased band width (FWHM). The emission color tunablity with the increase in temperature and concentration of the $CaSrSiO_4$ phosphor were also discussed by CIE chromaticity diagram.

Keywords: $CaSrSiO_4$; Photoluminescence; Thermal Stability; pc-white LED Phosphor; PGMS.

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Abstract

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Achieving independent control of core diameter and carbon shell thickness in Pd-C core–shell nanoparticles by gas phase synthesis

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Abstract

Pd-C core–shell nanoparticles with independently controllable core size and shell thickness are grown by gas phase synthesis. First, the core size is selected by electrical mobility values of charged particles, and second, the shell thickness is controlled by the concentration of carbon precursor gas. The carbon shell grows by adsorption of carbon precursor gas molecules on the surface of nanoparticles, followed by sintering. The presence of a carbon shell on Pd nanoparticles is potentially important in hydrogen-related applications operating at high temperatures or in catalytic reactions in acidic/aqueous environments.

Keywords: gas phase synthesis, core–shell nanoparticles, controlled shell thickness, size selected Pd-C nanoparticles

(Some figures may appear in colour only in the online journal)

1. Introduction

Pd is one of the most studied materials for catalytic and gas sensing applications and modifications in the Pd-H interaction have been achieved by alloying and nanoparticle routes [1–4]. It has been shown that the nanoparticle nature results in a modification of properties due to the enhanced surface area and quantum confinement effects which modify the Pd 4d centroid position. The presence of surface and subsurface defects is also known to influence the Pd-H interaction [3, 5]. The deposition and decoration of the Pd surface with other materials like carbon are used to modify physical adsorption and molecular dissociation processes taking place at the Pd surface [6–8]. The use of Pd-C core–shell nanoparticles is especially attractive, since in this case the interaction with hydrogen can be significantly higher than that for bare Pd nanoparticles [9]. The carbon shell also increases the stability of the Pd nanoparticles and prevents their agglomeration [10, 11].

A variety of physical and chemical methods have been used to prepare metal-carbon core–shell nanoparticles [12–16]. In these methods, the main challenge is to achieve simultaneous control over both the size of the core and thickness of the carbon layer. Metal-carbon core–shell nanoparticles made by chemical techniques suffer from low crystallinity, low purity and broad size distribution [14, 15]. Furthermore, these methods are restricted to those metals for which organometallic salts are available [17, 18]. In these synthesis techniques a support, placed inside the heating reactor, collects the metal-carbon nanoparticles. Working at high temperature (700 °C), the method is limited to temperature-resistant supports [14]. Pd/C core–shell nanoparticles have also been synthesized at lower temperature (80 °C) through reduction of $PdCl_2$ in ethanol [19]. However, the core size could not be controlled in this case.

An Approach to Locate TCSC Optimally for Congestion Management in Deregulated Electricity Market

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***Abstract*— Congestion mitigation is one of the major problem faced by the transmission system operator in deregulated electricity market. In this paper, a congestion management approach based on optimal placement of thyristor controlled series capacitor (TCSC) in deregulated environment has been proposed. The most critical line having highest probability of occurrence of congestion is investigated. The optimal location for TCSC placement to mitigate congestion is found based on probability of occurrence of congestion in a transmission line. The performance of proposed technique is tested on IEEE 14-bus system.**

***Keywords*— FACTS; congestion management; ISO; deregulated electricity market.**

I. INTRODUCTION

Restructuring of power system causes its traditional monopolistic structure to be replaced with three independent entities which are generation companies (GENCOS), transmission companies (TRANSCO) and distribution companies (DISCO) [1]-[3]. Due to increase in adoption of competition by different sectors, the same has been introduced in electricity market too. Generally, the competition in electricity market is limited to generation and distribution sides only while due to economy of scale, the transmission system is operated by a single entity in order to keep the system secure and reliable.

With the increase in electricity demand around the world and introduction of competition in electricity market, the independent system operators (ISO) are forced to operate the power system near its operating limit. Due to this, the probability of violation of system constraints increases which endangers the security of transmission system. This causes the transmission line to become congested. Congestion of a transmission line can be defined as a condition which arises with the violation of any of its operating constrains such as thermal limit, voltage limit, stability limit etc. The competition in electricity market promises the greater benefits to all, but congestion may take away all the benefits. Therefore the management of congestion in competitive electricity market is vital to operate the system in a secure manner.

The management of congestion can be either cost free or non-cost free [4][5]. Non-cost free means of congestion management can be achieved either by generation rescheduling [6][7] or load curtailment [8] while the cost free means make use of the FACTS devices [9], transformer taps and phase shifters. In competitive electricity market, a number of committed bilateral and multilateral transaction of electricity has to be performed which may cause the power flow in some of the line above its limit while other lines may be underutilized. Therefore proper utilization of available transfer capability of transmission line becomes important which can be easily achieved by installing FACTS devices which control the flow of power in transmission network without its reconfiguration and generation rescheduling. As the congestion management using FACTS devices [10]-[16] posses a number of advantages over other methodologies, therefore in this paper, FACTS devices are implemented for congestion management. However there are certain issues related to FACTS devices such as its optimal placement, proper size and setting, cost etc.

A number of work has been reported in literature to analyse the impact of implementation of FACTS devices to manage transmission line congestion [10]-[14]. A curtailment strategy based on FACTS devices has been proposed in [15] to alleviate congestion. A congestion management method together with static security margin improvement by optimally placing SVC and TCSC is discussed in [16].

As the installation of FACTS devices involves heavy investment, therefore its optimal location and size plays a very vital role in keeping the benefits of competitive electricity market intact. The competitive environment of electricity market makes the transmission lines more prone to congestion. The probability of occurrence of congestion on a specific line may me more as compared to others. Therefore in this paper, a method to find the most critical line having greatest probability of occurrence of congestion is proposed based on which optimal location of FACTS device to relieve congestion

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An eco-friendly and inexpensive solvent for solution processable CuSCN as a hole transporting layer in organic solar cells

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ABSTRACT

During past few years, significant research on solution-processable deposition of copper(I)thiocyanate (CuSCN) as an efficient hole transporting layer (HTL) for excitonic solar cells have been successfully reported. Surprisingly, till now only two solvents diisopropyl sulfide and diethyl sulfide are known which have been used for CuSCN film deposition as a HTL for device fabrication. Here, we have used eco-friendly and inexpensive solvent dimethyl sulfoxide (DMSO) for solution processed thin film deposition of CuSCN for organic solar cells. The photovoltaic devices were fabricated using two different donor polymers PCDTBT and PTB7 blended with $PC_{71}BM$ as an acceptor material with device structure of ITO/CuSCN/active layer/Al. The power conversion efficiency (PCE) based on CuSCN using DMSO as a deposition solvent have been achieved up to 4.20% and 3.64% respectively, with relative higher fill factor (FF) as compared to previously reported values in literature. The resultant HTLs were characterized by UV–vis–NIR spectroscopy, X-ray diffraction (XRD), scanning electron microscope (SEM) and atomic force microscope (AFM) for better understanding.

1. Introduction

Power conversion efficiency (PCE) with adequate stability in excitonic solar cells is the most difficult challenge for their possible commercial applications [1,2]. Particularly, solution processable organic solar cells are most often referred due to their easy fabrication process, cost effectiveness and large area devices [3]. Commonly, conventional bulk heterojunction (BHJ) solar cells have been fabricated based on five different components as active layer (donor/acceptor materials), hole transport layer (HTL), electron transport layer (ETL), indium tin oxide (ITO) as a positive electrode and metal as a negative electrode. Among them, active layer is widely studied to achieve the highest possible performance [4–6]. With respect to effort on active layer, very scanty is known about solution processed HTL, while HTL in photovoltaic device plays an important role for device stability and PCE [7,8]. It is observed that water soluble poly(3,4-ethylenedioxythiophene):poly(styrenesulfonate) (PEDOT:PSS) is frequently used HTL in organic solar cells, although it influences the device stability and degradation [9–11]. Transition metal compounds [12–17] are also well reported for efficient HTL in organic solar cells including copper(I)iodide (CuI) [18] and copper(I)thiocyanate (CuSCN) [19–21]. Nowadays CuSCN has been successfully used as an efficient HTL in excitonic solar cells such as organic solar cells (PCE; 8.22%) [22], dye sensitized solar cells (DSSCs) [20] and perovskite [23,24] solar cells (PCE; 15.6%) [21,25].

In past few years, significant research on solution-processable deposition of CuSCN as an hole transporting layer for fabrication of efficient electronic devices namely field effect transistors [26,27], organic light emitting diodes [28] and solar cells have been successfully reported. Recently, our group reported CuSCN as an efficient and solution-processable HTL in low band gap polymeric solar cells using diisopropyl sulfide solvent for thin film deposition [29]. Anthopoulos and co-workers reported CuSCN as a solution-processable transparent anodic interface material as a replacement of PEDOT:PSS for highly efficient solution processable BHJ device using different combination of donor and acceptor materials [30]. In 2015, another report on advantages of solution-processable CuSCN used as a hole collection/transport layer for polymer/fullerene based organic solar cells have been reported [31]. Very recently, Mishra et al. reported solution-processable CuSCN as an interfacial hole transporting layer in organic solar cells using

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Analysis of Single Phase Grid Connected PV System to Identify Efficient System Configuration

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***Abstract*— Deregulated power system nowadays is grooming rapidly. Distributed generators are providing support to existing power system to fulfill the demand of power. Solar Photovoltaic system is one of the distributed generators which are being utilized by the customers globally. Small and medium power consumers have started striving on solar power for economically and environmentally reasons. Most of the customers on distribution side have single phase connection. Presently the single phase grid connected photovoltaic system is getting popularity among all renewable energy sources used for the distribution side. This paper mainly focuses on the component analysis of single phase grid connected photovoltaic system. For better understanding of the system and for attaining maximum efficiency of the PV system, an efficient power electronics converter is being required. The paper reviews the existing topologies of the various components used in a single phase grid-tied PV system which leads to identify the efficient system configuration of the PV system.**

Keywords— Solar Photovoltaic; grid connected system; Modeling, MPPT; DC-DC Converter; Transformerless inverter

I. Introduction

To boost the renewable energy application in modern power system, government agencies all over the globe are introducing new schemes and policies. Agencies are trying to motivate the customers by initiating monetary benefits for using renewable source of energy for power generation. Solar photovoltaic energy being a well known and established technology for power generation in the category of renewable energy is nowadays mushrooming. People all over the world are awaked by the importance and benefits of solar photovoltaic power system. But the solar power itself is not sufficient to fulfill the requirement of the consumers. So next possible solution emerges is the grid connected system. In grid connected system, the requirement of power is being filled by both an infinite source of power called grid and solar photovoltaic power. Thus the evolution of grid connected photovoltaic system evolved. Few standards are also being imposed by the governments so that the quality and safety of existing power system could be maintained. IEEE has also prepared the standards for connecting distributed resources like solar photovoltaic with the power system, which is accepted globally [1-2].

Solar being an easily available free source of energy is always be the area of interest for the researchers. Power electronics has a significance role in the field of solar photovoltaic system. The enhancement of efficiency of the solar PV system is mainly depends on the power electronics based devices like converter and inverter. The conversion efficiency and losses have significantly reduced by the application of these devices. Advancement in the power electronics field leads to new cost effective and efficient solar power system.

The main drawbacks of the solar photovoltaic system are the need of ample space for generation and its dependence on environmental conditions [3-4]. Also the small power consumers always have a risk and uncertainty in terms of investment [5-6]. To overcome this uncertainty, few researchers have developed the methods for reducing investment uncertainty [7].

To overcome these technical challenges, the researchers are trying for the efficient and reliable solar photovoltaic system integrated into distribution grid so that power can be produced in effective manner and uncertainty can be reduced. The main components of the grid connected photovoltaic power plant comprises of solar PV panel which combines to form an array, DC-DC converter for constant DC supply and inverter for converting this constant DC into AC so that it can inject into existing grid. For better power quality, advancements have already being developed and tested like interleaved boost converter, transformer less inverter and single stage solar power system.

This paper presents the analysis of single phase grid connected PV system to identify efficient system configuration. The paper provides a comprehensive idea about the system and its requirements. It also offers the latest development in this field which helps in finding and configuring the cost effective and efficient solar photovoltaic system for single phase application.

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Building Concordant Ontologies for Drug Discovery

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***Abstract*— In this study we demonstrate how we interconnect three different ontologies, the BioAssay Ontology (BAO), LINCS Information FramEwork ontology (LIFEo), and the Drug Target Ontology (DTO). The three ontologies are built and maintained for three different projects: BAO for the BioAssay Ontology Project, LIFEo for the Library of Integrated Network-Based Cellular Signatures (LINCS) project, and DTO for the Illuminating the Druggable Genome (IDG) project. DTO is a new ontology that aims to formally describe drug target knowledge relevant to drug discovery. LIFEo is an application ontology to describe information in the LIFE software system. BAO is a highly accessed NCBO ontology; it has been extended formally to describe several LINCS assays. The three ontologies use the same principle architecture that allows for re-use and easy integration of ontology modules and instance data. Using the formal definitions in DTO, LIFEo, and BAO and data from various resources one can quickly identify disease-relevant and tissue-specific genes, proteins, and prospective small molecules. We show a simple use case example demonstrating knowledge-based linking of life science data with the potential to empower drug discovery.**

***Keywords*— drug discovery; bioinformatics; cheminformatics**

I. INTRODUCTION

Big data are ubiquitous in business, technology and science. Life science research data are no exception. However, the nature of research data, in particular in the life sciences brings additional challenges due to broad diversity of data types and formats, the quick evolution of knowledge and advancements in technologies to generate data. Despite large investments in information systems in the pharmaceutical industry and non-profit research organizations, the difficult problem of describing, organizing, integrating, analyzing diverse, fast evolving and large scale data in the context of biological knowledge remains a critical and not fully solved challenge.

In this study we demonstrate in a simple case study how to represent and organize such data better by using Semantic Web technologies. Although this approach is not novel, we contribute by leveraging three ontologies developed in our group and that are largely aimed at addressing different aspects of drug discovery data.

The BioAssay Ontology (BAO) [3] has been developed to formally describe knowledge of chemical biology assays and screening results using Description Logic (DL) [14] and OWL (OWL2.0) [17]. The first version of BAO [9] focused on High Throughput Screening (HTS) assays and contained descriptions of many assays from PubChem. BAO since evolved to better integrate with other ontologies and better align with established upper level models and improve usability. BAO was also extended to support profiling assays such as those in LINCS [21]. The systems biology nature of LINCS data required a formal model to describe the relations of cells, disease, tissues and relevant bio-molecules, such as proteins, transcribed genes, used in different roles the various assays. The LINCS Information FramEwork (LIFE) [20] was developed to process, integrate, query, and explore this data. The LIFE application ontology (LIFEo) was developed as a knowledge model to capture the relevant relationships to facilitate this functionality. The Drug Target Ontology (DTO) is being developed as a reference framework to formalize knowledge about drug targets in the context of simple assays and more complex model systems; it is developed as part of the Illuminating the Druggable Genome (IDG) project [22]. For example DTO can readily be used in BAO or in LINCS to describe protein targets in an assay or known targets of small molecule drugs.

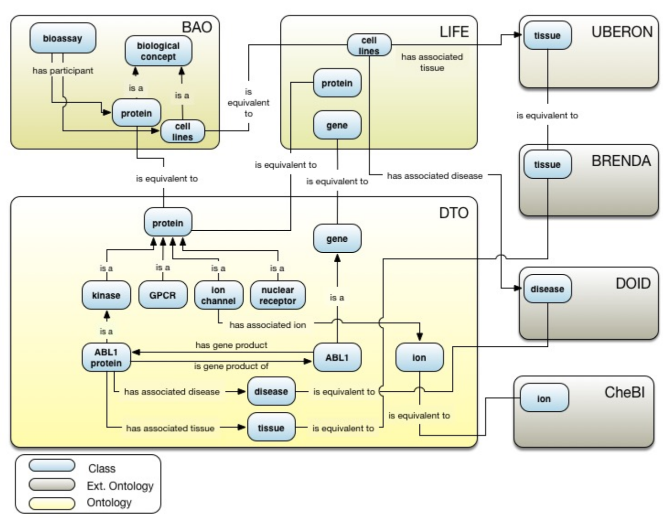

Figure 1 BAO, LIFEo, and DTO with select external ontologies

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Case-based modeling of prolific liars and constant truth-tellers: Who are the dishonesty and honesty self-reporters?☆

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ABSTRACT

Do some individuals identify themselves to be prolific liars? Here, "big-liars" are individuals who self-report telling lies twelve-or-more times annually. What share of Americans (or any other national population) is big-liars? What share reports telling no lies? Can individual social-economic status (SES) and social factor configurations identify big-liars consistently? The present study includes proposing and testing the case-based theoretical tenet that single-variable SES and social factors do not identify big-liars or self-report truth-tellers consistently even if these single-variables associate significantly statistically with lying/truth-telling in symmetric tests. The theory here proposes that configurations (i.e., screening algorithms or recipes of SES and social factors) are capable of identifying big-liars as well as self-reported persons claiming to never lie. A national omnibus, representative, sample of Americans ($n = 3350$ provide some surprising answers to the questions and substantial support for the usefulness of case-based configurational models for identifying big-liars. To prevent, "I knew that" perceptions, before reading further (using a pen or pencil), consider answering the following multiple-choice questions. What share (%) of Americans identify themselves to be non-liars: 30, 40, 50, 60, or 70? What share (%) identify themselves to be big (i.e., monthly) liars: 30, 40, 50, 60, or 70?

1. Introduction

Possibly unsurprisingly, telling lies is headline news especially in 2015 and 2016. The following two brief stores illustrate. Running for U.S. President in 2015–16, Donald Trump has repeatedly labeled his political opponents liars. He dubbed Senator Ted Cruz lying when it became clear that Cruz was a serious rival for his nomination; he identified Senator Marco Rubio an "even a bigger liar" than Cruz. He dubbed Dr. Ben Carson a pathological liar and said former Florida Governor Jeb Bush's lies were almost as bad as Cruz's. Trump has termed virtually every mildly adversarial media member a liar, too. Yet for the "2015 Lie of the Year Award", PolitiFact (a Pulitzer award-winning fact checking organization) recognized "the misstatements of Donald Trump" as the recipient of the award, "PolitiFact has been documenting Trump's statements on our Truth-O-Meter, where we've rated 76 percent of them 'Mostly False', 'False' or 'Pants on Fire', out of 77 statements checked. No other politician has as many statements rated so far down on the dial" (Holan & Qiu, 2015, p. 1).

The Wells Fargo retail banking scandal of 2016 is a second example of widespread lying. For years, Wells Fargo employees secretly issued credit cards without a customer's consent—an assumed consent lie. The employees created fake email accounts to sign up customers for online banking services. They set up sham accounts that customers learned about only after they started accumulating fees. In 2016 these illegal banking practices cost Wells Fargo $185 million in fines, including a $100 million penalty from the Consumer Financial Protection Bureau, the largest such penalty the agency has issued. Federal banking regulators said the practices, which date back to 2011, reflected serious flaws in the internal culture and oversight at Wells Fargo, one of the nation's largest banks. In September 2016 Wells Fargo fired at least 5300 employees who were involved but no senior managers. In all, Wells Fargo employees opened roughly 1.5 million bank accounts and applied for 565,000 credit cards that may not have been authorized by customers, the regulators said in a news conference (Corkery, 2016).

The present study conceptualizes four types of individuals based on their self-reported lying versus non-lying frequency and whether they view most others as being honest or dishonest. This study investigates whether individual social-economic status (SES) and prosocial and anti-social behaviors identify big-liars consistently. The study describes the "heavy-half" of self-reported big-liars—adopting the heavy-half proposition from prior marketing theory (Cook & Mindak, 1984; Perfetto & Woodside, 2009; Twedt, 1964), that is, half or the majority of lies are

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Charge injection in large area multilayer graphene by ambient Kelvin probe force microscopy

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ABSTRACT

This study demonstrated an in situ method for quantitative characterization of nanoscale electrostatic properties of as-grown multilayer-graphene (MLG) sheets on nickel by a combination of atomic force microscopy (AFM) and Kelvin probe force microscopy (KPFM). Large area epitaxial MLG sheet were grown on nickel by Hot Filament-Thermal chemical vapor deposition (CVD) technique. The high crystalline MLG sheets on nickel were confirmed by Raman spectroscopy that revealed average G-bandwidths in the range of $\sim$20 cm^{-1}. Herein, for the first time, the charge injection as well as subsequent charge diffusion over time on the MLG/nickel surface was demonstrated. The results unveiled that: (i) MLG surface can be either positively or negatively charged through injection process using Pt coated Si-based AFM probes; (ii) the charges accumulated and eventually reached to saturated concentrations of +4.45 ($\pm$0.1) μC/m^2 and $-$1.3 ($\pm$0.1) μC/m^2, respectively; (iii) the charge diffusion coefficients on graphene surface were measured to be 1.50 ($\pm$0.05) $\times$ 10^{-16} m^2/s and 0.64 ($\pm$0.05) $\times$ 10^{-16} m^2/s for the positive and the negative charges, respectively. The discovery of charge injection in MLG may pave the way for designing a new class of energy harvesting devices. Additionally, our study demonstrated a technique for nano-patterning/charge lithography of surface charges by contact electrification, which could be a promising application to create charged nanostructures for next generation graphene based nanoelectronic devices.

1. Introduction

From both scientific and technological point of view, charge injection on insulating films has been of great interest in the development of multiple devices including triboelectric nanogenerators for building self-powered portable electronics, large-scale energy harvesting, and also to develop data storage devices [1]. In particular, a charge injection combined with Kelvin probe force microscopy (KPFM) technique was reported to be a *state-of-the-art* tool to study the electrostatic properties of objects at the nanoscale level [2]. Determination of the interface in carbon nanotubes (CNTs) based devices or distinguishing the metallic and semiconducting nature of CNTs with the same diameters, silicon nanoparticles, and semiconducting quantum nanorods are the major examples of the application of KPFM technique. In addition, KPFM has also been used to study the different charge states of single metal atoms, molecules, atomic point defects, and imaging of the charge percolation pathways in two-dimensional quantum dot arrays [3]. Recently, KPFM was used for imaging the charge distribution in different complex systems such as semiconducting quantum dots, carbon nanotubes, graphene on SiO_2 substrates, organic molecules, and even bacterial protein filaments [4–16].

Besides the KPFM measurements, researchers have also performed nanolithography and manipulation of graphene by using AFM. For example, conductive atomic force microscopy [16] has been used to analyze the local current mapping and patterning of reduced graphene oxide. Sibel et al. used electrostatic force microscopy (EFM) technique for elucidating the charge transport property in reduced graphene oxide [17]. With the given highlighted measurement types it is possible to correlate the detailed morphology of graphene (e.g., wrinkles, multilayer regions, and local defects) with its nanoscale electrical characteristics, reading/writing charges on graphene, and local electronic behavior at graphene–metal interface.

In this particular direction, for the first time the present study demonstrated the charge injection (both positive and negative)

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Circumferential Temperature Analysis of One Sided Thermally Insulated Parabolic Trough Receiver Using Computational Fluid Dynamics

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Abstract. Low temperature industrial thermal applications like process heating involving solar thermal technology renders the usage of inexpensive air filled annuli receivers despite they are below par in thermal performance. This work is cantered around the air filled receiver system and more importantly try to assess both conventional and modified air filled annulus system using computational fluid dynamics (CFD) in terms of their performance parameters. For modification purpose, conventional receiver was fitted with thermal insulation in non-concentrating half section of receiver which is actually short of concentrated sun's radiation. Finally it was simulated for significantly reduced circumferential temperature distribution (CTD) around the absorber and was compared with conventional air filled annulus receiver. This comparison could be supposed to serve as a means of advancement for the development of small scale solar thermal based heat producing plants.

Keywords: Parabolic trough collectors · Air filled annulus receiver · Computational fluid dynamics

1 Introduction

Linear concentration technology has taken concentrated solar power (CSP) by storm: there is no definitive focusing point, rather a line. Serious development and evolution of this technology, in fact, came into existence when researchers analyzed step by step and wrap by wrap, the existing forefront point focusing technology and suddenly stumbled upon a common notion—why, point concentrate the heat, when it will be redistributed anyways, in line circuitry of the heat transfer fluid. Parabolic trough based concentrated solar thermal power plants, for the most part consists of parabolic trough solar fields, heat generation system or absorber/receiver system, power block powered with Rankine steam turbine and a temporary or optional power storage system.

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RESEARCH ARTICLE

Computational Modeling of Small Molecule Inhibitors of Mitochondrial Fusion

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Abstract: ***Background:*** Mitochondria are membrane bound structures found in most eukaryotic cells.The most prominent function of this essential organelle is the generation of ATP and the regulation of cell metabolism. However, being a vital part of the cell, mitochondrial dysfunction has been associated to many diseases due to its influence on cellular metabolism. A range of disorders and diseases have been reported as a result of damage and dysfunction in mitochondria which include cancer, diabetes mellitus and neurodegenerative diseases that affect millions of people worldwide. This has made mitochondrial processes an attractive and novel target for potential therapeutic intervention. The application of cheminformatics tools has made possible prioritization and in-depth understanding of small molecules with mitochondrial phenotypes at a much faster rate and reduced cost compared to traditional high-throughput screening.

Results: We have used a publicly available dataset of inhibitors of mitochondrial fusion to build accurate predictive cheminformatics models. We have used the machine learning based classification algorithms and further enhanced this approach using a maximum common substructure (MCS) approach. Three classification algorithms, namely Naive Bayes, Random forest and J48 were used in the present study. Random forest based model was found to be the most accurate, with an accuracy of about 80%. As a proof of application, themodel was further used to prioritize a subset of drug like molecules from a large chemical library, ZINC as well as used to annotate potential new mechanisms of action of molecules with anti-cancer activities.

Conclusions: We show that machine learning approaches could be effectively used to build highly accurate classification models for high-throughput screen datasets. We show as proof of concept that such models could be used to screen and prioritize large datasets in silico, for further experimental validation and also assign potential mechanism of action for molecules.

Keywords: Apoptosis, Mitochondria, Mitochondrial fusion, Mitofusins, Machine learning.

INTRODUCTION

Mitochondria are essential organelles in eukaryotic cells primarily associated with cellular energetics. Apart from the well-studied roles in the cellular energetics [1-3], mitochondria play intricate roles in apoptosis [4, 5], cell signaling [6] and metabolism of iron [7, 8]. The organelle comprises of a double membrane enclosing a circular genome of 16 kilobases and codes for 37 proteins [9, 10]. In addition, a number of proteins and transcripts encoded by the nuclear genome are imported into the mitochondria to maintain its integrity and function. A number of genetic disorders have been mapped to mitochondrial loci [10]. Recent evidence also suggests the intricate role of mitochondria in modulating the nuclear epigenome of the cell [11]. A number of complex diseases including cancers and Diabetes Mellitus have recently been associated with mitochondrial dysfunction [12, 13].

Mitochondria in the cell form a rather complex and interconnecting network, modulated through mitochondrial fusion and fission. Mitochondrial fusion has been extensively studied in the recent past and in mammalian cells it has been primarily understood to be modulated by a set of proteins known as mitofusins- Mfn1 and Mfn2 [14]. Inner membrane fusions are modulated by *Opa1* and *Mgm* genes. A number of human diseases are presently known to be modulated by genetic mutations in the proteins modulating mitochondrial fusion. One of the most well characterized examples of disorders of mitochondrial fusion is the Charcot-Marie-Tooth disease which affects the

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Design and Implementation of an Intrusion Detection System using MLP-NN for MANET

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Abstract: Communication in Mobile Ad hoc (MANETS) networks for end-to-end delivery of packets is achieved cooperatively. This model assumes that an intermediary node will always forward traffic originating from other nodes willingly, other than traffic emanating from the node itself. Conversely, in hostile environments where we find most applications of our ad hoc networks, an always cooperative and submissive behavior on behalf of the other nodes of the network cannot be presumed as the ultimate action undertaken by all the nodes. Our focus in this paper is on detecting the presence of malicious nodes that selectively or randomly drop packets intended for other destination nodes, we further classify each packet drop attack, according to its attack type by observing and analysing how each packet drop attack affect the network characteristics. Using a simulated MANET environment and MLP-NN modelling we can illustrate an Intrusion detection System that can successfully detect malicious packet dropping attacks with great accuracy.

Keywords: Intrusion Detection Systems, MANET, Multi-layer Perceptron, Artificial Intelligence, Network Security, Machine Learning.

1. Introduction

Mobile Ad hoc Network (MANET) is a collection of nodes which are mobile and self-organize themselves into a network, with no fixed topology. As such nodes can freely roam around, join or leave the network randomly [1]. MANETs can be established devoid of any infrastructure hence are becoming very useful, especially in environments that are geographically constrained for instance in next generation of battlefield applications envisioned by the military as well as in applications like disaster recovery and message exchanges in rescue missions [2]. Also, each node can function as a router, utilizing its multi hop routing facility [18]. This eliminates the need for a dedicated router or access point for communication between nodes. However, the MANET is vulnerable especially due to its continuously changing topology, open medium, lack of central monitoring point as well as no clear defensive mechanism. [5] For instance any un-trusted node is capable of joining the network, subsequently posing threats to it. This can be done either by dropping the packets or by providing wrong information to the network among other things.

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Development of a multipurpose beam foil spectroscopy set-up for the low cross-section measurements

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ABSTRACT

A multipurpose facility for low cross section measurements has been developed at Inter University Accelerator Centre, New Delhi, India. The facility consists of a multipurpose miniature chamber equipped with 1 m focal length normal incidence Monochromator and charge coupled device based detection system which has been aligned to realize the best resolution of the spectrometer. The chamber in this facility collects radiation 100 times more efficiently from the older system, without using any extra focusing mirror assembly. It is ensured to have the provision of mounting an X-ray detector and the spectrometer transverse to the beam direction simultaneously in the same chamber. The atomic spectroscopic studies can be performed by interaction of ions beams with both thin foil and gas targets. Provision for using photomultiplier tube instead of charge coupled device, is employed in the system depending on the condition of the source strength or other detection issues. We observed the essence of a very weak atomic phenomenon, a triply excited autoionizing forbidden transition, using the above facility to demonstrate its capability for measuring such low cross section phenomena. The present developed facility covers a large spectroscopic region from X-rays to the near infrared (0.1–10,000 Å).

1. Introduction

Beam-foil spectroscopy (BFS) is popularly known for its potential in producing highly stripped ions and excited states [1] including various ionic states up to H-like ions with one or multi electrons in Rydberg [2,3] or continuum states [4]. Therefore it produces enormous atomic and nuclear data which should be interpreted for understanding the weak transitions rarely measured by other spectroscopic techniques [5–9]. With the development of much faster heavier beams, ion-atom collision spectroscopy proves to be a milestone in confirming the theoretical transition energies, oscillator strengths and other parameters calculated by various theoretical models or spectroscopic codes [10,11]. After many decades of beam-foil spectroscopy many gaps still exist in the identification of many transitions that are not yet observed or difficult to observe. However, they have been predicted theoretically or observed in systems other than beam-foil [12–16], whereas some others have been claimed to be observed indirectly from delayed observation of X-rays [15,16].

To observe such low cross section transitions and all the components of any cascade at the same time we have developed a multipurpose facility that covers the spectroscopic region from intense X-rays to Near infrared (0.1–10,000 Å). While the old set-up was able to be used with a beam-foil set-up only; the new system can be used for the study of beam-foil, beam-gas and plasma spectroscopy. The collection efficiency is also enhanced by 100 times from our previous setup. The grating spectrometers are very sensitive to minute vibrations therefore optical alignment of a spectrometer is the most challenging task during the development of the complete BFS set-up. So, the detailed optical alignment of spectrometer is discussed to put more emphasis and understanding on it and its related configurations.

2. Instrumentation: implementation and function

2.1. Limitations of the existing setup

The existing setup at the Inter University Accelerator Centre (IUAC), New Delhi, India can only be used with beam foil spectroscopy covering the X-ray regime from 1 keV onwards. On the other hand the 300 mm diameter size of the chamber, although

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Development of an innovative polygeneration process in hybrid solar-biomass system for combined power, cooling and desalination

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Abstract:

In the polygeneration process simultaneous production of power, vapor absorption refrigeration (VAR) cooling and multi-effect humidification and dehumidification (MEHD) desalination system from different heat sources in hybrid solar-biomass (HSB) system with higher energy efficiency take place. It is one of the solutions to fulfill energy requirements from renewable sources and also helps in the reduction of carbon dioxide emissions. The VAR cooling system operates using the extracted heat taken from turbine and condenser heat of the VAR cooling system is used in desalination system for production of drinking water as per demand requirement. Though the production of electricity decreases due to extraction of heat from turbine for VAR cooling and desalination, the complete system meets the energy requirements & increases the primary energy savings (PES). The thermodynamic evaluation and optimization of HSB system in polygeneration process for combined power, cooling and desalination is investigated to identify the effects of various operating parameters. Primary energy savings (PES) of polygeneration process in HSB system is achieved to 50.5%. The energy output is increased to 78.12% from this system as compared to simple power plant.

Key Words: Polygeneration, hybrid solar-biomass, energy, exergy, primary energy savings

1. Introduction

The energy demand for cooling and process heat/desalination applications are increasing continuously due to increase in the electricity requirements for industries, office campuses, institutions. Globally, in industrial sector about two-thirds of total consumption of energy is used

Development of surface functionalized ZnO-doped $LiFePO_4$/C composites as alternative cathode material for lithium ion batteries

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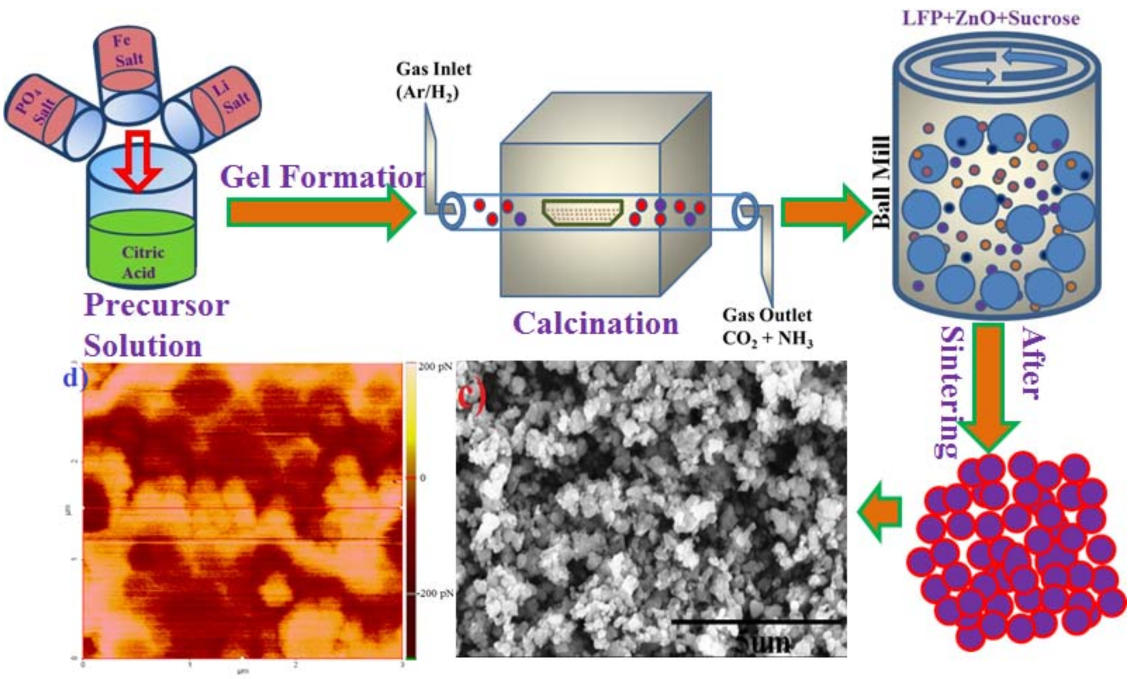
Graphical Abstract:



Highlights

- Pristine $LiFePO_4$ and ZnO/C- hybrid coated $LiFePO_4$ samples has been synthesized using sol-gel assisted ball milling route.

- Effect of ZnO/C-hybrid coating on the $LiFePO_4$ has been studied thoroughly.
- Electronic conductivity of pristine $LiFePO_4$ increases to 10^2-10^3 orders of magnitude for ZnO/C- coated samples.
- AFM results indicate the presence of more volumetric charge density at the surface for ZnO/C-coated $LiFePO_4$ sample.
- LFPZ2.5 shows best cycling and rate performances among all the prepared samples.
- Lithium ion diffusion coefficient increases significantly.

ABSTRACT

Surface modified olivine-type $LiFePO_4$/C-ZnO doped samples were synthesized using sol-gel assisted ball-milling route. In this work, the influence of ZnO-doping on the physiochemical, electrochemical and surface properties such as charge separation at solid-liquid interphase, surface force gradient, surface/ionic conductivity of pristine $LiFePO_4$/C (LFP) has been investigated thoroughly. Synthesized samples were characterized using X-ray diffraction, scanning electron microscopy, atomic force microscopy, and transmission electron microscopy. All the synthesized samples were indexed to the orthorhombic phase with *Pnma* space group. Pristine $LiFePO_4$ retain its structure for–higher ZnO concentrations (i.e. 2.5 and 5.0 wt.% of LFP). Surface topography and surface force gradient measurements by EFM revealed that the kinetics of charge carriers, e^-/Li^+ is more in ZnO-doped LFP samples, which may be attributed to diffusion or conduction process of the charges present at the surface. Among all the synthesized samples LFP/C with 2.5 wt.% of ZnO (LFPZ2.5) displays the highest discharge capacity at all C-rates and exhibit excellent rate performance. LFPZ2.5 delivers a specific discharge capacity of 164 (±3) $mAhg^{-1}$ at 0.1C rate. LFPZ2.5 shows best cycling performance as it provides a discharge capacity of 135 (±3) $mAhg^{-1}$ at 1C rate and shows almost 95 % capacity retention after 50 charge/discharge cycles. Energy density plot shows that LFPZ2.5 offers high energy and power density measured at high discharge rates (5C), proving its usability for hybrid vehicles application.

Keywords: Olivine-cathode; ZnO-doping; Charge separation; Surface force gradient; Ragone Plot.

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Dextrose modified flexible tasar and muga fibroin films for wound healing applications

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This paper is focused on preparation and characterization of regenerated muga and tasar fibroin flexible films from cocoon using ionic liquid. These flexible muga and tasar fibroin films were prepared by incorporating dextrose (5 to 15% *w*/w) as plasticizer. The mechanical, thermal, physical, morphological and biological properties of dextrose plasticized muga and tasar fibroin films were characterized. These plasticized films showed higher elongation at break as well as water holding capacity as compared to the un-plasticized films. The surface roughness and water absorbance capacity of the dextrose plasticized films were higher than un-plasticized films, which results in improved adherence and proliferation of L929 fibroblast cells. Gentamicin loaded plasticized muga and tasar fibroin films showed slightly higher rate of release as compared to un-plasticized films. The biodegradability of dextrose plasticized films was significantly higher as compared to their respective counterpart. The regeneration of flexible muga and tasar silk fibroin films pave the way to expand potential use of non-mulberry in the field of biomedical such as wound dressing.

1. Introduction

Non-mulberry silk fibroin such as muga (*Antheraea assama*) and tasar (*Antheraea mylitta*) are produced from organism belonging to class saturniidae of the order Lepidoptera [1–2]. Tasar and muga fibroin have been engineered in the form of films [1], nanofibers [3], cryogels [4], aerogels [5], freeze dried scaffolds [6] and have shown promising materials in the field of tissue engineering due to their excellent biocompatibility, controlled biodegradability and higher mechanical property. It is reported that non-mulberry fibroin proteins contain tripeptide Arg(R)–Gly(G)–Asp(D) (AY136274), which is responsible for adherence of cells [1,7].

Recently, various researchers have utilized muga fibroin gland protein to prepare the films, nanofibers, cryogel and 3D scaffolds for tissue engineering and biomedical applications [8–11]. Dutta et al. [8] prepared 2D muga silk fibroin film and characterized their physicochemical properties. Kasoju et al. [9] prepared muga fibroin based micro-nano fibrous nonwoven scaffolds. These micro-nano architecture based porous scaffolds are highly biocompatible and non-hemolytic. Kar et al. [10] have found that muga silk fibroin protein extracted from gland of silkworm is more compatible than mulberry fibroin. Highly porous muga fibroin based cryogels are able to absorb large amount of water, withstand high mechanical stress without deformation and showed very good viability of human hepatocarcinoma cells [4].

Tasar silk fibroin obtained from silkworm gland have been successfully utilized for cornea [12], cardiac [13], skin [1,14] and cartilage [15] tissue engineering. Mandal et al. [6] have regenerated tasar silk fibroin in the form of highly porous 3D scaffold by using freeze drying technique. They reported that freeze dried 3D scaffolds are highly biocompatible and showed good biodegradability over the time. Andiappan et al. [16] have prepared electrospun eri and tasar silk fibroin blend mats for biomedical application and found that these electrospun mats showed good biocompatibility and hemocompatibility. Hydroxyapatite coated eri-tasar silk fibroin nanofibrous mats showed good physiological characteristics [17].

Although a good amount of work have been carried out on the muga and tasar silk fibroin protein extracted from silkworm gland, but only little work has been carried out on the muga & tasar silk fibroin extracted from cocoon due to its insolubility in most of the catastrophic solvents [11–12]. Recently, it is reported that muga and tasar cocoon fibroins can be dissolved in ionic liquids and be regenerated in the form of films using alcohol as coagulating agent [11,12,18]. These regenerated fibroin films are highly brittle in nature so it becomes unsuitable for wound dressing & regenerative medicine [19]. It is also observed that mechanical properties of different non-mulberry silk fibroin proteins regenerated from the cocoon have not been reported, which is very important for a material to be used as wound dressing. In our previous research, we have successfully regenerated cocoon extracted

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Differentially expressed galactinol synthase(s) in chickpea are implicated in seed vigor and longevity by limiting the age induced ROS accumulation

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Galactinol synthase (GolS) catalyzes the first and rate limiting step of Raffinose Family Oligosaccharide (RFO) biosynthetic pathway, which is a highly specialized metabolic event in plants. Increased accumulation of galactinol and RFOs in seeds have been reported in few plant species, however their precise role in seed vigor and longevity remain elusive. In present study, we have shown that galactinol synthase activity as well as galactinol and raffinose content progressively increase as seed development proceeds and become highly abundant in pod and mature dry seeds, which gradually decline as seed germination progresses in chickpea (*Cicer arietinum*). Furthermore, artificial aging also stimulates galactinol synthase activity and consequent galactinol and raffinose accumulation in seed. Molecular analysis revealed that GolS in chickpea are encoded by two divergent genes (*CaGolS1* and *CaGolS2*) which potentially encode five CaGolS isoforms through alternative splicing. Biochemical analysis showed that only two isoforms (CaGolS1 and CaGolS2) are biochemically active with similar yet distinct biochemical properties. CaGolS1 and *CaGolS2* are differentially regulated in different organs, during seed development and germination however exhibit similar subcellular localization. Furthermore, seed-specific overexpression of *CaGolS1* and *CaGolS2* in *Arabidopsis* results improved seed vigor and longevity through limiting the age induced excess ROS and consequent lipid peroxidation.

Synthesis of Raffinose Family of Oligosaccharides (RFOs) is a highly specialized metabolic event in higher plants where galactinol synthase (GolS; EC: 2.4.1.123) catalyzes the key step in RFO biosynthesis. These RFOs participate in many physiological processes like translocation of photoassimilates, abiotic stress tolerance, seed desiccation tolerance etc.[1–4]. Apart from these functions, RFOs were recently shown to act as signaling molecules upon pathogen attack and wounding[5–8]. RFOs are generally non-structural, non-reducing but soluble oligosaccharides present at high concentrations within the cell. The RFO biosynthetic pathway is initiated by the synthesis of galactinol (1-O-α-D-galactopyranosyl-L *myo*-inositol) which subsequently serves as a galactosyl donor and provides galactose moieties to the sucrose for the synthesis of raffinose. Further sequential addition of galactosyl group to the chain leads to the generation of series of RFOs like stachyose, verbascose and ajugose[9,10]. Galactinol is synthesized from UDP galactose and *myo*-inositol by the action of GolS which is considered as the key regulatory enzyme of this pathway[11]. GolS is a member of glycosyltransferase 8 (GT8) family and is usually encoded by a small gene family in higher plants. In *Arabidopsis*, GolS enzymes are encoded by a family of seven distinct genes which are spatially and developmentally regulated[2]. Studies have also shown that disruption of *AtGolS1* gene resulted in a decrease in galactinol and raffinose content after heat stress[12]. *Arabidopsis* plants overexpressing *AtGolS2* exhibited improved tolerance to drought stress[2]. Differential transcriptional regulation of the members of the galactinol synthase gene family was also observed in several other plant species. An increase in the production of galactinol and RFOs, as a consequence of coordinated transcriptional induction of the *GolS* coding genes in response to various abiotic stresses has been reported in several plant species[13–17]. In addition, *ZmGolS2* was

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Dy^{3+} ions doped single and mixed alkali fluoro tungsten tellurite glasses for LASER and white LED applications

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Quantum efficiency

ABSTRACT

A new-fangled series of Dy^{3+} ions doped Single and Mixed Alkali Fluoro Tungsten Tellurite Glasses have been prepared by using melt quenching technique and their spectroscopic behaviour was investigated by using XRD, optical absorption, photoluminescence and lifetime measurements. The bonding parameter studies reveal the ionic nature of the Dy–O bond in the present glasses. From the absorption spectra, the Judd-Ofelt (J-O) intensity parameters have been determined and in turn used to determine various radiative properties for the different emission transitions from the $^4F_{9/2}$ fluorescent level. The photoluminescence spectra of all the glasses exhibit two intensified peaks in blue and yellow regions corresponding to the transitions $^4F_{9/2} \rightarrow {}^6H_{15/2}$ (483 nm) and $^4F_{9/2} \rightarrow {}^6H_{13/2}$ (575 nm) respectively. From the photoluminescence spectra, it is observed that the luminescence intensity is maximum for Dy^{3+} ion doped potassium combination of tungsten tellurite glass (TeWK:1Dy). The highest emission cross-section and branching ratio values observed for the $^4F_{9/2} \rightarrow {}^6H_{15/2}$ and $^4F_{9/2} \rightarrow {}^6H_{13/2}$ transitions suggest the possible laser action in the visible region from these glasses. By correlating the experimental lifetimes (τ_{exp}) measured from the decay spectral features with radiative lifetimes (τ_R), the quantum efficiencies (η) for all the glasses have been evaluated and found to be maximum for potassium combination tungsten tellurite (TeWK:1Dy) glass. The CIE colour chromaticity coordinates (x, y), (u, v), colour correlated temperature (CCT) and Y/B ratio were also estimated from the photoluminescence spectra for different compositions of glasses. The chromaticity colour coordinates evaluated for all the glasses fall within the white light region and white light emission can be tuned by varying the composition of the glass. From all these studies, it was concluded that 1 mol% of Dy^{3+} ions doped TeWK glass is more suitable for lasing and white-LED applications.

1. Introduction

Rare earth ions doped glasses are exhibiting applications in diversified fields of science and technology such as bulk lasers, optical fiber amplifiers and waveguide lasers. In recent times, the applications possessed by rare earth doped glasses are not only confined to infrared optical devices, but also spread in the area of visible optical devices, especially for white light emitting diode (w-LED) applications such as indicators, back light, automobile headlights and general illumination [1]. In the current research, white light emitting diodes (w-LEDs) which are also known as next generation of solid state lighting (SSL) technology has become very popular because of their potential applications in diversified fields [2]. The wide spread of SSL is of great importance to reduce significantly the global electricity consumption and the usage of fossil fuels [3]. The w-LEDs have several superior features such as high luminous efficiency, long operation lifetime reliability, safety and environmental friendly characteristics when compared with other conventional sources such as incandescent and fluorescent lights [4]. Currently, these w-LEDs are made up of by the combination of blue light emitting diode (LED) (GaN-blue chip) chip with yellow phosphor (yellow YAG: Ce^{3+} phosphor) [5]. In this method,

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Economic assessment of use of pond ash in pavements

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ABSTRACT
The paper introduces a new type of industrial waste-based subbase material which can replace conventional subbase material (CSM) in pavement construction. Utilisation of this industrial waste, namely pond coal ash produced from a thermal power plant in road construction will help to reduce the disposal problem of this waste and also will help to reduce the problem of scarcity of CSM. Lime and fibre were also added to the pond ash at various percentages to improve the suitability of this type of mix as subbase material. The optimum service life of pavement is studied with the help of numerical modelling and the cost benefit is also presented in the current study. The study reveals that stabilisation of the coal ash with 2% lime may produce an optimal material and, even though a greater thickness may be required to deliver the same pavement performance, direct cost savings of around 10% may be achieved in addition to less easily quantifiable environmental benefits. Design charts are provided to exploit the findings.

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KEYWORDS
Pond ash; geotechnical characterisation; numerical analysis; economic assessment

1. Introduction

One of the major challenges facing the manufacturing and processing industries is the disposal of residual waste products. Ash, resulting from the combustion of coal to produce electricity, is a readily available by-product – particularly in India, the focus of this paper. As this availability is becoming more appreciated, demand for economic pavement construction materials, that impose a low environmental impact, is rapidly growing. Therefore, ash is considered in this paper as an alternative subbase material. Though a powdered material, but, due to its pozzolanic properties and when stabilised with cement, it might be made to meet the requirements of cement bound subbase material. Alternatively, lime could be used instead of cement, to give comparable long-term strengths (Sherwood 1995) albeit less rapidly developed (Atkinson *et al*. 1999). Fibre reinforcement is another possible improvement strategy (Kumar and Singh 2008).

Thus, the aim of this paper is to provide means of reliably incorporating ash, as found in disposal ponds at Indian power stations, into viable layers of pavement construction. The paper draws on laboratory test data reported earlier, using this data to numerically compute likely *in situ* behaviour. The aim is ultimately achieved by the production of design charts to guide users to the appropriate material and thickness of pavement layer incorporating that material and by providing an illustrative cost comparison.

2. Pavement layer practice and materials used

In India, in practice, flexible pavements are considered to act as a three-layer structure – subgrade, unbound (so-called) and bound layer. The lowest part of the unbound layers, which is just above the subgrade layer, is commonly known as the subbase layer of the pavement. The higher 'unbound' layer usually comprises a water bound macadam (WBM) or a wet mix macadam that forms the pavement base layer. While no cementing agent is added, compaction and water combine to provide a material held together by physical interlock and suction. It lies just above the subbase layer. The bound layer is usually divided into two parts, viz. the dense bituminous macadam (DBM) that lies above WBM and the top layer, known as bituminous concrete (BC) or wearing course. The subgrade layer is made up of locally available soil. The subbase layer is typically formed of unbound granular materials viz. natural sand, moorum, gravel and or crushed stone based on a combination of availability, economic factors and previous experience. The commonly used materials for the WBM layer are crushed, graded aggregate and granular material, and premixed with water. Crushed stone is also used as coarse aggregate. A DBM is a binder course in which bitumen binds together with a mixture of coarse and fine aggregate. The top bituminous layer (BC) comes directly into contact with the vehicle tyres. It consists of a mixture of aggregates and sufficient bitumen so that it provides an impermeable barrier to water percolation (Chakroborty and Das 2003).

3. Environmental considerations when using conventional materials

The most common materials that are used in road construction are bitumen, aggregate, crushed rock, sand and gravel.

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Electronic Properties and Migration Pathways of Cl Functionalized Zigzag Graphene Nanoribbons

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Abstract. We have investigated the electronic properties of pristine and Cl functionalized zigzag graphene nanoribbons (ZGNR) by employing density functional theory (DFT) based calculations. The migration pathways of Cl adatom adsorption on Cl functionalized ZGNR are also discussed. It is revealed that Cl functionalization results in additional electronic states across the Fermi level which enhances the metallic character of ZGNR. Interestingly, it is predicted that migration of Cl adatom on ZGNR network is most likely to take place along the ribbon edges whereas migration across the ribbon width is found least energetically favorable.

Keywords: Graphene, nanoribbons, halogen, adsorption.
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INTRODUCTION

Being first layered material and exhibiting unique chemical bonding of C, graphene is still dominating other 2-D materials [1]. However, some inorganic layered materials have also been explored [2, 3], but none of them could attract enough attention similar to graphene. Various techniques of synthesizing graphene [4] and the existence of sophisticated characterization have ignited the research to explore its potential for organic electronic application. Efforts have been made to use deliberate addition of impurities and various defects to tailor their properties [5, 6]. Previously, transition metal impurities were investigated in zigzag GNR (ZGNR) as well as in armchair GNR (AGNR) which predicted enhanced metallicity in GNR [7, 8]. Mao *et al.,* studied the adsorption of K on GNR [9]. It is worth to notice that most of the studies till date are devoted to ZGNR (passivated with H) due to their magnetic ground state. On the other hand, investigations on the functionalization with other elements are still limited. Halogens exhibit larger electro-negativity than that of H and are expected to form stable bonds with C. Therefore it would be interesting to study the functionalization of ZGNR with halogens. In the present work we have investigated functionalization of ZGNR with halogen taking Cl as a typical representative. Further, the migration pathways of Cl adatom adsorption are also discussed in Cl passivated edges of the ribbons.

METHODOLOGY

Density functional theory (DFT) based ab-initio approach has implemented to investigate the functionalization of AGNR via Cl adatoms using ATK-VNL package. We considered ZGNR having with N_Z= 4 and 6 to consider the width effects. The schematic of defining the nanoribbon width is depicted in Fig. 1. Supercell models, having periodicity along Z axis and confined in X and Y directions, were employed in the present study. The energy mesh cut off value equal to 70 Rydberg and k-point sampling of $1\times1\times50$ was considered for the optimization of the structures. To calculate the electronic band structures and density of state (DOS) profiles, a dense grid of $1\times1\times100$ was utilized. The exchange and correlation was accounted with the help of generalized gradient approximation (GGA) in the Perdew-Burke-Ernzerhof (PBE) form [10].

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Wireless Pers Commun
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Energy Efficient Probabilistic Clustering Technique for Data Aggregation in Wireless Sensor Network

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Abstract Economic utilization of energy in wireless sensor network, composed of tiny battery powered sensor nodes constrained in energy and computation power is a critical issue. Clustering techniques are most often used to reduce the consumption of energy by the sensor nodes due to data transmission. A widely used class of clustering techniques is probabilistic clustering in which a predetermined optimal probability is used to facilitate the cluster head selection process. This paper aims to devise a technique that improves the energy efficiency of probabilistic clustering algorithms by optimizing the number of clusters and the distribution of cluster heads in the network. We also present two generic approaches to integrate proposed technique into the existing probabilistic clustering algorithms. The simulation results show a considerable improvement in energy efficiency of probabilistic clustering protocols and consequently a prolonged network life time.

Keywords Clustering · Data aggregation · Probabilistic · Sensor network · Energy efficiency · Epoch

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Engendering color tunable emission in calcium silicate based phosphors *via* ageing of silicate source

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ABSTRACT

In this work, an artificially tunable luminescence emitting Ca_2SiO_4 based Eu^{2+} ions doped phosphor was successfully developed using differently aged propylene glycol modified silane (PGMS) as the silica source. The powder XRD patterns of all the prepared samples confirm the presence of three different crystal phases namely α_L', β & γ, which afford for the variable site accommodation of Eu^{2+} dopant in the host. Prototype phosphor converted LEDs (pc-LEDs) have also been fabricated using all the prepared phosphors. Photoluminescent and electroluminescent properties were investigated for the synthesized phosphors and prototype pc-LEDs, respectively. Colorimetric properties such as CIE coordinates, CCT and CRI values calculated to compare the effects of differently aged PGMS on the Eu^{2+} doped Ca_2SiO_4 phosphor, which confirmed the ability to produce color tuning with ageing of silicate source. The results indicate that these phosphors are potential candidates to use in solid state lighting applications.

1. Introduction

In recent years, there is a growing importance in generating energy saving and environmental friendly white light emitting sources, which emit light with less power consumption and without releasing any harmful gases [1–5]. Among those sources, the fabricating phosphor converted warm white LED that closely mimics the light spectrum of the sun received much more attention due to its low cost, ease of preparation and high energy efficiency [6–10]. Normally, the method of tuning emission wavelength or emissive color of light can be obtained by altering the phosphors. This alteration is possible within the phosphor by changing the host lattice, synthetic approaches, the dopant and its concentration as well [11–14]. The structural and luminescence properties of few rare earth ions activated alkaline earth orthosilicate M_2SiO_4 ($M:Ca^{2+}/Sr^{2+}/Ba^{2+}$) phosphors have been investigated and reported elsewhere [3,15–19]. Especially, there are various emission colors reported for Eu^{2+} or Ce^{3+} doped Ca_2SiO_4 phosphors by changing the concertation or synthesizing different methods. This colour variation is mainly possible due to the existence of several crystal phases namely blue emitting β-Ca_2SiO_4:Ce^{3+}, yellow emitting γ-Ca_2SiO_4:Ce^{3+}, green emitting β-Ca_2SiO_4:Eu^{2+} and red emitting α_L'-Ca_2SiO_4:Eu^{2+}. Our previous studies reported the tunable emission from the single host by changing the concentration of dopant or using crystal phase stabilizers [20]. There are also few studies that show the tunable emission from a single host by introducing co-dopants where the tunable emission is possible by altering the dopant/co-dopant ratio across the single host [21,22]. However, the unique attempt has been successfully implemented for the first time in this paper to synthesize a single host phosphor to obtain an emission color tunability by ageing of silicate source (PGMS) to alter the crystal site engineering.

In this study, we report a novel method to achieve the artificial tunable emission from a single host using PGMS as a silicate source *via* sol-gel technique. As a new input, the differently aged PGMS was employed to synthesize Ca_2SiO_4:Eu^{2+} phosphors. The silicate source PGMS was prepared and divided into four parts in which the first part was utilized on the day of preparation to make phosphor. The other parts were utilized in the consecutive days 2–4 to syn-

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Engendering color tunable emission in calcium silicate based phosphors *via* ageing of silicate source

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1. Introduction

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In this study, we report a novel method to achieve the artificial tunable emission from a single host using PGMS as a silicate source *via* sol-gel technique. As a new input, the differently aged PGMS was employed to synthesize Ca_2SiO_4:Eu^{2+} phosphors. The silicate source PGMS was prepared and divided into four parts in which the first part was utilized on the day of preparation to make phosphor. The other parts were utilized in the consecutive days 2–4 to syn-

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ORIGINAL PAPER

Experimental Investigations of Performance and Emissions Characteristics of Kusum (*Schleichera Oleosa*) Biodiesel in a Multi-Cylinder Transportation Diesel Engine

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Abstract In the present work, an underutilized and promising feedstock, Kusum seed oil (KSO) is converted into biodiesel through transesterification process. The physico-chemical properties of Kusum biodiesel (Kusum oilmethyl ester; KOME), measured via standard methods, were well within the ASTM D6751/EN14214 standard limits. After that, experiments were conducted using various blends (B5, B10, B15, and B20) of methyl ester of KSO with diesel in a multi cylinder diesel engine at varying engine speeds, ranging from 1000 to 4000 rpm under full load conditions. Engine performance (brake power, brake specific fuel consumption, brake specific energy consumption and brake thermal efficiency) and emissions (CO, HC, NO_x and smoke opacity) were measured to analyse the behavior of the diesel engine running on biodiesel. The test results showed that with the increase of biodiesel in the blends CO, HC and smoke opacity reduces significantly while fuel consumption and NO_x emission of biodiesel increases slightly compared with diesel. Brake specific energy consumption decreases and thermal efficiency of engine slightly increases when operating on 10 % biodiesel than that operating on diesel. It may be concluded from the experimental investigations that Kusum biodiesel is a potential alternative to diesel fuel.

Keywords Multi cylinder diesel engine · Kusum oil biodiesel(KOME) · Performance and emissions

Abbreviations

KOME	Kusum oil methyl ester
B100	Neat biodiesel
B0	Neat diesel
B05	Blend of 05 % KOME and 95 % diesel
B10	Blend of 10 % KOME and 90 % diesel
B15	Blend of 15 % KOME and 85 % diesel
B20	Blend of 20 % KOME and 80 % diesel
CO	Carbon monoxide
UHC	Unburnt hydrocarbons
NO_x	Oxides of nitrogen
BTE	Brake thermal efficiency
BSFC	Brake specific fuel consumption
BSEC	Brake specific Energy consumption
Ppm	Parts per million
cSt	Centi-Stoke
kWh	Kilo-watt-hour
RPM	Rotations per minute

Introduction

The petroleum reserves are diminishing day by day. There has been an increase in effort to reduce the dependence on petroleum fuel for energy generation and transportation and attention is being focussed on alternate fuel. Biodiesel

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Exploration of phytochemicals found in *Terminalia* sp. and their antiretroviral activities

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Abstract

The human immunodeficiency virus (HIV) infects cells of the immune system and destroys their function. Approximately, 2 million people die every year from HIV as reported by the World Health Organization. HIV/AIDS is difficult to treat as the virus continuously develops resistance to drugs being developed. Approach is now turning toward natural products for the development of anti-HIV drugs. Although HIV/AIDS is not a new disease, but research based on plant-derived products is still under clinical trials. Experimentally, it has been proven that plants have the potential for HIV treatment. The process involves identification of the active ingredients responsible for the reported anti-HIV activities, testing of the extract, and development of appropriate bioassays. Further development would require optimization of the formulation and manufacturing in compliance with preclinical safety and efficacy testing. The most challenging task for the natural product scientists is to separate these highly complex extracts containing several compounds into its individual components that are biologically active. Recently developed direct binding assay with mass spectrometry (MS) technology (viz., real-time time-of-flight-MS) is helpful in this respect but needs extensive optimization. At present, we have compiled all the information for the various phytochemicals present in Terminalia catappa having anti-HIV properties. These include tannins, gallotannins, ellagitannins, cyanidin, and flavonoids. Further, we have also discussed their pharmacological as well as pharmacokinetics studies.

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Full Text

Introduction

Plants are the important source of several medicines for various incurable deadly diseases as known from literature (several thousand years old). Natural products obtained from the plants are known to be potential source for pharmaceutical applications. It has been found that about 80% of world population still believes in traditional medicine as compared to modern days' drugs therapy (WHO). Generally, a number of current drugs either mimic the naturally occurring molecules or have structures that are fully or in part derived from natural moieties.[1] From ancient times to modern research, plants have made important contribution to the field of science due to their large number of medicinal properties. The scientific reports on the family of Combretaceae concluded that this family is very rich in secondary metabolites. These metabolites have significant physiological as well as pharmacological effects (www.wikigenes.org/e/mesh/e/20357.html).[2],[3] This family has attracted keen attention due to its potential medicinal applications in diseases such as cancer, diabetes, cardiac arrest, hepatocarcinoma, human immunodeficiency virus (HIV), and hepatitis. Thus, they have solution toward various incurable diseases. Terminalia catappa is an important member of this family, which is also known as Indian Almond, Malabar Almond, and Tropical Almond. The leaves from Terminalia catappa contains various phytochemicals known for curing rheumatic joint pain, leprosy and skin diseases. Further, bark extract from the same plant is diuretic as well as cardiotonic.[4],[5] The extract of T. catappa leaves inhibits Lewis lung carcinoma cells that contribute to lung cancer.[6] Ethanolic extract of T. catappa leaves has been shown to protect against acute liver injury produced by some hepatotoxicants.[7] It has been found that T. catappa inhibits the occurrence of preneoplastic lesions in rat colon carcinogenesis.[8] It has been demonstrated that hydrolysable ellagitannins and other tannin-related compounds from leaves and bark of T. catappa have shown to inhibit HIV replication in infected H9 lymphocytes with little cytotoxicity.[9],[10],[11]

Antiretroviral drug therapy has been very useful in drastic reduction of morbidity and mortality associated with HIV infection. Further, the use of combination drug therapies has significantly improved HIV patients' chances for long-term survival. Unfortunately, the effectiveness of antiretroviral therapy has been markedly reduced by the emergence of drug resistance. It has been reported recently that ~76% of world population exhibited resistance to single or multiple antiretroviral drugs (www.who.int/drugresistance/hivaids/en/).[12],[13] The presence of antiretroviral drug resistance is an important cause of treatment failure in HIV patients. There are multiple classes of synthetic antiretroviral drugs present in the market. These drugs are not been so successful as predicted due to emergence of drug-resistant virus which has complicated the HIV/AIDS therapy. Therefore, it requires intensive studies on the mechanism of drug resistance to come out with suitable solutions towards the disease. Lots of efforts are being made to discover new agents and classes, particularly from natural source to find solution with emerging HIV drug resistance.[14],[15],[16] The search for safe and effective therapies to treat infections caused by the HIV and related opportunistic infections is among the highest priorities of the National Institutes of Health. NIAID, NIH has provided the chemical structures of all the anti-retroviral drugs known till date and their efficacies. It would be helpful for researchers for background information related to role of various functional groups for developing effective anti-retroviral drug with no side effects. Information on compounds evaluated preclinically for HIV and the opportunistic infections is acquired by continuous surveillance of primary literature sources (UNAIDS: Joint United Nations Programme on HIV/AIDS).

This review will focus on the various phytochemicals present in T. catappa having potential anti-HIV activity and their pharmacokinetics studies. The overview of the present review is shown in [Figure 1]. These analyses would assist investigators to elucidate what has been done with each phytochemical and their exploitation in HIV-therapeutics.{Figure 1}

Morphological Description and Scientific Classification (Www.cabi.org/isc/datasheet/53143)

Exploratory Test Oracle using Multi-Layer Perceptron Neural Network

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***Abstract*—In the context of exploratory testing (ET), human knowledge and intelligence is applied as a test oracle. The exploratory tester designs and executes the tests on fly and compares the actual output produced by the application under test with the expected output in the testers' mind. The shortcoming of human oracle is that they are fallible, that is exploratory testers do not always detect a failure even when a test case reveals it. Depending on a human tester to evaluate program behaviour has also some problems such as cost and correctness. Therefore, in this paper an effort has been made to explore the feasibility of using a multilayer perceptron neural network (MLP-NN) as an exploratory test oracle. The MLP-NN was improved by adding another weight on each connection to perfectly generate reliable exploratory test oracles for transformed different data formats.**

***Keywords:* Test Oracle, Software Testing, Multilayer Perceptron Neural Network, Software under Test.**

I. INTRODUCTION

Software testing has always been a crucial phase in the software development life cycle. The previous studies has witnessed many software projects failures that result from lack of proper testing. Software that has been improperly tested can easily break a company's reputation. A better relationship between testing and requirements would finally result in enhanced tests and better-quality software [1]. Consequently, test methods were established to mitigate this limitation [2].

When the flow of requirements is parallel to the development phase, the systematic test case based approach is considered difficult to use owing to the constant requirement change while designing tests [3]. Hence, an approach such as ET can be worthwhile for such environments, where the requirements elicitation has not been completed early in the software development process.

ET is a software testing approach, at times called ad-hoc testing [4] which is not dependent on test cases documentation prior to execution. Today, most researchers defined ET as an activity where a tester learns, design and execute the tests simultaneously [4]. To summarize, this means the tester is discovering the application, studying its functions and running tests based on his/her knowledge. There is no logical method followed as in scripted testing that guides the tester the test steps to run the tests. The tester himself controls the test designs while running and studying the application under test. This supports designing effective test cases while exploring unrealized parts of the software.

In modern days, this approach has gained attention and reputation particularly among professional software testers [5]. The ET term was initially coined by Bach and Kaner in 1983 and it was adopted by many professional testers [6]. ET is used in combination with other testing techniques in industry [6] which includes, Risk Based Testing, Cross functional testing, Requirements based testing, Pair wise testing, Acceptance testing, Checklist based testing, Scripted Testing, Usability Testing, Security Testing and Boundary Value Analysis.

Exploring means focused wandering, navigating through a space with a general assignment, but without a pre-defined route. Exploration encompasses on going studying and execution of tests [7].

In the context of ET, human knowledge and intelligence is applied as a test oracle. A test oracle is defined as a technique used to differentiate an accurate result from an inaccurate result during testing [8]. The challenge of finding a reliable oracle is referred to as "the oracle problem."

In practice, the identification of failures is left to be decided by a human tester [9]. Therefore, the oracle problem is very important in ET and solved using the tester's knowledge and skills. The shortcoming of human oracle is that humans are fallible, that is exploratory testers do not always detect a failure even when a test case reveals it. Depending on human testers to evaluate program behaviour has also some problems such as cost and correctness. How could this be tackled with some subroutines to do such work?

The motivation for work done in ET is its exponential adoption by many software development firms. ET has been recommended as a worthwhile approach due to numerous advantages it has [6], [7]. The quality of the software under test (SUT) is highly dependent on the ability of the tester. The exploratory tester may not properly understand the requirements and specifications of the software and consequently endangers the quality of the product by judging correct results as wrong or wrong results as correct. Sometimes

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Exploration of phytochemicals found in *Terminalia* sp. and their antiretroviral activities

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Abstract

The human immunodeficiency virus (HIV) infects cells of the immune system and destroys their function. Approximately, 2 million people die every year from HIV as reported by the World Health Organization. HIV/AIDS is difficult to treat as the virus continuously develops resistance to drugs being developed. Approach is now turning toward natural products for the development of anti-HIV drugs. Although HIV/AIDS is not a new disease, but research based on plant-derived products is still under clinical trials. Experimentally, it has been proven that plants have the potential for HIV treatment. The process involves identification of the active ingredients responsible for the reported anti-HIV activities, testing of the extract, and development of appropriate bioassays. Further development would require optimization of the formulation and manufacturing in compliance with preclinical safety and efficacy testing. The most challenging task for the natural product scientists is to separate these highly complex extracts containing several compounds into its individual components that are biologically active. Recently developed direct binding assay with mass spectrometry (MS) technology (viz., real-time time-of-flight-MS) is helpful in this respect but needs extensive optimization. At present, we have compiled all the information for the various phytochemicals present in Terminalia catappa having anti-HIV properties. These include tannins, gallotannins, ellagitannins, cyanidin, and flavonoids. Further, we have also discussed their pharmacological as well as pharmacokinetics studies.

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Full Text

Introduction

Plants are the important source of several medicines for various incurable deadly diseases as known from literature (several thousand years old). Natural products obtained from the plants are known to be potential source for pharmaceutical applications. It has been found that about 80% of world population still believes in traditional medicine as compared to modern days' drugs therapy (WHO). Generally, a number of current drugs either mimic the naturally occurring molecules or have structures that are fully or in part derived from natural moieties.[1] From ancient times to modern research, plants have made important contribution to the field of science due to their large number of medicinal properties. The scientific reports on the family of Combretaceae concluded that this family is very rich in secondary metabolites. These metabolites have significant physiological as well as pharmacological effects (www.wikigenes.org/e/mesh/e/20357.html).[2],[3] This family has attracted keen attention due to its potential medicinal applications in diseases such as cancer, diabetes, cardiac arrest, hepatocarcinoma, human immunodeficiency virus (HIV), and hepatitis. Thus, they have solution toward various incurable diseases. Terminalia catappa is an important member of this family, which is also known as Indian Almond, Malabar Almond, and Tropical Almond. The leaves from Terminalia catappa contains various phytochemicals known for curing rheumatic joint pain, leprosy and skin diseases. Further, bark extract from the same plant is diuretic as well as cardiotonic.[4],[5] The extract of T. catappa leaves inhibits Lewis lung carcinoma cells that contribute to lung cancer.[6] Ethanolic extract of T. catappa leaves has been shown to protect against acute liver injury produced by some hepatotoxicants.[7] It has been found that T. catappa inhibits the occurrence of preneoplastic lesions in rat colon carcinogenesis.[8] It has been demonstrated that hydrolysable ellagitannins and other tannin-related compounds from leaves and bark of T. catappa have shown to inhibit HIV replication in infected H9 lymphocytes with little cytotoxicity.[9],[10],[11]

Antiretroviral drug therapy has been very useful in drastic reduction of morbidity and mortality associated with HIV infection. Further, the use of combination drug therapies has significantly improved HIV patients' chances for long-term survival. Unfortunately, the effectiveness of antiretroviral therapy has been markedly reduced by the emergence of drug resistance. It has been reported recently that ~76% of world population exhibited resistance to single or multiple antiretroviral drugs (www.who.int/drugresistance/hivaids/en/).[12],[13] The presence of antiretroviral drug resistance is an important cause of treatment failure in HIV patients. There are multiple classes of synthetic antiretroviral drugs present in the market. These drugs are not been so successful as predicted due to emergence of drug-resistant virus which has complicated the HIV/AIDS therapy. Therefore, it requires intensive studies on the mechanism of drug resistance to come out with suitable solutions towards the disease. Lots of efforts are being made to discover new agents and classes, particularly from natural source to find solution with emerging HIV drug resistance.[14],[15],[16] The search for safe and effective therapies to treat infections caused by the HIV and related opportunistic infections is among the highest priorities of the National Institutes of Health. NIAID, NIH has provided the chemical structures of all the anti-retroviral drugs known till date and their efficacies. It would be helpful for researchers for background information related to role of various functional groups for developing effective anti-retroviral drug with no side effects. Information on compounds evaluated preclinically for HIV and the opportunistic infections is acquired by continuous surveillance of primary literature sources (UNAIDS: Joint United Nations Programme on HIV/AIDS).

This review will focus on the various phytochemicals present in T. catappa having potential anti-HIV activity and their pharmacokinetics studies. The overview of the present review is shown in [Figure 1]. These analyses would assist investigators to elucidate what has been done with each phytochemical and their exploitation in HIV-therapeutics.{Figure 1}

Morphological Description and Scientific Classification (Www.cabi.org/isc/datasheet/53143)

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Healant release from microcapsules with varied internal microstructure

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ABSTRACT

One of the most common methodologies of introducing extrinsic healing property to a polymer composite involves inclusion of healant-loaded microcapsules in the formulation prior to curing. In this paper,we discuss an analytical model for predicting the amount of healant released due to microcapsule rupture. Of particular interest is to understand the role of internal microstructure in the context of extrinsic healing. In microcapsules possessing "reservoir" type microstructure, the healant exists as a single droplet, and the entire contents are released upon rupture. On the other hand, in monolithic microcapsules, the healant is dispersed in the form of discrete micro-droplets, and depending upon the micro-droplet dimensions, significantly lower amount of healant is released in comparison to reservoir microcapsules. For the purpose of validation, composites were prepared using epoxy encapsulated microcapsules with varied internal structures. In line with our predictions, the extent of healing was much lower in the case of samples containing monolithic microcapsules. At 20% w/w microcapsule loadings, healing efficiencies close to 60% was observed upon introduction of reservoir type microcapsules, while under similar loadings, only 10% healing could be evidenced in the presence of monolithic microcapsules.

1. Introduction

One of the most common methodologies towards introduction of self-healing functionality to any polymer involves inclusion of healant-loaded microcapsules in the formulation prior to curing [1]. Upon rupture of these microcapsules, the encapsulated healant flows into the crack plane and undergo crosslinking, forming a polymer which bridges the gap thereby arresting the crack growth. Conventionally, the healant is encapsulated in a fragile shell by adopting a dispersion polymerization route, which leads to formation of microcapsules with "reservoir" type microstructure. Typically, during the polymerization process, the shell wall constituents within the aqueous phase form a low molecular weight pre-polymer, which deposit preferentially over the hydrophobic healant at the oil-water interface. Eventually, a spherical solid shell is formed around a droplet of liquid healant forming a microcapsule with healant "reservoir".

Another relatively less complex methodology is that of "solvent evaporation", which is routinely employed for drug encapsulation [2]. The same is lately been explored for encapsulation of healants too [3–6]. The adoption of this route leads to the formation of microcapsules with monolithic structure, where the healant is dispersed as micro-droplets within the polymeric shell. It is obvious that the self-healing efficiency is strongly dependent on the internal morphology of the microcapsule. Numerical models for healant delivery exist for rupture of "reservoir" type microcapsules [7], however, to the best of our knowledge, such models for a monolithic type geometry have not yet been developed, which prompted us to take up this study.

In the present paper, we propose and discuss an analytical model for estimating the amount of healant released in the event of rupture of microcapsule with monolithic morphology and compared with "reservoir" type microcapsules. The predictions have been validated with experimental studies, where epoxy encapsulated microcapsules with varied microstructure were included in the formulation to obtain mendable compositions. The healing efficiency was quantified in terms of the ratio of impact strength and the effect of internal microstructure was evidenced.

2. Experimental

2.1. Materials

Aliphatic Epoxy resin (Ciba Geigy, Araldite CY 230; epoxy equivalent 200eq g^{-1}) and TETA based hardener (HY 951; amine content 24 eq kg^{-1}) was used as received. Urea, formalin (37% formaldehyde in water), sodium hydroxide, resorcinol, ammonium chloride, dichloromethane and polyvinyl alcohol (PVA) (Mw ~14,000) was obtained from

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High performance dendrimer functionalized single-walled carbon nanotubes field effect transistor biosensor for protein detection

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We report a single-walled carbon nanotube (SWNT) field-effect transistor (FET) functionalized with Polyamidoamine (PAMAM) dendrimer with 128 carboxyl groups as anchors for site specific biomolecular immobilization of protein antibody for C-reactive protein (CRP) detection. The FET device was characterized by scanning electron microscopy and current-gate voltage (I-V_g) characteristic studies. A concentration-dependent decrease in the source-drain current was observed in the regime of clinical significance, with a detection limit of ∼85 pM and a high sensitivity of 20% change in current ($\Delta I/I$) per decade CRP concentration, showing SWNT being locally gated by the binding of CRP to antibody (anti-CRP) on the FET device. The low value of the dissociation constant ($K_d = 0.31 \pm 0.13\,\mu$g ml^{-1}) indicated a high affinity of the device towards CRP analyte arising due to high anti-CRP loading with a better probe orientation on the 3-dimensional PAMAM structure. *Published by AIP Publishing*. [http://dx.doi.org/10.1063/1.4972110]

C-reactive protein (CRP) is an acute phase pentameric plasma protein, consisting of five identical ∼23 kDa homologous subunits, which are non-covalently associated in a cyclic form. It is synthesized by the liver[1] and widely accepted as a biomarker of cardiovascular diseases and inflammation.[2–4] The American Heart Association and the United States Centre for Disease Control have suggested three different levels of CRP concentrations for the evaluation of cardiovascular disease risk.[5–8] CRP concentration less than 1 μg ml^{-1} represents a low risk state; concentration between 1 and 3 μg ml^{-1} is considered as an average risk state; and any CRP concentration above 3 μg ml^{-1} represents a high risk state. Currently, a number of CRP testing methods are available in clinical laboratories, such as nephlometric,[9] turbidimetric,[10] visual agglutination,[11] and the enzyme-linked immunosorbent assay (ELISA) kits.[12] However, these methods are time-consuming, cost-ineffective, and are not readily applicable for the rapid point-of care analysis.[13] CRP quantification methods based on surface plasmon resonance (SPR),[14] microfluidics,[15] and electrochemistry[16] have been developed during the past few years. However, majority of these techniques require labels, expensive equipment, and well-trained personnel. Therefore, a more straightforward methodology [17,18] with features of (i) high sensitivity and specificity; (ii) non-labeling method; (iii) rapid assays; and (iv) portable, disposable, and low cost is needed.

Single-walled carbon nanotubes (SWNT) have been extensively used as an effective transducer for the fabrication of highly sensitive field-effect transistor (FET) sensors because of their ultra high surface area to volume ratio, extreme electrical (conductance/resistance) sensitivity to absorption/perturbation of analyte molecule on its surface, and its facile surface modification possibilities.[19] A major barrier for using SWNTs in nano and microelectronics applications has been associated with the difficulties in assembling the SWNTs precisely into small devices for scalable fabrication. This has been overcome by the use of random network of SWNTs for large area microelectronics devices, which exhibits the average properties of a large number of random individual SWNTs. In this work, we report a significant improvement in the performance of FET device fabricated with SWNTs networks between 3 μm gap interdigitated 10 pairs of gold microelectrodes array on SiO_2/Si, for the quantitative detection of CRP in Phosphate Buffer Saline (PBS). Further, to facilitate and to improve the density of the biorecognition molecule, the SWNTs networks were functionalized with Polyamidoamine (PAMAM) dendrimer of generation 4.5 (G-4.5) with 128 carboxyl groups as anchors. The relatively high density of carboxyl group in G-4.5 PAMAM ensures the incorporation of a large number of protein antibodies (anti-CRP) through carbodiimide coupling reaction on the SWNTs network surface for immunoreaction (antibody-antigen complex formation) with target protein CRP, producing a major decrease in the source-drain current, resulting to a high sensitivity Bio-SWNT-FET device. Therefore, the prime novelty of the manuscript is to highlight the significance of using G-4.5 PAMAM for the site specific biomolecular immobilization of protein antibody, anti-CRP, which provides a favorable microenvironment for the immunoreaction for antigen-antibody conjugation with a high output current response than earlier reported FET devices for CRP detection.[20–22] This electronic immunosensor has additional advantages of being compatible with a low-cost and scalable fabrication procedure for the label-free detection of CRP biomarker.

The device is schematically presented in Fig. 1. The sensor fabrication, performance, and sensing mechanism were investigated by the measurement of the current as a function of the back-gate voltage ($I-V_g$) characteristics.

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High-Quality Laser Cavity based on All-Dielectric Metasurfaces

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Abstract

In the last few years, all-dielectric metasurfaces cause great interest because of their ability to create broadband perfect reflectors. It opens unique opportunities for designing of optical lenses, reflectors, and cavities for semiconductor lasers. Here, we propose a very compact design for a laser cavity based on all-dielectric metasurface perfect reflectors. We demonstrate that all-dielectric metasurface perfect reflector increases quality factor and reduces threshold power.

1. Introduction

Metasurfaces are two dimensional sheet type metamaterials having thickness several times smaller compared to wavelength of operation. Their subwavelength structure spreads in two dimensions in either periodic or aperiodic arrangement. Metasurfaces can be used to provide such peculiar optical properties to a device which cannot be achieved by thin films of naturally occurring materials [1, 2, 3]. Recently, all-dielectric metamaterials and metasurfaces have been proposed as a more effective counterpart for plasmonic ones

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Implementation of Echo-State Network Based Control for Power Quality Improvement

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***Abstract*— This paper proposes a new control algorithm for mitigation of power quality problems at the distribution level. The control algorithm is designed on the basis of echo-state network, which is a type of recurrent neural network. This technique is used to extract fundamental weight components from non-sinusoidal load currents. These weight components are used to evaluate reference grid currents and consequently generate switching logic for the voltage source converter used in the active filter. The shunt connected active filter with the proposed control algorithm is used to overcome several current related power quality problems and provides the load compensation. Problems such as the presence of lower order harmonics, insufficient reactive power and load unbalancing are corrected using a shunt filter in both the power factor correction (PFC) and voltage regulation (VR) modes. The proposed control algorithm is validated on a real time system which is a prototype of a shunt filter. The algorithm is tested in MATLAB using Sim Power Systems and SIMULINK and implemented on a digital signal processor.**

***Index Terms*— Power quality, harmonics, shunt active filter, echo state network, recurrent neural network**

I. Introduction

Electric power system is getting polluted due to an increase in power electronics based converters in household appliances and industrial equipment. Substantial increase in nonlinear loads, such as converters, switch mode power supplies (SMPS), arc furnaces, electric/ electronic discharge lighting, variable speed drives, computers, fax machines and house hold electronic equipment installed at the distribution level play a major role in distorting the sinusoidal waveform of supply voltages and currents. The main concern of electricity consumers is to obtain uninterruptable power supply with improved power quality. For the electrical utility, there are several sensitive loads viz. hospitals and processing plants that require unpolluted and uninterruptable electric power supply [1]. Thus, to ensure quality power to all consumers even when some of the loads are themselves polluting in nature, becomes a major challenge. The power quality problems related to currents are mainly harmonics, insufficient reactive power and unbalanced loads and these affect the performance of other equipment, which are coupled at point of common connection (PCC). International standards have been recommended to specify the permissible limit of power quality problems and to provide guidelines for the end user, manufacturer and utility to improve the quality of power [2]-[3]. The mitigation of harmonics and other power quality issues are important tasks of utility companies. Today shunt active power filters (SAPFs) are the popular choice in achieving good power quality levels. The SAPFs are utilized for harmonics suppression, reactive power generation/ absorption and providing compensating currents to balance the load. An implementation of a shunt active filter in a cost effective way, becomes possible because of remarkable development in area of semiconductor devices related to power and signal processing [4]. Research in this area has led to innovations in the area of different configurations and control algorithms for the control of the shunt active filter. Akagi et al. [5] have discussed a three phase compensator controlled by instantaneous reactive power technique. Singh et al. [6] have developed power balance theory for active power filter for directing AC mains real power, reactive power flow and harmonics from the active filter to the load. Rao et al. [7] have discussed instantaneous symmetrical component theory (ISCT) for compensation under three phase balanced/ unbalanced supply voltages and the advantages and drawbacks of these control algorithms are presented based on various current and voltage related power quality problems. Silva et al. [8] have presented control based on modified synchronous reference frame (MSRF) for SAPF.

An adaptive control theory is based on the automatic adjustment of controller in an organized and calculated manner during the control operation by changing process parameters [9]-[11]. A number of publications are available on control algorithms for SAPF based on adaptive control such as adaptive notch filter [12], Wiener and least mean square (LMS) filters [13], recursive least square [14], improved linear sinusoidal tracer [15], frequency-adaptive fractional-order repetitive control [16], immune feedback controller [17], and recursive least square (RLS) control in which the convergence rate and tracking capabilities are controlled by variable forgetting factor [18]. The field of artificial intelligence has

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Inducing half-metallicity with enhanced stability in zigzag graphene nanoribbons via fluorine passivation

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Abstract

Half metals are the primary ingredients for the realization of novel spintronic devices. In the present work, by employing density functional theory based first-principles calculation, we predict half metallic bahavior in fluorine passivated zigzag graphene nanoribbons (F-ZGNR). Four different structures have been investigated viz. one edge F passivated ZGNR (F-ZGNR-1), both edges F passivated ZGNR (F-ZGNR-2), F passivation on alternate sites in first configuration (alt-1) and F passivation on alternate sites in second configuration (alt-2). Interestingly, it is noticed that F passivation is analogous to H passivation (pristine), however, F-ZGNR are reckoned energetically more stable than pristine ones. An spin induced band gap is noticed for all F-ZGNR irrespective of their widths although its magnitude is slightly less than the pristine counterparts. With an external transverse electric field, ribbons undergo semiconducting to half metallic transformation. The observed half metallic character with enhanced stability present F-ZGNR as a better candidate than pristine ZGNR towards the realization of upcoming spintronic devices.

Keywords: `Graphene nanoribbon, fluorine, electronic structure, half-metal`
2010 MSC: 73.22.Pr, 31.15.E-, 71.20.-b, 85.75.-d

1. Introduction

Since from inception of the idea for beyond Si electronic devices, graphene has become a ray of hope for the future electronic and sensing devices [1, 2, 3, 4]. However, other 2-dimensional (2-D) materials have also been investigated [5, 6, 7] but the dominance of graphene is still maintained due to its exotic

☆Fully documented templates are available in the elsarticle package on CTAN.
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Influence of 100 MeV Au^{+8} ion on photovoltaic response of $BiFeO_3/BaTiO_3$ multilayer structures

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Abstract

This work presents the swift heavy ion (SHI) irradiation induced possible modifications in structural strain and surface morphology of ($BiFeO_3$)BFO/($BaTiO_3$)BTO multilayer structures prepared by chemical solution deposition technique. Furthermore, the role of structural defects (induced due to irradiation) on the ferroelectric property and photovoltaic response of BFO/BTO multilayer structures having different number of layers has been studied. Significant modifications in the morphological and ferroelectric properties of BFO/BTO (two, four and six layers) multilayer structures due to induced structural defects were observed after SHI irradiation performed using 100 MeV Au^{+8} ion with ion fluence of ~ 1×10^{12}, $1x10^{13}$ and 3×10^{13} ions/cm^2. Ferroelectric photovoltaic response decreases with increase in ion fluence from $1x10^{12}$ to $1x10^{13}$ ions/cm^2 along with change in open circuit voltage from 0.41 V to 0.23 V, short circuit current density from 5.177 μA/cm^2 to 1.71 μA/cm^2 and I_{on}/I_{off} ratio from 33.02 to 13.02. This study on effect of SHI irradiation on multilayer ferroelectric photovoltaic cell is important to understand the possible application of BFO/BTO multilayer photovoltaic cells in the regions susceptible to radiations. Furthermore, the study of perovskite solar cell performance in the presence of SHI radiation, is essentially required for the development of durable solar energy harvesters.

Keywords : Irradiation, photovoltaic, fluence, ferroelectric.

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Influence of growth temperature on laser molecular beam epitaxy and properties of GaN layers grown on c-plane sapphire

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Nanoindentation

ABSTRACT

We have investigated the influence of growth temperature on the in-plane strain, structural, optical and mechanical properties of heteroepitaxially grown GaN layers on sapphire (0001) substrate by laser molecular beam epitaxy (LMBE) technique in the temperature range 500–700 °C. The GaN epitaxial layers are found to have a large in-plane compressive stress of about 1 GPa for low growth temperatures but the strain drastically reduced in the layer grown at 700 °C. The nature of the in-plane strain has been analyzed using high resolution x-ray diffraction, atomic force microscopy (AFM), Raman spectroscopy and photoluminescence (PL) measurements. From AFM, a change in GaN growth mode from grain to island is observed at the high growth temperature above 600 °C. A blue shift of 20–30 meV in near band edge PL emission line has been noticed for the GaN layers containing the large in-plane strain. These observations indicate that the in-plane strain in the GaN layers is dominated by a biaxial strain. Using nanoindentation, it is found that the indentation hardness and Young's modulus of the GaN layers increases with increasing growth temperature. The results disclose the critical role of growth mode in determining the in-plane strain and mechanical properties of the GaN layers grown by LMBE technique.

1. Introduction

In the last two decades, group III-nitride materials have derived keen research interests and been highly successful in proving their cutting-edge applications in optoelectronics and high power, high frequency electronics due to its wide direct bandgap, high mobility and high breakdown field [1–5]. The performance of group III-nitride devices highly depends on crystal quality and strain of epitaxial layers that are building the device structure. Due to the difficulty in achieving bulk GaN growth, III-nitride layers are normally grown hetero-epitaxially on foreign substrates that lead to generation of a high density of crystalline defects and high strain in the grown epitaxial layers. The crystalline defects play a key role in determining the efficiency of devices, and there are numerous reports related to the studies of quantitative analysis of defect concentrations [6–8]. Thus, the minimization of defects and growth of high quality epitaxial layers are required to promote the production of reliable and high performance devices. The conventional techniques for GaN growth are metal organic chemical vapor deposition (MOCVD), hydride vapor phase epitaxy (HVPE), and plasma assisted molecular beam epitaxy (PAMBE). Laser molecular beam epitaxy (LMBE) is a relatively new and least explored technique for III-nitride growth. But, LMBE has an advantage over other conventional techniques that the growth of GaN films can occur at low temperatures due to the high kinetic energy of film precursors produced by laser ablation [9–11]. Low temperature growth process is critical to further improve GaN epilayer quality by employing thermally vulnerable but closely lattice-matched substrates like ZnO, $LiGa_2O_3$, etc. and also to develop high quality In-rich III-nitride materials.

III-nitrides are grown hetero-epitaxially on different substrates like sapphire, silicon, silicon carbide, etc. But, due to the fact that

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Intrinsic half metallicity in lithium terminated zigzag graphene nanoribbons

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Abstract

Half-metallic materials are the prime requisite for future spintronic devices. In present work, the possibility of half-metallic characteristic has been investigated in Li terminated zigzag graphene nanoribbons (ZGNR) using density functional theory. Two different configurations: (i) both edges Li termination (Li-both edges) and (ii) one edge Li termination (Li-one edge), have been examined in the present study. The calculated binding energy (ranging from -3.19 eV to -4.96 eV) confirms that both the considered configurations are energetically viable to obtain. All the considered structures settled in antiferromagnetic ground state which is more stable than that of spin compensated state. Further, it is revealed that upto 100% spin polarization can be achieved (without application of any external electric field) in ZGNR with Li-one edge. Moreover, the observed half-metallicity is found to be independent of the ribbon width and therefore pledges for applications in novel spin filtering devices.

Keywords

A. Graphene nanoribbon; A. lithium; D. binding energy; D. half-metal; D. spintronic

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ORIGINAL ARTICLE

Isolation, cloning, and characterization of a cuticle collagen gene, *Mi-col-5*, in *Meloidogyne incognita*

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Abstract Cuticle collagens form a major part of the nematode cuticle and are responsible for maintaining the overall shape of the animal and its protection from the external environment. Although substantial research on cuticle collagen genes has been carried out in *Caenorhabditis elegans*, their isolation and characterization in plant parasitic nematodes have been limited to a few genes only. In this study, a cuticle collagen gene, *Mi-col-5*, was isolated from root-knot nematode, *Meloidogyne incognita*. A partial segment of 402 bp was first cloned and analyzed on Gbrowse followed by subsequent cloning of the 1047 bp long full cDNA specifying the open reading frame. The deduced amino acid sequence showed 92% sequence identity with that of *Mj-col-5*. However, a transmembrane helix was predicted in *Mi-col-5* which was not present in *Mj-col-5*. The conserved pattern of cysteine residues in *Mi-col-5* suggested that it belonged to group 2 of nematode cuticle collagens but with a longer carboxy terminal region as was the case with *Mj-col-5*. Domain prediction revealed the presence of a nematode cuticle collagen N terminal domain and a pfam collagen domain along with collagen triple helix repeats. A phylogenetic tree based on the amino acid sequences showed evolutionary relationship of *Mi-col-5* with cuticle collagens genes of other nematodes. 3D models for *Mi-col-5* were predicted with the best confidence score of −2.78. Expression of *Mi-col-5* transcript was found to be maximum in egg masses followed by adult females and J2s suggesting its role in the early stages of the development of the nematode during its life cycle.

Keywords Cuticle collagens · *Mi-col-5* · *Meloidogyne incognita* · Egg masses

Introduction

Structural proteins, collagens are involved in the formation of cuticle in nematodes which maintains the shape of the animal and protects it from the external environment. The collagens constitute around 80% of total protein content of the nematode cuticle (Kingston 1991). Cuticle collagens possess characteristic Gly-X-Y repeats with frequent appearance of proline and hydroxyproline in place of X and Y, respectively (Page and Johnstone 2007). They also share conserved patterns of cysteine residues which forms the basis of their classification into different groups (Johnstone 2000). The collagen genes encode procollagens with molecular masses of approximately 30 kDa, which undergo post-translational modifications and trimerisation in the endoplasmic reticulum. The triple helicle structure is brought about by tyrosine–tyrosine bonds while disulphide bonds are involved in cross linking between the triple helices (Koltai et al. 1997; Kramer 1994). In the free living nematode, *C. elegans*, more than 150 collagen genes are found to be involved in the formation of the cuticle. Individual collagen genes are expressed at different stages of the life cycle of the nematode and exoskeletal defects may result from mutation in these individual collagen genes leading to defects in the shape of the animal which

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FULL LENGTH ARTICLE

Kaner biodiesel production through hybrid reactor and its performance testing on a CI engine at different compression ratios

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KEYWORDS

Hybrid reactor;
Hydrodynamic cavitation;
Mechanical stirring;
Kaner oil methyl ester (KOME);
CI engine

Abstract The present study deals with development of a hybrid reactor for biodiesel production based on the combined hydrodynamic cavitation and mechanical stirring processes. Biodiesel were produced using Kaner Seed Oil (KSO). The experimental results show that hybrid reactor produces 95% biodiesel yield within 45 min for 0.75% of catalyst and 6:1 M ratio which is significantly higher as compared to mechanical stirring or hydrodynamic cavitation alone. Thus biodiesel production process in hybrid reactor is cheap (high yield), efficient (time saving) and environmentally friendly (lower% of catalyst). Performance study on engine shows that an increase in compression ratios (from 16 to 18) improves the engine performance using biodiesel blends as compared to petroleum diesel.

1. Introduction

The increasing industrialization and motorization of the world has led to steep rise for the demand of petroleum based fuels. Moreover the finite reserves of crude oil are concentrated in certain regions of the world and most of the developing countries are net importer of the crude oil. Large outflow of foreign exchange and uncertainty in its availability is a matter of great concern for developing countries like India. Diesel engines are more popular for their low fuel consumption and better efficiency. The Road sector diesel fuel consumption in India was 31,378 kT in 2009, according to World Bank Indicators, published in 2010 [1]. As per one of the study within 40 years, the present reserves of petroleum fuel including diesel will deplete at an increased consumption rate estimated to be order of 3% per annum [2]. Excessive use of fossil fuels has led to global environmental degradation effects such as greenhouse effect, acid rain, ozone layer depletion, climate change, etc. The main reason for increased pollution level in spite of stringent emission norms that have been enforced is the increased demand for energy in all sectors and most significantly the transport sector. Depleting reserves of crude petroleum, uncertainty in availability, environmental degradation and rapid hike in petroleum prices have led to search of alternate fuels [3], with

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Kinetics of enzymatic hydrolysis of Indian tuna fish oil using *Candida rugosa* lipase

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Tuna fish oil is one of the richest natural source of docosahexaenoic acid (DHA) having nutraceutical and pharmaceutical potential. DHA has been also known as brain food and is also useful in prevention and control of various human diseases and disorders. The present paper investigates the kinetic study of Indian tuna fish oil catalyzed by *Candida rugosa* lipase (CRL) in biphasic solvent system. In 24 h, 80.1% hydrolysis was achieved. For hydrolysis, second order product inhibition was used for kinetic model fitting. The kinetic model was fitted using MATLAB® to determine the best kinetic parameters. The average value of kinetic constants were estimated as K_M = 12 μ moles FFA/ml, K_{i1} = 2.0 X 10^{-8} μ moles free fatty acids (FFA)/mg enzyme·h, K_{i2} = 0.078 μ moles free fatty acids (FFA)/mg enzyme·h and K_2 = 652.7 μ moles FFA/mg enzyme·h.R^2, root mean square error (RMSE), mean absolute percentage error (MAPE) was found to be 0.959 and 60.51 and 11.41, respectively.

Keywords: Indian tuna fish oil, *Candida rugosa* lipase, hydrolysis, biphasic system

Introduction

Healthy food and nutrition are the need of everyone in today's perspective to buildup immunity for different types of chronic and neurodegenerative diseases such as dyslexia, dyspraxia, alzheimer, schizophrenia and heart diseases[1-3]. Therefore, the social demand is to focus on the synthesis of compounds which can prevent these diseases. Docosahexaenoic acid (DHA) is widely reported to have excellent nutraceutical and pharmaceutical properties. DHA can be synthesized mainly from microbial (fungi, algae, yeast and bacterial species) and animal (fish oils) sources[4] and their precursor compounds known as linoleic acid (LA) and alpha-linolenic acids (ALA) can be directly extracted from the plant sources such as walnut, flaxseed and linseed oils[5]. Variety of fish oils are reported to be a good source of DHA synthesis because these oils contain approximately 10-30% of total fatty acids as DHA.The extraction of DHA from fish oil has been reported with both chemical and enzymatic hydrolysis[6-8].

Enzymatic hydrolysis occurs with high specificity at ambient temperature and pressure in comparison with the conventional fat splitting process[9] and therefore preferred over conventional methods from last few decades[10,11]. The advantages of enzymatic processes over conventional chemical processes include mild reaction conditions of pH, temperature, and reduced energy cost, low amount of enzyme consumption, high catalytic efficiency and wide range of fatty acid selectivity of lipases which leads to specific and pure products[12,13]. Lipases (commonly known as triacylglycerol acylhydrolyase and classified as EC 3.1.1.3) are used industrially[14-17] and commercially in the breakdown of the acyl glycerol bond in the presence of the sufficient quantity of the water and lead to the formation of the monoglycerides, diglycerides, free fatty acids (FFA) and the glycerol as by-products[3,18]. Lipases are interfacial enzymes remained activated at the oil-water interface due to the open lid conformation of lipases at the interface of biphasic system[19,20]. The mechanism involves the attachment of acyl group ($RCOO^-$) on the positive side chain (NH_3^+) and hydrogen ion (H^+) on the negative side chain (COO^-) on the lipase active site. This causes the release of free fatty acids (RCOOH) in the solvent biphasic system and lipase can also be recovered after the extraction of solvent phase.

The kinetics of enzymatic hydrolysis using lipases has been studied primarily in monolayer by Verger *et al*[21] assuming that all the products of reactions were soluble in the water phase, diffuse rapidly away from the interface and induce no change in substrate with time. The above assumptions are not true for practical cases such as hydrolysis of oils/fats containing long

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Leveraging multimodal information for event summarization and concept-level sentiment analysis

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ABSTRACT

The rapid growth in the amount of user-generated content (UGCs) online necessitates for social media companies to automatically extract knowledge structures (concepts) from photos and videos to provide diverse multimedia-related services. However, real-world photos and videos are complex and noisy, and extracting semantics and sentics from the multimedia content alone is a very difficult task because suitable concepts may be exhibited in different representations. Hence, it is desirable to analyze UGCs from multiple modalities for a better understanding. To this end, we first present the EventBuilder system that deals with semantics understanding and automatically generates a multimedia summary for a given event in real-time by leveraging different social media such as Wikipedia and Flickr. Subsequently, we present the EventSensor system that aims to address sentics understanding and produces a multimedia summary for a given mood. It extracts concepts and mood tags from visual content and textual metadata of UGCs, and exploits them in supporting several significant multimedia-related services such as a musical multimedia summary. Moreover, EventSensor supports sentics-based event summarization by leveraging EventBuilder as its semantics engine component. Experimental results confirm that both EventBuilder and EventSensor outperform their baselines and efficiently summarize knowledge structures on the YFCC100M dataset.

1. Introduction

The number of UGCs (*e.g.*, photos and videos) has increased dramatically in recent years due to the ubiquitous availability of smartphones, digital cameras, and affordable network infrastructures. An interesting recent trend is that social media companies such as Flickr and YouTube, instead of producing content by themselves, create opportunities for a user to generate multimedia content. Thus, capturing the multimedia content anytime and anywhere, and then instantly sharing them on social media platforms, has become a very popular activity. Since UGCs belong to different interesting events (*e.g.*, festivals, games, and protests), they are now an intrinsic part of humans' daily life. For instance, on the very popular photo sharing website Instagram, over one billion photos have been uploaded so far. Moreover, the site has more than 400 million monthly active users [1]. However, it is difficult to automatically extract knowledge structures from the multimedia content due to the following reasons: (i) the difficulty in capturing the semantics and sentics of UGCs, (ii) the existence of noise in textual metadata, and (iii) challenges in handling big datasets. First, aiming at the understanding of semantics and summarizing knowledge structures of multimedia content, we presented the EventBuilder[1] system in our earlier work [2]. It enables users to automatically obtain a multimedia summary for a given event from a large multimedia collection in real-time (see Fig. 1). This system leverages information from social media platforms such as Wikipedia and Flickr to provide a useful summary of the event. Since this earlier work mainly focused on a real-time demonstration, its performance evaluation was limited. Thus, in this study, we perform extensive experiments of EventBuilder on a collection of 100 million photos and videos from Flickr and compare the

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[1] http://www.yiyu.nii.ac.jp:8080/EventBuilder/

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PAPER

Mechanical properties of thermoelectric n-type magnesium silicide synthesized employing *in situ* spark plasma reaction sintering

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Keywords: nanoindentation, thermoelectric materials, spark plasma sintering, fracture, wear

Abstract

Thermoelectric devices employing magnesium silicide (Mg_2Si) offer an inexpensive and non-toxic solution for green energy generation compared to other existing conventional thermoelectric materials in the mid-temperature range. However, apart from the thermoelectric performance, their mechanical properties are equally important in order to avoid the catastrophic failure of their modules during actual operation. In the present study, we report the synthesis of Mg_2Si co-doped with Bi and Sb employing *in situ* spark plasma reaction sintering and investigate its broad range of mechanical properties. The mechanical properties of the sintered co-doped Mg_2Si suggest a significantly enhanced value of hardness ~5.4 ± 0.2 GPa and an elastic modulus ~142.5 ± 6 GPa with a fracture toughness of ~1.71 ± 0.1 MPa $\sqrt{}$m. The thermal shock resistance, which is one of the most vital parameter for designing thermoelectric devices, was found to be ~300 W m^{-1}, which is higher than most of the other existing state-of-the-art mid-temperature thermoelectric materials. The friction and wear characteristics of sintered co-doped Mg_2Si have been reported for the first time, in order to realize the sustainability of their thermoelectric modules under actual hostile environmental conditions.

1. Introduction

Thermoelectric devices based on the Seebeck effect, which convert waste-heat into green energy using solid state materials, are gaining momentum for renewable energy applications [1–8]. Mg_2Si-based thermoelectric materials are promising materials for thermoelectric generators (TEGs) in the mid-temperature range, owing to their attractive figure-of-merit (ZT), chemical stability, low density, non-toxicity and earth-abundance of their constituent elements [9–11]. These properties of Mg_2Si make them attractive for waste-heat recovery applications in the mid-temperature range, as compared to other competing thermoelectric materials, such as, chalcogenides, skutterudites and half-Heuslers [12–16]. Although, there is an abundance of studies available on the thermoelectric properties of Mg_2Si based materials [1, 10, 11], however, there is a dearth of literature on their complete set of mechanical properties [17–21], as the majority of the reported research on these materials has been directed towards enhancing their thermoelectric performance.

However, in thermoelectric devices, the individual thermo-elements are subjected to significant stresses during its in-service operation due to several factors, including, thermal cycling, thermal expansion mismatch and other external mechanical stresses. Additionally, most often than not, the thermoelectric devices operate under a hostile environment, thus making the service durability and reliability of their modules a major concern in their development. Therefore, in order to ensure the structural integrity of Mg_2Si-based thermoelectric modules, it is imperative that the material must withstand numerous mechanical and thermal stresses under actual operating conditions. Therefore, apart from the thermoelectric performance, the mechanical properties of the thermoelectric material are equally important to avoid catastrophic failure of their thermoelectric modules during actual operation. Several mechanical properties that need to be addressed while the development of thermoelectric devices for their actual deployment, include hardness, elastic modulus, fracture strength and thermal shock resistance, prior to their operational deployment.

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Mesoporous silica as amine immobiliser for endowing healing functionality to epoxy resin

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ABSTRACT

Feasibility of physical entrapment approach towards the immobilisation of amine hardener in mesoporous silica has been demonstrated for potential applications in the perspective of self-healing. A representative mesoporous silica (SBA-15) was synthesised using polymer-templated technique and employed as a substrate for immobilizing triethylene tetramine, a conventional epoxy hardener. Polymeric composites containing microencapsulated epoxy microcapsules and amine loaded SBA-15 were prepared by room temperature curing. The autocatalytic nature associated with the curing of epoxy remained unaltered due to introduction of either SBA-15 or epoxy loaded microcapsules, as confirmed by calorimetric studies. Healing efficiency, as quantified in terms of the ratio of impact strength before and after healing, was found to increase proportionally with increasing loading of healing additives in the formulation, with complete healing (100%) being exhibited at 20% microcapsule loading.

1. Introduction

Self-healing materials are an emerging class of smart responsive materials, which are finding increasing applications in varied fields, e.g anti-corrosive, scratch resistant coatings, structural fiber-reinforced composites to name a few [1]. As is suggestive, these materials possess an innate ability to regain their structural integrity in the event of damage, which can be initiated by any external stimulus e.g. light, mechanical force, surrounding pH-variations etc. Extrinsic self-healing functionality can be bestowed to any composite by the inclusion of healant loaded microcapsules in the formulation. In a conventional self-healing organization, an encapsulated liquid healing agent and a solid phase hardener or catalyst is dispersed homogenously throughout the polymeric matrix. Crack propagation leads to the rupture of microcapsules lying within the crack plane, which result in the release of the healant to subsequently undergo polymerization and restrict the crack growth.

The first generation self-healing systems were based on monomeric healants capable of undergoing ring opening polymerization, e.g. endo-dicyclopentadiene, 5-ethylidene-2-norbornene [2]. Lately, this elementary theme has been extended to encompass diverse healing chemistries, e.g. unsaturated polyester [3], siloxane [4], epoxy-amine system [5,6] with the latter being most extensively studied in view of the associated economic factors. It is imperative to mention here that though there exist a number of successful methodologies for encapsulation of liquid epoxy, but encapsulation of the liquid hardener still remains a major challenge in view of its hydrophilic nature. To address this issue, several strategies have been adopted including encapsulation of amine in polyurea shells using reverse emulsion technique [7] and interfacial polymerization [8]. Alternatively, hollow microballoons of poly(urea-formaldehyde) and silica have also been explored as amine containment structures [9,10]. However, these microcapsules usually exhibit low core contents, which has led researchers to explore other alternatives.

Surprisingly, porous siliceous substrates e.g. SBA-15, MCM 41, which are routinely employed towards enzyme immobilization [11–13] have not yet been explored for immobilizing amines. In view of their extremely high surface areas, and suitable pore sizes, these materials apparently possess excellent candidature as amine containments. In this paper, we adopt a “physical” entrapment technique for immobilisation of triethylene tetramine hardener for potential application in self-healing applications. Here, the liquid amine remains immobilized within the extended interconnected channels of SBA-15, and is made available to the flowing epoxy in the event of crack propagation. The feasibility of such a system has also been experimentally demonstrated.

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Metal-Organic Frameworks as curing accelerators for benzoxazines

Pratibha Sharma,[a, b] Manju Srivastava,[a, c] Bimlesh Lochab,[d] Devendra Kumar,[b] Arunachalam Ramanan,[c] and Prasun Kumar Roy*[a]

Benzoxazine resins, although exhibiting attractive properties; particularly high thermal stability and near zero- shrinkage, suffer from a major drawback associated with its high curing temperature. In view of the Lewis acidity associated with the Zn_4O nodes in a zinc based metal organic framework [$Zn_4O(BDC)_3$, MOF5], we considered it of interest to explore its potential as a curing accelerator for a representative biobased benzoxazine resin. MOF 5 was solvothermally synthesized and characterized using different techniques including powder X-ray diffraction (PXRD), Scanning Electron Microscopy (SEM), Thermogravimetric Analysis (TGA), Fourier transform infrared spectroscopy (FT-IR) and Nitrogen physisorption measurements. Bio-based benzoxazine resin was synthesized by mannich type condensation of cardanol and aniline with formaldehyde under solventless conditions, the structure of which was confirmed using FT-IR and ^{1}H-NMR. The curing behavior of the synthesized resin was systematically investigated using non-isothermal Differential Scanning Calorimetry (DSC). Introduction of MOF 5 led to a shift in the curing profile to lower temperature, the extent of which was proportional to the amount of MOF 5 in the formulation. DSC studies were performed at different heating rates to establish the kinetic parameters associated with the curing of the resin. Activation energy, as calculated using Kissinger Akahira Sunose method, was found to concomitantly decrease from 98 kJ/mol to 58 kJ/mol upon addition of MOF 5 (5% w/w).

Introduction

Metal organic frameworks (MOFs) are a rapidly developing class of microporous materials, which are finding increasing applications in varied fields including gas adsorption,[1] separation, chemical sensing and catalysis.[2] Inherent characteristic properties of MOFs, particularly in terms of their ultra-high surface areas, possibility of pore structure modification and a high degree of chemical and thermal stability bestow them excellent candidature for the aforementioned applications. One such application, of particular interest to our group, concerns catalytic curing of bio-based benzoxazine resins.[3]

Benzoxazines are cyclic N,O-acetal-type monomers, capable of undergoing ring-opening polymerization reaction[4] to form cross-linked networks with exceptional thermal stability.[4b,5] However, majority of benzoxazine resins polymerize at elevated temperatures[6] which turns out to be an issue for practical applications. To overcome this drawback, several accelerators have been explored. In this context, organic acids[6a,7] and lewis acids[8] are of particular interest, but their presence in the cured resin has been reported to reduce the chemical resistance of the polymer and adversely affect the physical properties of the resulting polymer.[9] Organic base such as amines,[10] and imidazoles[11] have also been explored as curing accelerators and the effectiveness of acid-base combination has also been reported.[12] Sudo et al[6b] studied the efficiency of acetylacetonatocomplexes of 4th period transition metals as catalysts for the ring opening polymerisation of benzoxazine. The examination revealed that acetylacetonato complexes of manganese, iron, cobalt and zinc exhibited the highest activity, which inspired us to explore the potential of zinc based MOFs in the context of curing of benzoxazine monomer.[6b] The possibility of tailoring the chemical environment around the metal centre with exceptionally high surface area of MOFs leave enormous scope for these MOFs in the context of catalysis.

MOF 5, is an archetypal robust three dimensional zinc carboxylate framework ([$Zn_4O(BDC)_3$], BDC = 1,4-benzenedicarboxylate), reported by Yaghi et.al.[13] The crystal structure of MOF 5 is comprised of oxocentered Zn_4O nodes, connected through linear BDC units forming an extended 3D cubic network with interconnected pores of 0.9 nm (Figure 1). Zinc oxide clusters

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ORIGINAL RESEARCH

Microencapsulation of reactive amine by interfacially engineered epoxy microcapsules for smart applications

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Abstract The most common approach for incorporation of extrinsic self-healing functionality relies on introducing healant-loaded micro-containers in the polymeric formulation. In this context, a healing system based on encapsulated epoxy resin and amine hardener appears to be one of the most economically viable solutions, in view of the chemical as well as mechanical compatibility with the matrix. Encapsulation of epoxy resins has been extensively studied while the high reactivity of the amine hardener renders its encapsulation rather difficult and has been attempted with only modest success. The purpose of the present work is to adopt an interfacial polymerization approach for the preparation of epoxy microcapsules encapsulating a reactive amine hardener (triethylene tetramine). The effects of experimental parameters, including reaction temperature, stirring speed and epoxy/amine concentration ratio on the microcapsule formation were investigated. A polymeric surfactant was used to stabilize the suspension to modulate the particle size distribution of the resultant microcapsules. The highest encapsulation efficiencies were obtained when the reaction medium was maintained at 70 °C under stirring (600 rpm) at epoxy/amine ratio of 10/3.2. The microcapsule dimensions and core content could be tailored, following this encapsulation approach of interfacial polymerisation. Under optimal conditions, spherical microcapsules with 100% yield and 12% core content were obtained.

Keywords Microencapsulation · Interfacial polymerization · Microstructure · Surfactant · Core content

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Introduction

In view of the exceptional mechanical properties offered by polymeric composite materials, their use in structural applications is increasing steadily in areas mandating high specific strength, particularly automotives, wind turbine blades, etc. Epoxy resin is the preferred choice as the matrix material for preparation of fiber-reinforced composites; however, the cross-linked resin is highly sensitive to crack initiation. The cracks initiate at nano-scale, which subsequently enlarge to micro-scale and finally to macro-scale until total failure ensues. To increase the serviceability and reliability of the polymeric structural composites, development of self-healing polymers as an area received intense attention by the scientific community over the last decade.

The economic viability of healing in the structure of the composites requires cost-effective chemical approaches that are robust, efficient and stable. In this context, three primary approaches are in vogue towards introducing self-healing functionality to polymers including extrinsic, intrinsic and vascular [1]. The most common approach for incorporation of extrinsic self-healing functionality relies on introducing healant-loaded micro-containers in the polymeric formulation [2, 3]. Alternately, healing agents can also be encapsulated in 3D microvascular channels [4]. Many

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RESEARCH Open Access

Molecular modeling and lead design of substituted zanamivir derivatives as potent anti-influenza drugs

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Abstract

Background: Influenza virus spreads infection by two main surface glycoproteins, namely hemagglutinin (HA) and neuraminidase (NA). NA cleaves the sialic acid receptors eventually releasing newly formed virus particles which then invade new cells. Inhibition of NA could limit the replication of virus to one round which is insufficient to cause the disease.

Results: An experimentally reported series of acylguanidine zanamivir derivatives was used to develop GQSAR model targeting NA in different strains of influenza virus, H1N1 and H3N2. A combinatorial library was developed and their inhibitory activities were predicted using the GQSAR model.

Conclusion: The top leads were analyzed by docking which revealed the binding modes of these inhibitors in the active site of NA (150-loop). The top compound (AMA) was selected for carrying out molecular dynamics simulations for 15 ns which provided insights into the time dependent dynamics of the designed leads. AMA possessed a docking score of −8.26 Kcal/mol with H1N1 strain and −7.00 Kcal/mol with H3N2 strain. Ligand-bound complexes of both H1N1 and H3N2 were observed to be stable for 11 ns and 7 ns respectively. ADME descriptors were also calculated to study the pharmacokinetic properties of AMA which revealed its drug-like properties.

Keywords: Neuraminidase, H1N1, H3N2, NA, Influenza, QSAR

Background

Type A influenza virus, member of orthomyxoviridae family [1] is one of the most lethal and virulent strains of influenza virus which has been responsible for worldwide havoc including seasonal epidemics and major pandemic breakthroughs [2]. Pandemic Influenza could have originated via two major mechanisms, either by direct transmission from birds to humans as in 1918 "Spanish Influenza" virus (H1N1) or via genetic reassortment between avian influenza virus and human influenza virus as happened in the case of 1968 "Hong Kong" influenza virus (H3N2) [3]. It is a highly contagious virus and causes severe respiratory associated problems. Complications include post influenza encephalitis, secondary bacterial pneumonia and change in cardiac electrocardiogram [4, 5].

Subtypes of the type A virus has been classified based on the serological activity of the glycoprotein antigens hemagglutinin (HA) and neuraminidase (NA). Sixteen serotypes of HA have been found to circulate in mammalian and avian hosts. HA is a surface envelop protein of influenza virus and performs crucial viral functions like host recognition and membrane fusion [6]. HA often recognizes sialic acid receptors found in the human upper respiratory tract which act as initial key step of viral infection [7]. The second glycoprotein NA is a sialidase which destroys HA present on the surface of the virus allowing release of the infected viral progeny from infected cell thus preventing their self-aggregation [8]. Thus, inhibiting NA prevents second round of

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Newtonian and Non-Newtonian Pulsatile Flows through an Artery with Stenosis

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Abstract: The current study presents three-dimensional modeling and analysis of blood flow through artery stenosis under several variants of pulsatile flow to mimic the atherosclerosis artery disease. The study considered Newtonian and non-Newtonian blood flow models and solved the three-dimensional laminar and unsteady Navier-Stokes (NS) equations for different inlet velocity profiles. The Carreau Yasuda model was used for hemodynamics modeling of fluid viscosity. A comparative analysis was carried out for Newtonian and non-Newtonian fluid models under several simple pulsatile, equivalent pulsatile and physiological velocity profiles. The non-Newtonian fluid exhibited a higher centerline velocity. Wall shear stresses, shear strain rates, velocity fields, and vortex distribution for Newtonian and non-Newtonian fluid flows show significant differences. A higher wall shear was noticed near the stenosis. The vortex formed near the stenosis shifts to upstream and downstream of the stenosis with the change of velocity pulse. The velocity profile deflates more for non-Newtonian flows than the Newtonian flows.

Keywords: Non-newtonian fluid; Blood flows; Artery stenosis; Physiological flows; Pulsatile flows.

تدفقات النبض النيوتونية وغير النيوتونية عبر شريان مصاب بالضيق

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الملخص : قامت الدراسة الحالية بتقديم نمذجة ثلاثية الأبعاد وتحليل لتدفق الدم عبرشريان مصاب بضيق وذلك تحت عدة تدفقات نبض متغيرة و ذلك لمحاكاة مرض تصلب الشرايين. وأخذت الدراسة في الاعتبار نماذج تدفق الدم النيوتونية وغير النيوتونية وحلت الرقائق ثلاثية الأبعاد و معادلة نافيير ستوكس (نس) و معادلات الاشكال المختلفة للسرعة عند المدخل.وقد تم استخدام نموذج كاريو ياسودا للزوجة السوائل من أجل نمذجة ديناميكا الدم .و تم اجراء تحليل مقارن لنماذج السوائل النيوتونية وغير النيوتونية تحت عدة نبضات بسيطة مضاهية لاشكال سرعة النبض الفسيولوجيي. وقد أظهر السائل غير النيوتوني سرعة أعلى في خط الوسط. كما تبين وجود اختلافات كبيرة في إجهاد القص، ومعدلات القص و مسارات السرعة وتوزيع كتلة الدوامة على السوائل النيوتونية وغير النيوتونية. و قد لوحظ وجود ارتفاع في جدار القص بالقرب من منطقة الضيق و تنقل كتلة الدوامة المتكونة بالقرب من منطقة الضيق من المدخل الى المخرج مع تغير في سرعة النبض وانخفاض في درجة التدفقات غير النيوتونية بسرعة أكثر من التدفقات النيوتونية.

الكلمات المفتاحية : التدفقات النابضة، السوائل غير النيوتونية تدفقات الدم. ضيق الشريان. التدفقات الفسيولوجية

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Molecular Therapy
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Non-invasive Oil-Based Method to Increase Topical Delivery of Nucleic Acids to Skin

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Topical delivery of nucleic acids to skin has huge prospects in developing therapeutic interventions for cutaneous disorders. In spite of initial success, clinical translation is vastly impeded by the constraints of bioavailability as well as stability in metabolically active environment of skin. Various physical and chemical methods used to overcome these limitations involve invasive procedures or compounds that compromise skin integrity. Hence, there is an increasing demand for developing safe skin penetration enhancers for efficient nucleic acid delivery to skin. Here, we demonstrate that pretreatment of skin with silicone oil can increase the transfection efficiency of non-covalently associated peptide-plasmid DNA nanocomplexes in skin ex vivo and in vivo. The method does not compromise skin integrity, as indicated by microscopic evaluation of cellular differentiation, tissue architecture, enzyme activity assessment, dye penetration tests using Franz assay, and cytotoxicity and immunogenicity analyses. Stability of nanocomplexes is not hampered on pretreatment, thereby avoiding nuclease-mediated degradation. The mechanistic insights through Fourier transform infrared (FTIR) spectroscopy reveal some alterations in the skin hydration status owing to possible occlusion effects of the enhancer. Overall, we describe a topical, non-invasive, efficient, and safe method that can be used to increase the penetration and delivery of plasmid DNA to skin for possible therapeutic applications.

INTRODUCTION

Recent developments in topical and transdermal delivery across skin highlight its immense potential for administration of therapeutics as well as cosmeceutics.[1–3] In addition to the advantages of large surface area and easy access, therapeutic delivery through skin can also bypass the hepatic metabolism of oral delivery.[4,5] Although a wide repertoire of cargo has been delivered in skin, the clinical benefits achieved are still limited.[6,7] This limitation is largely attributed to the poor percutaneous permeability of administered cargo molecules owing to the significant barrier properties of skin. The major barrier is imposed by its superficial layer, the stratum corneum, whose unique lipid-rich composition along with richness of desmosomes effectively impedes the entry of hydrophilic macromolecules.[5,8] Moreover the delivered molecules should also enter skin in therapeutically sufficient amounts in order to efficaciously alleviate the condition without disturbing the skin integrity. In order to achieve this, researchers have focused on different strategies based on physical interventions or chemical and carrier-based methods.[9–15] However, many of these methods suffer from an invasive nature, cumbersome application, and toxic effects, which render them noncompliant for practical use.[11,16]

Synthetic and essential oils constitute a category of enhancers being explored for improved delivery to skin in a nontoxic manner. Polysiloxane or silicone oil (polymerized siloxane with organic side chains) is used as a component in many of these enhancers. Silicone oil has many applications determined by its structure, viscosity, volatile nature, and thermal stability. In skin care, silicones (oil or variants) have been used to prepare sunscreen formulations, non-sticky moisturizers, and body perspirants. It also has therapeutic applications, such as facilitating collagen production in hypertropic scars and providing sealant properties in wound-healing applications to avoid subsequent invasion by pathogens.[17–20] In spite of large-scale applications in skin with limited or no safety concerns, it has still not been explored much as a skin penetration enhancer for increased delivery of macromolecules.

Recently, skin-penetrating peptides (SPPs) have also emerged as relatively safe and non-invasive agents that assist efficient entry of both small and macromolecules across skin either through co-administration or non-covalent association.[21–29] Therefore, it is interesting to explore whether they can serve as potential alternatives to the existing chemical penetration enhancers. Insights will help us not only design better penetration enhancers with minimal side effects but also realize its therapeutic benefit in clinical settings. Most of these methods mentioned above are able to mediate increased entry of molecules in skin by means of interaction with skin lipids or proteins, leading to reversible alterations in skin permeability.[11,16]

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Numerical optimization and convective thermal loss analysis of improved solar parabolic trough collector receiver system with one sided thermal insulation

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ABSTRACT

Two type of receiver systems currently employed in solar parabolic trough collector technology are evacuated annuli receivers and air filled annuli receivers. While former receiver finds its way into high-temperature grid-acquaintance solar parabolic trough collectors, latter are more inclined towards non-grid solar thermal applications like low-temperature process heat. Evacuated receivers utilize vacuum filled annuli to reduce down the convection losses; this makes them substantially expensive – while prizing them as benchmark among receivers. Contrary, air filled annuli based receivers are relatively less expensive but are sub-par in thermal performance relative to evacuated receivers. This work deals with the air filled receiver system and would try to abridge the economy and efficiency between both types of systems using computational fluid dynamics (CFD) based numerical simulation approach. A heat blocking thermal insulation was tailored and fitted in the sun facing receiver annulus which does not receive concentrated radiation of the Sun, and was simulated for the reduction in convective losses and for favourable circumferential temperature distribution (CTD) around the absorber. Consequently, its convective heat losses were investigated for varying wind speeds and mass flow rates of heat transfer fluid (HTF) and were compared with mainstream air filled annuli receivers. Simulation results are compared with experimentation in which wind velocity was in a range of 0.43–4.99 m/s. It has been found that glass envelope temperature decreases with increase in wind velocity which directly insinuates the decrease in convection losses around glass envelope. These comparative implications could be served as a point of reference to develop solar parabolic trough collector for small scale process heat applications in India.

1. Introduction

Linear concentration technology has made parabolic trough collector vanguard of concentrated solar power (CSP): there is no definitive focusing point, rather a line. Serious development and evolution of this technology, in fact, came into existence when researchers analyzed existing forefront point focusing technology and suddenly stumbled upon a general concept – why, point concentrate the heat when it will be redistributed in line circuitry of the heat transfer fluid. Parabolic trough based concentrated solar thermal power plants, for the most part, consists of parabolic trough solar fields, heat generation system or absorber/receiver system, power block powered with Rankine steam turbine and a temporary or optional power storage system. Good performance of solar fields or collectors is undeniably indispensable for parabolic trough technology. A decade long of research on parabolic trough technology has been summed up by Fletcher (2001) and Barlev et al. (2011) who clearly adduced the work of Steinmann et al. (2005); Arasu and Sornakumar, 2007; Dudley et al. (1994), Alguacil et al. (2014) and Zhang et al. (2015). This interesting and invaluable research includes – performance and analysis of heat transfer fluids and thermal storage, support structure and reflector development, receiver development, process development for direct steam generation and numerical optimization of thermo-physical factors. In addition, thermo - physical parameters such as solar irradiance, wind velocity, mass flow rate and inlet temperature of heat transfer fluid (HTF) are urgently critical, in order for parabolic trough collector (PTC) to perform efficiently. To illustrate, Fig. 1 describes a PTC receiver with vacuum filled annulus that is being used as a *'nouveau technology'* to put down

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On the Application of Search-based Techniques for Software Engineering Predictive Modeling: A Systematic Review and Future Directions

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Abstarct:

Software engineering predictive modeling involves construction of models, with the help of software metrics, for estimating quality attributes. Recently, the use of search-based techniques have gained importance as they help the developers and project-managers in the identification of optimal solutions for developing effective prediction models. In this paper, we perform a systematic review of 78 primary studies from January 1992 to December 2015 which analyse the predictive capability of search-based techniques for ascertaining four predominant software quality attributes, i.e., *effort, defect proneness, maintainability* and *change proneness*. The review analyses the effective use and application of search-based techniques by evaluating appropriate specifications of fitness functions, parameter settings, validation methods, accounting for their stochastic natures and the evaluation of developmental models with the use of well-known statistical tests. Furthermore, we compare the effectiveness of different models, developed using the various search-based techniques amongst themselves, and also with the prevalent machine learning techniques used in literature. Although there are very few studies which use search-based techniques for predicting maintainability and change proneness, we found that the results of the application of search-based techniques for effort estimation and defect prediction are encouraging. Hence, this comprehensive study and the associated results will provide guidelines to practitioners and researchers and will enable them to make proper choices for applying the search-based techniques to their specific situations.

Keywords:

Search-based techniques, Change prediction, Defect prediction, Effort estimation, Maintainability prediction, Software quality.

1. Introduction

Software engineering predictive modeling (SEPM) helps software professionals in optimizing resources and thus, in producing high quality, efficient, and maintainable software products at low costs. For instance, an efficient predictive model, which suggests the occurrence of defects in a particular class in the forthcoming release of the software, will enable the practitioners to closely evaluate that class by allocating more resources to its testing than the other classes. Such an allocation may help in reducing the errors in the next release of the software. In order to develop an efficient predictor, a classifier needs to be trained with the help of available historical data. The trained classifier can then be used to predict various

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Optimization of synthesis technique and luminescent properties in Eu^{3+}-activated $NaCaPO_4$ phosphor for solid state lighting applications

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ABSTRACT

Europium activated $NaCaPO_4$ phosphor has been synthesized by various synthesis techniques such as solid-state reaction (SSR), molten salt synthesis (MSS) and sol-gel combustion (SGC) method to optimize the synthesis procedure. The comparative investigations of structural and luminescent properties have been studied to know the best synthesis method. The XRD patterns and Rietveld refinement analysis of the synthesized phosphors confirmed the single phase orthorhombic structure of $NaCaPO_4$. Excitation spectra indicate the strong absorption in near ultraviolet (n-UV) region and the emission spectra exhibit strong emission band at 595 nm corresponds to $^5D_0 \rightarrow {}^7F_1$ transition under n-UV (λ_{ex}=392 nm) excitation. The SGC route synthesized phosphor exhibit intense emission than that of the SSR and MSS method. Therefore, the effect of dopant (Eu^{3+}) concentration on the emission intensity and concentration quenching mechanism has been discussed in detail for the Eu^{3+} doped $NaCaPO_4$ phosphor synthesized by SGC method. The CIE chromaticity coordinates have been calculated for the phosphors synthesized by SSR, MSS and SGC methods to reveal the emitting color and also to know the utility of this phosphor for white LEDs.

1. Introduction

Recently, there is an increasing demand for phosphor converted (pc) white light emitting diodes (LEDs) in the field of solid state lighting due to their excellent advantages such as small size, high energy efficiency, energy-saving, robustness, high brightness, fast switching, longer lifetime (>1,00,000 h) and environmental friendliness [1–3]. The first commercial method to obtain the phosphor converted white light emitting diode (pc-WLED) involves the combination of blue LEDs with yellow emitting cerium-doped yttrium aluminum garnet (YAG: Ce^{3+}) phosphor. However, this technique is suffering with some disadvantages like hallo effect due to the separation of blue-yellow color, thermal quenching and poor color rendering index (R_a) [4–6]. The second alternative method to generate better white light is the composition of the three RGB (i.e. red, green and blue) phosphors with a n-UV LED chip as an excitation source. However, in this approach, the efficiency of red phosphor is very poor as compare to the green and blue [7,8]. Therefore, it is necessary to investigate chemically stable, environmental friendly and highly efficient n-UV or blue excited phosphors to use in pc-converted WLED [9,10].

Inorganic alkali-alkaline-earth orthophosphate with general formula $ABPO_4$ (where A=alkali and B=alkaline earth metals) has been studied widely as efficient host materials due to their excellent luminescent properties [11–14]. In orthophosphate group, $NaCaPO_4$ is known as emerging host lattice for potential applications in solid-state lighting [15,16]. Along with excellent thermal and charge stability, $NaCaPO_4$ also possess some unique qualities such as strong UV absorption, high conversion efficiency with low cost, lower synthesis temperature, higher physical and chemical stability [17–19]. The doping of rare-earth ions in suitable orthophosphate host lattices have been considered as an excellent material for luminescent device applications [20]. Moreover, incorporation of rare-earth ions provide strong emission intensity as well as stability of the oxide materials. Among all the rare-earth ions, Eu^{3+} is the most commonly used activator in many host lattices for the desired red luminescence properties. Generally, europium can enter in the host lattice either in its divalent or trivalent states [20,21].

Various synthesis methods such as SSR, MSS, SGC, hydrothermal, combustion and solvothermal have been used to

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ORIGINAL PAPER

Performance of the vanadium redox-flow battery (VRB) for Si-PWA/PVA nanocomposite membrane

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Abstract The performance of Si-PWA/PVA nanocomposite membrane in vanadium redox-flow battery (VRB) is reported. Structurally, the membrane consisted of a dispersion of sub-micron-sized silica immobilized phosphotungstic acid (Si-PWA) inorganic ion-exchanging phase in the continuous phase of cross-linked poly(vinyl alcohol) (PVA). SEM micrographs indicated the defect-free top surface of membrane with similar morphology of Nafion-115. Good ion selectivity and availability of ion-exchangeable sites were observed as indicated by higher transport number (0.89) and ion-exchange capacity (IEC) (1.20 meq g^{-1}), respectively. Oxidative stability of the membrane was good in vanadium ion species (V^{4+}, V^{3+}, and V^{2+}) but its stability in V^{5+} solution and Fenton's reagent was slightly lower than Nafion-115. Vanadium ion permeability (0.69×10^{-7} cm min^{-1}) of Si-PWA/PVA membrane was significantly lower than Nafion-115. Suitability for VRB with Si-PWA/PVA membrane was assessed from open-circuit voltage (OCV) decay which was lower compared to Nafion-115. Single-cell VRB with Si-PWA/PVA membrane exhibited lower voltage during charge and higher during discharge with excellent cyclic stability compared to VRB with Nafion-115.

Keywords Nanocomposite membrane · Vanadium redox-flow battery · Oxidation stability · Vanadium permeability · OCV decay

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Introduction

Electrical energy storage technologies have a crucial role in load leveling and off-grid applications including integration of electricity grid with various renewable energy devices [1, 2]. However, storing large amount of energy and employment of renewable energy devices into large power distribution system is still one of the major challenges at this moment. In the past two decades, interest in redox-flow batteries (RFB), using different redox couples, has increased tremendously due to their high capacity of large energy storage in the range of kilowatt-hour to megawatt-hour with tunable power capacity, high energy efficiency, long cycle life, and rapid response time [3]. RFB mainly works on various redox couples like vanadium/bromide, iron/chromium, zinc/bromine, and vanadium/vanadium [4]. Among all, the vanadium/vanadium redox couples used in vanadium redox-flow battery (VRB), pioneered by Maria Skyllas Kazacos and co-workers at UNSW [4], have unique advantages of the fact that the redox couples in both half-cells involve vanadium in four different oxidation state (V^{2+}/V^{3+} and V^{4+}/V^{5+}). In addition, VRB includes high efficiency, long cycle life, deep discharge, lower cost, and flexible design over conventional redox-flow systems [5, 6].

VRB mainly employs V^{2+}/V^{3+} and V^{4+}/V^{5+} redox couples as electrolyte in negative and positive half-cells, respectively. Ion-exchange membrane (IEM), a core component of VRB, not only separates two half-cells in order to prevent mixing of electrolytic solutions but also allows selective transport of protons (H^+). An ideal membrane for VRB should possess high proton conductivity, low vanadium permeability, and good oxidative stability with low cost [7]. Nafion series membranes (Nafion-112/115/117) are preferred in VRB due to their high proton conductivity (0.1 Scm^{-1}) and excellent chemical/oxidative stability [8]. However, high vanadium ion permeability of Nafion membranes leads to lower

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Pharos: Collating protein information to shed light on the druggable genome

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ABSTRACT

The 'druggable genome' encompasses several protein families, but only a subset of targets within them have attracted significant research attention and thus have information about them publicly available. The Illuminating the Druggable Genome (IDG) program was initiated in 2014, has the goal of developing experimental techniques and a Knowledge Management Center (KMC) that would collect and organize information about protein targets from four families, representing the most common druggable targets with an emphasis on understudied proteins. Here, we describe two resources developed by the KMC: the Target Central Resource Database (TCRD) which collates many heterogeneous gene/protein datasets and Pharos (https://pharos.nih.gov), a multimodal web interface that presents the data from TCRD. We briefly describe the types and sources of data considered by the KMC and then highlight features of the Pharos interface designed to enable intuitive access to the IDG knowledgebase. The aim of Pharos is to encourage 'serendipitous browsing', whereby related, relevant information is made easily discoverable. We conclude by describing two use cases that highlight the utility of Pharos and TCRD.

INTRODUCTION

In 2014, the National Institutes of Health (NIH) initiated the Illuminating the Druggable Genome (IDG) program (https://commonfund.nih.gov/idg/index). The goal of the IDG program is to shed light on poorly characterized proteins that can potentially be modulated using small molecules or biologics. The program comes at a time when genomic information suggests that at least 3000 gene coded proteins can be 'drugged', yet only 10% of these potential

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Sustainable Chemistry

Poly(benzoxazine–co–urea): A Solventless Approach Towards The Introduction of Alternating Urea Linkages In Polybenzoxazine

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In this paper, an alternative approach towards synthesis of phenolic/urea copolymers has been explored via benzoxazine chemistry. Biobased poly(benzoxazine-co-urea) has been prepared through ring opening polymerisation of a benzoxazine monomer containing urea linkages. The amine co-reactant for the benzoxazine synthesis was derived by the additive rearrangement of 4,4′-methylenebis(phenyl isocyanate) (MDI) with ethylene diamine, which underwent Mannich like condensation with cardanol and paraformaldehyde to yield biobased benzoxazine monomer containing urea linkages. The structure of the amine and the benzoxazine has been characterized by Fourier transform infrared spectroscopy (FT-IR) and nuclear magnetic resonance spectroscopy (^{1}H-NMR). Benzoxazine monomer undergoes thermally accelerated ring opening polymerization to form cross-linked networks, which has been demonstrated using rheometry and non-isothermal differential scanning calorimetry (DSC). The presence of alternating urea linkages in the benzoxazine network is expected to improve the adhesive properties of the resin, which was quantified in terms of Lap shear strength. Thermal degradation of the crosslinked copolymer has also been studied by thermogravimetric analysis (TGA).

1. Introduction

Polybenzoxazines, belonging to a class of advanced high performance polymers, are gaining a lot of attention lately in view of their potential to bridge the gap between mechanically robust polyepoxies and thermally stable maleimides.[1] These materials, in view of their excellent mechanical properties,[2] low moisture absorption,[3] inherent flame retardancy,[4] and dimensional stability,[5] are excellent candidates for demanding applications particularly in aerospace. The possibility of molecular designing, by choosing the raw materials astutely, allows structural tenability, which in turn can be used to develop different materials with wide ranging properties.[6] Benzoxazine monomers undergo cationic ring opening polymerization upon heating and the curing process does not mandate the presence of curing initiators or catalyst.[7]

Blending and copolymerization are undoubtedly the most extensively explored routes towards preparing of materials with intermediary properties. In this context, benzoxazines moieties have been integrated into other polymeric networks, especially where improvement in thermal and mechanical properties is required e.g. polybenzoxazine precursor has been copolymerized with ester,[8] epoxy,[9] urethanes, siloxane,[12] acetylene,[13] nitriles.[14] Surprisingly, the potential of benzoxazines has not been explored towards improving the property of polyurea, the latter being reported of exhibiting exceptional blast resistance,[15] but relatively inferior thermal stability.

A general flow chart, illustrating possible routes for preparation of benzoxazine copolymers is presented in Figure 1. Self polymerizable monomers can be integrated in the polymeric network by functionalizing the benzoxazine with the co-monomer, followed by thermal treatment (Figure 1, Approach 1).[14] Blending/reaction of benzoxazine with co-monomer is usually performed, where the monomer mandates a curing agent (Figure 1, Approach 2).[16] Baqar et al.[10] reported a route where benzoxazine is first substituted and subsequently reacted with the curing agent of the co-monomer, followed by the thermal polymerization of oxazine moiety, resulting in cross-linked alternating copolymer (Figure 1, Approach 3).

The present work deals with another alternative for preparation of benzoxazine-urea copolymers by Mannich like condensation of cardanol with amine terminated model compound containing urea linkages. These terminal oxazine moieties are expected to undergo ring-opening polymerisation leading to the formation of cross-linked polymer with alternating benzoxazine-urea linkages. The phenolic moieties thus generated are preserved and will be involved in formation of intramolecular six-membered ring hydrogen bonding responsible for bestowing unique properties of polybenzoxazines.[7a,b] The effect of introducing urea linkages on the adhesive and thermal properties of the resin is discussed.

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Prominent photovoltaic response in multiferroic BFO/BTO heterostructures

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Abstract-Present work focuses on the photovoltaic properties of the multilayered structure of Bismuth ferrite (BFO) and Barium titanate (BTO) thin films prepared by Pulsed Laser Deposition (PLD) technique on platinum coated silicon substrate. The five and six layered structures of BFO/BTO showed a remarkable increase in current density (J) (from 2.23×10^{-7} A/cm^2 to 3.18×10^{-4} A/cm^2 and from 4.50×10^{-8} A/cm^2 to 3.84×10^{-4} A/cm^2) upon illumination with laser light of wavelength 405 nm at an intensity of 160 mW/cm^2. The values of short circuit photocurrent and open circuit voltage (V_{oc}) for five layered BFO/BTO PV cell were 0.3184 mA/cm^2 and -1.25 V respectively. The BFO/BTO six layer PV cell exhibits higher value of V_{oc} = -1.52 V and $J_{ON/OFF}$ = 8.53 x 10^3 due to improved ferroelectric properties related to significant interface coupling between 6 stacking layers of BFO and BTO. The BFO/BTO PV cell highlights its possible practical application in photovoltaics and multifunctional devices.

I. INTRODUCTION

In the past decades, BFO has attracted much attention due to its well known room temperature multiferroicity offering a series of possible applications in high density memory, spintronics and photovoltaics devices [1-4]. With the current trends of high integration and miniaturization in semiconductor industry, it becomes impulsive to emerge with next generation multiferroics with multifunctional applications. Ferroelectric photovoltaic effect (FPV) is a fascinating phenomenon with many unique features such as extremely large photo-voltage, where a photocurrent is proportional to the polarization magnitude. Designing of materials having enhanced multiferroic responses can be achieved using the principle of strain engineering employed for multilayer structures and superlattices (SLs). Recently, numerous studies on multilayer heterostructures containing alternating ferroelectric and multiferroic layers, such as $Pb(Zr,Ti)O_3/CoFe_2O_4$ [5-7], $(Pr_{0.88}Ca_{0.15}MnO_3)/(Ba_{0.6}Sr_{0.4}TiO_3)$ [8], $CoFe_2O_4/BaTiO_3$ [9], $BiFeO_3/BaTiO_3$ [10], $(Bi,Nd)FeO_3/(Ba,Sr)TiO_3$ [11], $BiFeO_3/BiMnO_3$ [12] have been performed but ferroelectric photovoltaic effect is seldom studied. Among the numerous ferroelectric oxides materials [13-15], BFO possessing narrow band gap (~2.2 eV) exhibit significant PV effect [13]. However being leaky in nature there are certain limitations to its applications. BTO being excellent ferroelectric material, provides high polarization value but has high band gap value. Thus, in order to improve the properties of both materials, in the present work, BFO/BTO multilayer structures with five and six individual layers were prepared using PLD technique towards the ferroelectric photovoltaic applications.

II. EXPERIMENTAL

BFO/BTO multilayered (five and six layered) structure was prepared by PLD technique. The single phase ceramic targets of BFO and BTO of one inch diameter were prepared using conventional solid state reaction method. The raw powders of Bi_2O_3, Fe_2O_3, $BaCO_3$ and TiO_2 (99.9% pure) were used for the preparation of BFO and BTO targets. The ceramic targets of BFO and BTO were ablated sequencially using the 4th harmonic of Nd:YAG pulsed laser (λ = 266 nm) and the multilayered structure of BFO/BTO were prepared on $Pt/Ti/SiO_2/Si$ substrates.

Total thickness of the multilayered structures was kept fixed at 350 nm. The multilayer structure was prepared at a substrate temperature of 750°C. The number of layers in multilayer structure was varied from five to six whilst keeping BTO as the bottom layer. The top circular electrodes (600 µm diameter, 40 nm thickness) of Au were deposited by thermal evaporation technique through a shadow mask on the surface of multilayered BFO/BTO structures. For comparison, thin films of both BFO and BTO of same thickness (350 nm) were also grown under the similar deposition conditions on $Pt/SiO_2/Si$ substrate.

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REVIEW

Role of interleukin-6 in cancer progression and therapeutic resistance

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Abstract In the last several decades, the number of people dying from cancer-related deaths has not reduced significantly despite phenomenal advances in the technologies related to diagnosis and therapeutic modalities. The principal cause behind limitations in the curability of this disease is the reducing sensitivity of the cancer cells towards conventional anticancer therapeutic modalities, particularly in advance stages of the disease. Amongst several reasons, certain secretory factors released by the tumour cells into the microenvironment have been found to confer resistance towards chemo- and radiotherapy, besides promoting growth. Interleukin-6 (IL-6), one of the major cytokines in the tumour microenvironment, is an important factor which is found at high concentrations and known to be deregulated in cancer. Its overexpression has been reported in almost all types of tumours. The strong association between inflammation and cancer is reflected by the high IL-6 levels in the tumour microenvironment, where it promotes tumorigenesis by regulating all hallmarks of cancer and multiple signalling pathways, including apoptosis, survival, proliferation, angiogenesis, invasiveness and metastasis, and, most importantly, the metabolism. Moreover, IL-6 protects the cancer cells from therapy-induced DNA damage, oxidative stress and apoptosis by facilitating the repair and induction of countersignalling (antioxidant and anti-apoptotic/pro-survival) pathways. Therefore, blocking IL-6 or inhibiting its associated signalling independently or in combination with conventional anticancer therapies could be a potential therapeutic strategy for the treatment of cancers with IL-6-dominated signalling.

Keywords IL-6 · Cancer · Therapeutic resistance · STAT-3 · Chemotherapy · Radio-resistance

Introduction

Inflammation has a very strong link with various types of cancer. Malignant cells are highly proliferative in nature, which is facilitated by the inflammatory molecules that are continuously being secreted by other cells and/or tumour cells themselves in a microenvironment [1, 2]. Interleukin-6 (IL-6) is one such inflammatory molecule, which is produced and secreted by various types of cells including the tumour cells. It is involved in the proliferation and differentiation of malignant cells and found to be high in serum and tumour tissues of a majority of cancers, viz. colorectal cancer [3], breast cancer [4], prostate cancer [5], ovarian carcinoma [6], pancreatic cancer [7], lung cancer [8], renal cell carcinoma [9], cervical cancer [10] and multiple myeloma [11]. Elevated levels of IL-6 are associated with aggressive tumour growth and response to therapies in many types of cancer [12, 13]. Patients with high levels of circulating IL-6 are generally associated with poor prognosis and shorter survival, whilst a lower level of IL-6 is associated with better response to therapy [14, 15].

Anticancer drugs and ionizing radiation used during cancer therapy induce inflammatory signalling, mainly in the form of the nuclear factor-kappa B (NF-kB) pathway [16, 17]. NF-kB regulates the expression of different pro-inflammatory

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Role of Unmodified Low Generation – PAMAM Dendrimers in Efficient Non-Toxic Gene Transfection

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The present study is focused on a simple execution in the applicability of non-toxic lower generation poly amidoamine (PAMAM) dendrimers as effective nano-vectors in targeted gene delivery to the skin. So far the first three lower generation (G1, G2 and G3) PAMAM dendrimers have been overlooked as nucleic acid therapeutics. In this study, we have first carried out a systematic biophysical analysis to analyze their ability for plasmid DNA (pDNA) condensation and subsequent release by ethidium bromide assay to optimize dendrimer to DNA charge ratio for effective pDNA condensation and release. Interestingly, stopped flow fluorescence spectroscopic analysis on pDNA-dendrimer binding kinetics revealed the efficiency of generations G2 and G3 in pDNA condensation in comparison with G1 through four steps. Importantly, it validates aggregation and association of the dendrimer in the vicinity of pDNA. Based on these understanding, successful *in vitro* cellular uptake of dendriplexes followed by their transfection into CHO–K1 cells was demonstrated at the charge ratio $Z_{+/-}$ 5 and 10. The interesting observations of gene transfection with CHO–K1 cells were extended to HaCaT cell line and efficient pDNA transfections were evidenced with negligible cytotoxicity. In addition to this, the stability of the dendriplexes at the charge ratio $Z_{+/-}$ 5 for G3 and $Z_{+/-}$ 10 for G2 was found even upto 50% serum concentration suggesting possible future applicability in *in vivo*. Overall, the current approach promises the use of lower generation dendrimers for pDNA delivery to the skin using only electrostatic nanocomplex formation without any covalent linkage.

1.Introduction

A new paradigm in medicine called gene therapy involves altering of genes entailed in disease by delivering therapeutic gene (nucleic acid based drugs). Delivering such therapeutic gene to the specific target site is an irresistible challenge to drug delivery scientists. However, the polyanionic nature of DNA limits the cellular membrane interactions. Hence, successful therapeutic DNA based gene delivery highly relies on the efficient extracellular and intracellulardelivery of DNA molecules for empowering targetinteraction.[1–5] Non-viral vectors are being used in improving potential therapeutic effect of DNA because they are safe and non-immunogenic as compared to viral vectors. Even though lower transfection efficiency of non-viral vectors are proven compared to viral-mediated gene transfection, the observed shortcomings could be overcome by appropriate structural designing of carriers like cationic polymers or lipids. For example, non-viral vectors can easily be targeted to a target tissue or cell by coupling of cell- or tissue-specific targeting moieties on the carrier. Additionally, by controlling the size of DNA-cationic vector complex the biodistribution, cellular internalization and intracellular trafficking of the micro- or nanoparticle can be influenced. Most importantly, the success of the non-viral gene therapy is dependent on the various extra- and intracellular barriers that affect the efficiency of all gene delivery systems, including cellular uptake, endosomal escape, nuclear uptake and gene expression.[6–8] Poly cationic vector such as poly (amidoamine) (PAMAM) dendrimer is one of the versatile non-viral based gene delivery systems for efficient targeted delivery of DNA amongst numerous other cationic vectors.[9–11] In particular, PAMAM dendrimer is shown as a potential vehicle especially through several routes of administration, including oral, ocular, parenteral and transdermal.[9,12,13] The uniqueness of these dendrimers are that they are monodisperse, hyperbranched and of controlled size and molecular weight, possessing number of terminal groups with the increasing generation number.[14] More interestingly, PAMAM-DNA complexes have been found to be highly soluble and stable in almost all the physiological conditions and also observed to be resistant to nuclease digestion by Bielinska*et al.*[15] These distinctive characteristics of PAMAM dendrimer coupled with their architecture has attracted attention of several research groups and their applications in biology and medicine have been explored.[9,16–18] Additionally, various research groups also commenced to determine dendrimer toxicity and immunogenicity and reported that cytotoxicity increases with increase in generation numberi.e. smaller the generation of PAMAM dendrimerless the chances of cytotoxicity.[19,20] In spite of high cost and high cytotoxicity, there exist enormous successful targeted transfection reports using unmodified and modified dendrimers of higher gen-

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Original research article

SBS based slow-light generation in rectangular lattice graded-index photonic crystal fiber: Design and analysis

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ABSTRACT

Theoretical analysis of stimulated Brillouin scattering based slow-light in As_2Se_3 based chalcogenide photonic crystal fiber has been reported. A maximum time-delay of 252.8 ns has been achieved for 1 m long fiber at input pump power of 9.8 mW. A maximum gain of 99 dB/m has been obtained for the same input pump-power. The simulated results indicate that the time-delay can be tuned by varying the input pump-power and the size of the air holes to obtain tunable features. We feel that the comprehensive theoretical investigation carried out in this paper have potential impact in the design and development of slow-light based photonic devices.

1. Introduction

The Slow-light is a key method for the potential alternates of electronic delay lines in the telecommunications because such tunable delays helps in various digital signals processing functions that are very useful in communication systems. This method is quite helpful in accurate and fine control of an optical delay in high bit-rate systems such as time-division-multiplexers, data equalization using tapped-delay-lines, and optical correlation where the control of light within fraction of time is very tough [1,2]. There are many other applications of slow-light such as optical buffering, microwave photonics, optical memories, optical signal processing and precise interferometric instruments [3–5]. This technique also provides anticipative solution of broadband and tunable time-delay for microwave and milli-meter wave systems [6,7].

Slow-light is ultimately a technique that alters the propagation of pulses through any medium to generate unusual effects including time delay that refers to slow propagation velocities. As we all know that a monochromatic light travels at the phase velocity given by V_P

$$V_p = \frac{\omega}{k} = \frac{c}{n} \tag{1}$$

where, ω is angular frequency, k is the wave number, c is the speed of light in vacuum and n is the refractive index of the medium. From the above Eq. (1), it can be concluded that V_P is dependent on the refractive index of the material. As a pulse of light is generated by the interference of large number of sinusoidal waves and each of them has their own phase velocity. In a dispersive material, n varies with the wavelength and hence each component of wave packet will travel at different

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Security Framework for Portable NFC Mobile Based Health Record System

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***Abstract*—A portable healthcard on the patient mobile device can integrate Patient Health Records (PHRs) dispersed on various Hospital Information Systems (HIS) to provide a highly available medical history for correct diagnosis and treatment.In this paper, we present a broad overview of the design issues for the security framework of a novel NFC and Secure Element-based healthcard on a mobile device known as S-MAPLE (Secure Mobility-Assisted PortabLE) healthcard. We provide detailed design for Role-Based Access Control (RBAC) with selective read and write access. Evaluation results on Android-based devices indicate satisfactory performance results for delays due to security overheads.**

***Keywords*-PHR; NFC; Secure Element; RBAC; Attribute-Based Encryption; HL7**

I. Introduction

Patient Health Record (PHR) should be highly reliable, secure and available 24/7 for providing the complete health history of the patient for correct medical treatment. When PHRs gets dispersed across several Hospital Information Systems (HIS), it becomes challenging to collect records for a complete health history. People visit many hospitals due to mobility across different countries for work or tourism requirements, such as in developed countries across Europe. In developing countries, patients may have to visit physicians in various hospitals due to different specialisations and expertise. However, to get the right medical treatment, patient history must be readily available at the time of need. Due to the dispersal of PHRs, there is a requirement of storing them at a common place such as cloud. However, it has challenges of integration and problem of 24/7 availability in places with poor infrastructure and connectivity. Hence there is a requirement of a portable device that can integrate dispersed PHRs and retain in the form of a healthcard.

In our previous work [1], we have proposed a novel NFC-based mobile healthcard, which can maintain health records on a patient mobile device, to provide reliable and highly available health history. However, it lacks integration of health records in standard formats and provides limited security features with symmetric encryption and authentication. Although the mobile device of the patient can retain all the health information, it is vulnerable to threats. Hence, it is important to maintain privacy and security of the healthcard [2] as also stated in the regulations of Health Insurance Portability and Accountability Act (HIPAA) and the European Data Protection Directive 95/46/EC. It must address issues such as confidentiality, integrity, availability and non-repudiation of health records through techniques of encryption, authentication, selective authorization, digital signatures, scalable key distribution and revocation, the delegation of keys, audit logs and loss of healthcard.

In this paper, we present a broad overview of the design issues for the security framework of an S-MAPLE (Secure Mobility-Assisted PortabLE) healthcard on the patient mobile device. We briefly discuss the proposed solutions for the security requirements. Due to the limitation of space we present detailed design for the Role Based Access Policy (RBAC) with selective read and write access feature.

The S-MAPLE healthcard integrates dispersed PHRs using standard HL7 format. It retains all medical information including prescription, lab test reports, prescribed and current medications from various hospitals. Different authorised medical professionals access it by just tapping healthcard to their mobile device, using low energy wireless communication interfaces such as NFC [3] and Bluetooth. After reviewing the health history, the medical professional updates or writes a new prescription or lab tests through a secure tap. Both S-MAPLE healthcard application and reader application of the mobile devices of patient and medical professional respectively parse the health records and graphically visualise data for viewing and analysing the records.

The S-MAPLE healthcard uses a hardware tamper resistant SE (Secure Element) in the form factor of a microSD card, for storing cryptographic credentials. It organises the information into various sections. Since different stakeholders such as physician, nurse, lab technician and pharmacist must access the sections according to their roles, they must have selective privileges for each section. The S-MAPLE healthcard is supported by a cloud-based Healthsecure service to manage credentials and provide a data sync on a secure digital vault.

The health records are encrypted using Proxy-based Ciphertext Attribute-Based Encryption (CP-ABE) scheme [4] along with AES for encrypting the healthcard for fine-grained control and providing RBAC (Role Based Access Control) with selective read and write access. The Healthsecure Ser-

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Applications

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Simulation for whole-body vibration to assess ride comfort of a low–medium speed railway vehicle

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Abstract

Vibration in trains constitutes one aspect of the physical environment that can cause discomfort to passengers. In order to assess the vibration, a variety of techniques have been developed and used. The general approach is to acquire acceleration at the passenger–train interface, and to then process these acceleration signals in order to calculate human comfort. However, the comfort index so calculated is independent of the seat characteristics and human parameters. Thus, a human biodynamic model with dynamic seat characteristics is necessary in order to perform true comfort analysis. The biodynamics of human subjects has been a topic of interest over the years, and a number of mathematical models have been established. However, there are only a few studies incorporating biodynamic models in railway applications. So, the present work proposes to evaluate Sperling's Ride Index for a low–medium speed railway vehicle and further to calculate root mean square acceleration of different body parts, as per the International Organization for Standardization (ISO) 2631 guidelines, through bond graph technique. Car body flexibility is also incorporated using modal expansion of a free–free beam. Physiological effects of the vibrations on the human body were analyzed using the criteria specified in ISO 2631.

Keywords

Railway vehicle, simulation, ride comfort, ride quality, human biodynamic model, whole-body vibration

1 Introduction

Railway vehicles provide a more comfortable journey as compared to the other means of transportation. However, the issue of comfort in respect to vibration has become a common question in the railway industry since vibration is one of the vital factors affecting ride comfort. Vibration in trains constitutes one aspect of the physical environment that can cause a sense of discomfort to passengers. In order to assess the vibration, a number of techniques have been developed. The general approach of these techniques is to acquire acceleration at the passenger–train interface, and then to process these signals in order to calculate human comfort. However, the comfort so calculated is independent of the seat characteristics and human parameters.[1] Thus, a human biodynamic model with dynamic seat characteristics is necessary in order to perform true comfort analysis. Passengers, being humans, are most sensitive to whole-body vibration under low-frequency excitation.

The whole-body vibration of occupants in trains constitutes a major aspect of the physical environment that can cause discomfort to passengers and it generally occurs when the human body is supported on a vibrating surface. Frequencies of vibration, which are of interest, generally vary according to the surroundings. The range of frequencies asociated with the effects of whole-body vibration on health, activities, and comfort is approximately 0.5–100 Hz. Further, the range of 0.5–20 Hz is known as the low-frequency vibration range. Low-frequency vibration is the area of interest nowadays, as it has severe effects on human beings. Interference to hand activities (e.g., writing and drinking) can also be greatest at 4–5 Hz. Vision is

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Single NUV Band Pumped PbO-GeO_2-TeO_2:Tb^{3+} Yellowish Green Emitting Glass Material for Tricolor White LEDs

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Abstract

In this work, Tb^{3+} ions doped lead-germanate-tellurite (LGT) glasses were prepared by conventional melt quenching technique with different dopant concentrations ranging from 0.5 to 3.5 mol %. X-ray diffraction (XRD) and FT-IR analysis were carried out to analyze the structural properties of LGT glass. The excitation spectra revealed a single band centered in the NUV region at 380 nm by monitoring emission at 545 nm. The emission spectra consist of four bands, which are attributed to the $^5D_4\rightarrow{}^7F_J$ (J= 3-6) transitions. Among these transitions, the strong emission band was observed at 545 nm corresponding to the $^5D_4\rightarrow{}^7F_5$ transition and the optimized doping concentration of Tb^{3+} ions was 2 mol %. The Huang's theory and I-H model indicate the possibility of energy transfer via electric dipole-dipole interaction between Tb^{3+} ions. The CIE chromaticity coordinates were (x = 0.282 and y = 0.614) and emits intense yellowish green light. The decay curves measured for $^5D_4$ level for the samples with different doping concentrations and the lifetime for the optimized sample was 548 µs. The results indicated that these glasses have potential applications in solid state lighting and display devices.

Keywords: Rare earths, Glasses, Photoluminescence Spectra, CIE Chromaticity Coordinates

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ORIGINAL PAPER

Single Step Biodiesel Production from *Pongamia pinnata* (Karanja) Seed Oil Using Deep Eutectic Solvent (DESs) Catalysts

Yahaya Alhassan[1,2] · Naveen Kumar[1]

Received: 7 October 2015 / Accepted: 14 March 2016

Abstract This paper reports the production of biodiesel from *Pongamia pinnata* seed oil via single step process. The efficiency of deep eutectic solvents (DESs) synthesized from the mixture of choline chloride and para toluene solfonic acid (PTSA), was used with silica support (So-DES) and without support (Un-DES) as heterogeneous and homogeneous catalysts, respectively. The oil esterification with methanol and methyl *tert*-butyl ether as solvents was conducted. From the results, the optimum reaction conditions for esterification of *P. pinnata* seed oil with Un-DES are; catalyst loading 1 (wt%/v), reaction time was 120 min and temperature was 343 K. maximum total acid number (TAN) reduction obtained under these conditions was 0.57 mg/KOH/g and a corresponding biodiesel conversion of 97.53 %. The optimal reaction conditions for esterification with So-DES using methanol as solvent are; temperature of 353 K, catalyst loading was 5 (wt%/v) and reaction time was 240 min. The optimum TAN reduction obtained under these conditions was 1.42 mg/KOH/g with corresponding biodiesel conversion of 89.3 %. Catalysts reuse was between four to seven reuses for Un-DES and So-DES respectively. Physico-chemical properties studies indicated that, viscosity, density and calorific values were within acceptable standard limits. It could be concluded that, DES synthesized from choline chloride and PTSA either with or without supporting material, could effectively produce biodiesel with acceptable fuel quality via single step process.

Keywords Catalytic acidity · DESs · Esterification · FAMEs and total acid number

Introduction

Biodiesel as a diesel engine fuel has superior advantages over its fossil diesel counterpart including its renewability, lower emissions of green house gases and improved lubricity [1, 2]. Furthermore, its energy density is closer to that of diesel, which is a compliment of its high cetane number [3]. Biodiesel may likely contribute to ending the long-term energy crisis and energy politics in some time to come. Thus; biodiesel production is one of the most extensively investigated areas of biofuels, over the last three decades. Still, there is increasing demand for further process improvement in the area of its production, so as to make the final product more competitive in terms of quality and production economics. In line with such process improvements during biodiesel production, several new production processes like intensification [4] and reactive distillation [5] technologies have been reported, recently.

Another area that received appreciable attention in this regard is catalysis. Highly efficient catalysts are been added to the literature pool by the day. Of recent, the use of cation exchange resin [6], mixed oxides [7] and waste-based [8] catalysts showed improved yields, reduced production cost, which is translating into high return on investment. However, the most outstanding and promising catalysts are heterogeneous catalyst like solfonic acid–base and mixed oxides. Additional merits of these heterogeneous acids

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Spectroscopic studies of Pr^{3+} doped lithium lead alumino borate glasses for visible reddish orange luminescent device applications

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Abstract

Lithium Lead Alumino Borate (LiPbAlB) glasses doped with Pr^{3+} ions were prepared via melt quenching technique to study their luminescence behavior using absorption, excitation, photoluminescence (PL) and decay spectral studies. A broad hump observed in XRD confirms the amorphous nature of the as-prepared glass. The glass transition temperature (T_g) and thermal stability (ΔT) were measured from Differential Scanning Calorimetry (DSC). FT-IR and Raman studies were performed to understand the network functional groups involved in the host glass. Various radiative parameters for the prominent fluorescent levels of Pr^{3+} were evaluated with in the frame work of Judd-Ofelt theory. PL and confocal images recorded under 445 nm Continuous Wave (CW) diode laser excitation were used to understand the visible emission characteristic features of the as-prepared glasses. The decay profiles of $^1D_2 \rightarrow {}^3H_4$ show single exponential for lower concentration and non-exponential for higher concentration resulting decrease in experimental lifetime (τ_{exp}) with increase in concentration. Such decrease in τ_{exp} and decay conversion from single to non-exponential with increase in rare earth ion concentration has been attributed to the cross-relaxation processes and subsequent concentration quenching observed. From the emission cross-sections, branching ratios, quantum efficiency, CIE coordinates and confocal images, it was concluded that 1 mol % Pr^{3+} ion concentration is optimum in LiPbAlB glasses to develop visible reddish orange luminescent devices.

Keywords: Praseodymium, Glasses, Raman spectra, Judd-Ofelt parameters, Photoluminescence, Confocal images.

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Stress analysis of lower back using EMG signal.

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Abstract

The purpose of this study was to examine the force/EMG relationship during flexion and erection movement of human back during occupation at different positions using surface Electromyography (sEMG) signal. This tool is a non-invasive technique that allows the evaluation of muscle activity. Human's back is most sensitive part of human body and postures of human body have a significant role to analyze pain especially in the low back region. In this approach surface electrodes are used to record surface electromyography (sEMG) signals of lower back, in the limited forward and backward movement from vertical position, placed at different positions of vertebrae of the lumber region to have a prediction on the stress level of muscles involved in the movement. Preliminary Investigation on three subjects of age groups below 40 years and above 40 years was carried out for three different sitting postures to analyze the differences in EMG signals using Analysis of variance (ANOVA). After Preliminary investigation on three subjects, the experiment was extended to nine subjects in six different sitting postures. ANOVA test has clearly indicated that there exists a statistically significant difference amongst the mean values of EMG signals for different sitting postures and in further investigation, minimum stress level is found in the angle range from 90°-120°. According to the minimum stress level between the angle range 90°-120°, seat may be designed including back rest flexibility in the angle range of 90°-120°.

Keywords: Force, Low back pain, Position of lower back, sEMG.

Accepted on May 10, 2016

Introduction

The spine is a complicated structure providing support to the body [1]. One important mechanical function of the lumbar spine is to support the upper body by transmitting compressive and shearing forces to the lower body during the performance of everyday activities [2]. In recent times, low back pain is a common problem in all working professionals. In spite of growing knowledge pertaining to spinal diseases and momentous developments in modern medicine, chronic Low Back Pain (LBP) remains one of the most severe public health problems in all countries including India. Low back pain is the leading musculoskeletal disorder in terms of cost and work-absenteeism [3]. The effectiveness of different kinds of treatments has been studied in the literature, but a definite consensus has yet to be established [4]. LBP causes a socio-economic impact promoting many days lost in work [5]. Several studies suggest that instability can cause damages and lumbar dysfunctions and increase the risk of an initial episode and subsequent recurrence of LBP [6,7]. Severe back pain most often arises from intervertebral discs, apophyseal joints and sacroiliac joints, and physical disruption of these structures is strongly but variably linked to pain [8]. More of the people with persistent back pain who report limitations in functioning have used health care services compared with others in the sample who also reported functional limitations, presumably resulting from health conditions other than back pain [9]. Therefore, many authors have recommended inclusion in rehabilitation programs of exercises specifically designed to improve active stability of the spine [10,11].

The main motivation of this paper is to study the effect of sitting postures at different angles, which is primarily the main cause of occupational pain. Another purpose of the paper is to investigate the stress level of the muscles involved in these postures using Electromyographic (EMG) signals. Muscle activity is directly reflected by EMG signals. Low muscle activity indicates less energy is required to maintain the posture. So such a study will be useful ergonomic intervention to suggest a proper sitting angle. The proper posture is associated with elastic equilibrium, in which the least elastic stress and lowest joint load are produced [12], which is reflected by the low levels of muscle activity. The proper posture mean the less energy required to maintain the posture

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Study of corrosive fatigue and life enhancement of low pressure steam turbine blade using friction dampers †

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Abstract

The paper investigates the causes of failure of low pressure steam turbine blade of the last stage and suggests few techniques to overcome the failure causes is presented in this paper. The blade under investigation is made of chrome alloy steel. The fracture occurred at the airfoil region of the blade. The investigation included visual inspection, micro structural characterization, SEM-EDS microanalysis and spectroscopy test to identify the causes of failure. The paper also suggests the methods to reduce the blade fatigue subsequently through computation and to enhance the fatigue strength of the steam turbine blade. In order to reduce the blade fatigue susceptibility and to enhance the fatigue life of the steam turbine blade, the wedge shape friction damper is proposed.

Keywords: Steam turbine blade; Fracture; Corrosion; Fatigue; Friction damper; Bondgraph modeling

1. Introduction

Steam turbine is the simplest and most effective engine for converting large amounts of heat energy into mechanical work. During the past few decades, the operating temperatures of steam turbine engines have been on the rise to achieve higher and higher engine power and higher efficiency. This has necessitated a continuing advancement in high temperature withstand materials. The steam turbine blades are the critical components in main power equipment in nuclear and fossil power plants and in event of their failure, the power plant will shut down and cause long time power failure and economic loss.

As the high pressure steam from the boiler enters the turbine, it passes through different stages such as High pressure (HP), Intermediate pressure (IP) and Low pressure (LP) stage and with the help of turbine blades the linear motion of superheated steam gets converted into a rotary motion of the turbine shaft, which further drives the generator rotor [1]. As the steam expands, it acquires huge velocity and exerts a great force on the turbine blades [2]. In the course of steam expansion through LP turbine section, the steam generally crosses saturation line. This is the region where condensation of superheated steam begins and may be termed the Phase transition zone (PTZ) or Wilson line [3]. In steam turbines this

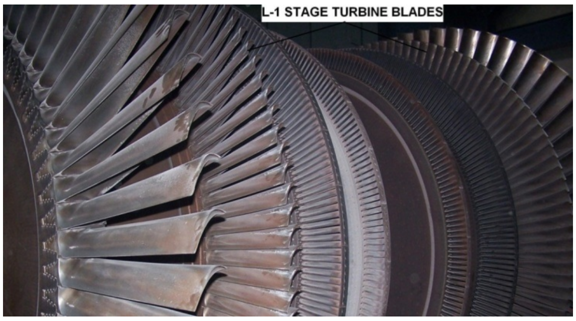

Fig. 1. L-1 row steam turbine blades of LP turbine stage.

phase transition zone is usually found at L-1 stage, which lies in the transonic flow region. Due to this transonic velocity (Mach = 1) the sonic shock waves is produced which, can be source of blade excitation and cyclic stresses that causing fatigue or corrosion fatigue [4]. Unfortunately, this is the region where maximum corrosion damage has been observed [5]. The general view of the double flow low pressure steam turbine blades is shown in Fig. 1, where L-1 stage blades are mentioned separately.

The steam turbine blade failures can happen for many reasons including corrosion fatigue, fatigue fracture, stress corrosion, erosion, defective manufacturing and assembly, fault operation, design errors and others but it has been observed that in steam turbines the forced outages due to corrosion fatigue accounts for the most [6]. It is well-documented that LP steam turbine blades are more susceptible to failure than HP

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Study on Airborne Heavy Metals in Industrialized Urban Area of Delhi, India

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Abstract This study assessed the concentrations of airborne heavy metals (HMs) in particulate matter with a cutoff size of 10 µm (i.e., PM_{10}) in an industrialized urban area (Naraina Industrial Area) of New Delhi, India. The samples were collected from January to December, 2011. The annual mean concentrations of selected HMs were as follows As (0.002 ± 0.002), Cd (0.030 ± 0.020), Co (0.003 ± 0.002), Cr (0.170 ± 0.081), Cu (0.183 ± 0.120), Fe (4.774 ± 1.889), Mn (0.258 ± 0.145), Ni (0.170 ± 0.146), Pb (0.345 ± 0.207) and Zn (1.806 ± 1.042) µg/m^3. The seasonal trend for HMs followed the order postmonsoon > winter > premonsoon > monsoon. Principal component analysis-multiple linear regression (PCA-MLR) suggested the three major emission sources: industrial emission (70 %), mobile and stationary combustion sources (16 %), and suspended/re-suspended dust (14 %). Mean seasonal concentrations of PM_{10} exceeded both the 24-hour and annual Indian National Ambient Air Quality Standards (NAAQS) of 60 and 100 µg/m^3, respectively, in all four seasons. Mean seasonal Ni concentrations in Delhi ambient air also exceeded the 24-h annual NAAQS of 0.020 µg/m^3 during all four seasons. Mean Pb concentrations exceeded the annual NAAQS of 0.50 µg/m^3 only during the post monsoon season. The high levels of Ni- and Pb-contaminated PM_{10} would appear to present the possibility of significant health risks.

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Keywords Heavy metals · Particulate matter · Season · Urban air pollution · Delhi

India is facing progressive deterioration in air quality attributable to growing trends of particulate matter (PM), particulate associated heavy metals (HMs), and gaseous pollutants in ambient atmosphere (Agrawal et al. 2003). Thus, air pollution and its adverse effects on human health have become a major concern among researchers in India. Air borne PM is a unique class of air contaminants because of its potential complexity both in terms of chemical composition and physical properties. The effects of PM on the atmosphere, climate and public health are among the central topics in recent environmental research. They are solid and liquid particles varying in size from nanometer to micrometer range. They are also responsible for climate change by disturbing the energy balance of the earth, hydrological cycles, atmospheric circulation and high emission of greenhouse and reactive trace gases (Pöschl et al. 2005).

Several studies have revealed that HMs and their compounds that are associated with PM_{10} are respirable and can persist in the atmosphere for longer duration. HMs are indestructible and most of the HMs have toxic effects on living organisms. Although some of the metals are essential to humans in order to remain healthy, but should not exceed the desired limit as they can also pose toxicological risks (Shinggu et al. 2010). They may originate from both natural and anthropogenic sources, but anthropogenic origin is of major concern (Mafuyai et al. 2014). The natural sources of HMs include terrestrial dust, bioorganic emanations, emission from forest fires etc. The anthropogenic sources includes emissions from power plants, non-ferrous metal smelters, incinerators, steel and cement plants, fossil fuel burning, electroplating, surface coating, transportation, domestic combustions and

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ORIGINAL PAPER

Suppliers' green performance evaluation using fuzzy extended ELECTRE approach

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Received: 6 June 2016 / Accepted: 13 August 2016

Abstract In the present context of the globalized market, sustainable manufacturing has become a major concern for all organizations. The sustainable manufacturing system includes economic, environmental, and social sustainabilities. Green manufacturing enhances the environmental sustainability but, it also affects the economic and social sustainabilities. The compulsion to follow the environmental rules and regulation in any business activity has increased the awareness for the use of green products, recyclable materials for packaging, reduction of carbon emission, etc. Due to the involvement of extra costs in green manufacturing, some ignorance in the implementation of green practices may be observed. To ensure sustainable systems, selection of suppliers based on green performance measures is very important. This study evaluates the suppliers' performances based on Green Practices as follows: environmental management and pollution control, cost, quality, and flexibility using the fuzzy-extended Elimination and Choice Expressing Reality approach. This approach helps the managers to incorporate the linguistic decision of the decision makers and convert it into quantitative scale. This method is used to eliminate and outrank the poor performers. As poor performers are outranked, this approach helps to select the most suitable green suppliers as per organization's requirement.

Keywords Green supply chain management · Sustainability · Supplier evaluation · Outranking · Fuzzy sets · ELECTRE

Electronic supplementary material The online version of this article (doi:10.1007/s10098-016-1268-y) contains supplementary material, which is available to authorized users.

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Introduction

In the recent past, climate change and its impacts on the society had been gaining momentum; and managing pollution-free environment is becoming very important in today's business scenario (Mangla et al. 2014). Therefore, business managers/practitioners are under immense pressure to lessen the harmful ecological and social impacts in their supply chains (Ağan et al. 2016). Sancha et al. (2015) established the relationship between institutional pressures and the sustainable supplier development in various locations. Mansi (2015) discussed sustainable disclosure practices in the purchasing activities of Indian government's public sector enterprises. Green manufacturing is concerned with the replacement of hazardous or nonrenewable inputs by less-hazardous materials or renewable materials, respectively; better control of operations at higher efficiency; equipment modification; technology change; and product modification for minimization of the waste and the emission. The compulsion of linking the green practices

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SWOT Analysis of Ontology Driven Software Engineering

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Abstract

In the past decade offshoring and outsourcing the software development phenomenon has been undeniably a key software engineering practice. The need to adapt to this new reality is obvious and is bound to have a long lasting influence on the software industry. This fosters the industry and researchers to look for intelligent supporting technologies and tools that can help interconnect and exchange Software Engineering knowledge. A rising trend to exploit ontologies for sharing and reusing information across web is well recognized. We examine the strategic alignment of ontologies to Software Engineering where the former can be used to improve and assist in intelligent software development process. The SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis is presented giving an insight to the use of ontologies to enrich and enhance Software Engineering processes.

Keywords: Ontology, Ontology Driven, SWOT Analysis, Semantic Web, Software Engineering

1. Introduction

"Semantic Web provides a common framework that allows data to be shared and reused across application, enterprise, and community boundaries"[1]. It is a machine processable "Web of Data"[2]. Semantic Web stack illustrates the architecture of the Semantic Web that encompasses of several languages or technologies. At the core of architecture is "Ontology, which is an explicit, formal specification of shared conceptualization"[3]. Ontologies are used to represent abstract model, where a domain is fixed with identified relevant concepts and relationship among those concepts. Ontology engineering in Semantic Web is principally supported by languages such as XML, RDF, RDFS and OWL[4].

At the same time, the conventional area of Software Engineering has come a long way in both research and practice. Formally, Software Engineering is "the application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software, and the study of these approaches; that is, the application of engineering to software"[5]. Software development is a multifaceted participative and collaborative task that comprises a lot of effort from various participants and yields considerable amount of information. Reusing extant pertinent information saves significant effort during the development and maintenance of software system. Moreover, according to the recent IT Outsourcing Statistics 2015/ 2016 report by Computer Economics[6] in 2015, around 62% of the Application development work has been outsourced either entirely or in part by IT organizations and in the past 5 years, over 60% of companies outsourced their application development work. Externalizing the software development would thus mean

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SymPy: symbolic computing in Python

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ABSTRACT

SymPy is an open source computer algebra system written in pure Python. It is built with a focus on extensibility and ease of use, through both interactive and programmatic applications. These characteristics have led SymPy to become a popular symbolic library for the scientific Python ecosystem. This paper presents the architecture of SymPy, a description of its features, and a discussion of select submodules. The supplementary material provide additional examples and further outline details of the architecture and features of SymPy.

Subjects Scientific Computing and Simulation, Software Engineering
Keywords Python, Computer algebra system, Symbolics

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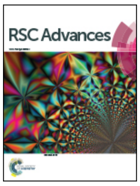

From the journal:
RSC Advances

The diurnal variability of sulfate and nitrate aerosols during wintertime in the Indo-Gangetic Plain: implications for heterogeneous phase chemistry

Check for updates

Prashant Rajput,[a] Tarun Gupta*[a] and Anil Kumar[b]

Author affiliations

Abstract

We have conducted this study (November 09–February 10) during the daytime (average PM_1: 113 μg m^{-3}; n = 51) and nighttime (average PM_1: 159 μg m^{-3}; n = 49) in the Indo-Gangetic Plain (IGP). Air-mass back trajectories suggest the impact of local emission and long-range transport (predominantly from the north–west direction). Mass fractions of SO_4^{2-} and NO_3^- in PM_1 are significantly (p < 0.05) different during both the daytime and nighttime, whereas NH_4^+/PM_1 were similar during the day and night. The relatively high concentration of SO_4^{2-} observed during the daytime was explained based on heterogeneous-phase reactivity due to the positive response of

Journal of Pharmacy & BioAllied Sciences

ORIGINAL ARTICLE
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Therapeutic potential of alpha-ketoglutarate against acetaminophen-induced hepatotoxicity in rats

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Abstract

Objective: Alpha-ketoglutarate (α-KG) is a cellular intermediary metabolite of Krebs cycle, involved in energy metabolism, amino acid synthesis, and nitrogen transport. It is available over-the-counter and marketed as a nutritional supplement. There is a growing body of evidence to suggest that dietary α-KG has the potential to maintain cellular redox status and thus can protect various oxidative stress induced disease states. The aim of the present study was to investigate the hepatoprotective role of α-KG in acetaminophen (APAP) induced toxicity in rats. **Materials and Methods:** Animals were divided into three groups of six animals each. Group I (Vehicle control): Normal Saline, Group II (APAP): A single intraperitoneal injection of 0.6 g/kg, Group III (APAP + α-KG): APAP as in Group II with α-KG treatment at a dose of 2 g/kg, orally for 5 days. Then the levels of alanine aminotransferase (ALT), aspartate aminotransferase (AST), and alkaline phosphatase (ALP) with oxidative stress markers including malondialdehyde (MDA), reduced glutathione (GSH), superoxide dismutase (SOD), catalase (CAT), and histopathology were analyzed. **Results:** The results indicate that APAP caused significant elevations in ALT, AST, ALP, and MDA levels, while GSH, SOD, and CAT were significantly depleted while co-administration of α-KG showed a significant ($P < 0.05$) reduction in the severity of these damages. Histologically, the liver showed inflammation and necrosis after APAP treatment, which were significantly restored with co-administration of α-KG. **Conclusion:** These results indicate the possible therapeutic potential of α-KG in protecting liver damage by APAP in rats.

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Full Text

Acetaminophen (N-acetyl-p-aminophenol; APAP), commonly known as Paracetamol, is one of the most successful analgesic and antipyretic drug. As an OTC drug, it can be readily obtained without prescription. Within recommended dosages (4 g/day), APAP is considered to be a safe drug whereas a dose greater than this can lead to severe liver damage.[1] APAP-induced hepatotoxicity results from saturation of normal metabolic pathways, cytochrome P-450, which leads to the formation of reactive metabolite, N-acetyl-p-benzoquinone imine (NAPQI). NAPQI depletes natural antioxidant such as reduced intracellular glutathione (GSH) and enhanced lipid peroxidation (LPO) which results in cellular oxidative stress.[2]

Alpha-ketoglutarate (α-KG), a citric acid cycle intermediate metabolite and precursor to glutamine which in turn is a precursor to GSH, has been marketed as nutritional supplement since a long time.[3] In vitro and in vivo studies have shown that exogenously administered α-KG has the potential to improve redox homeostasis and can protect cell from oxidative stress caused by free radicals.[4] The experimental findings suggest that exogenous α-KG may have the potential to prevent various oxidative stress induced diseased liver states. This study was therefore taken up to assess the protective role of α-KG in APAP-induced hepatotoxicity in an established rat model.

Materials and Methods

Chemicals and reagents

Disodium α-KG was purchased from Fluka Chemika, Buchs, Switzerland and APAP was purchased from Lambert Pvt. Ltd., India. All other chemicals were of analytical grade.

Experimental animals

Eighteen male Sprague-Dawley rats weighing (200–250 g) were obtained from the Experimental Animal facility of Institute of Nuclear Medicine and Allied Sciences, Delhi. The study protocol was approved by the Institutional Animal Ethics Committee (IAEC) of the institute (INM/IAEC/2009/06/009).

Acetaminophen-induced hepatotoxicity

Animals were divided into three groups of 6 animals each. Group I (vehicle control): Normal saline, Group II (APAP): a single intraperitoneal injection of 0.6 g/kg, Group III (APAP+ α-KG): APAP as in Group II with α-KG treatment at a dose of 2 g/kg, orally for 5 days. The doses for α-KG and APAP were selected on the basis of previous works reported in the literature from our laboratory and elsewhere.[5],[6] The animals were sacrificed after 24 h of the treatment period using diethyl ether. Blood and liver tissue samples were collected. Serum was separated by centrifugation at 3000 rpm for 10 min for liver profile test.

Measurement of liver function test and antioxidant activities

Intracellular enzymes - alanine aminotransferase (ALT), aspartate aminotransferase (AST), and ALP were determined using commercially available kits.

The homogenate of frozen liver tissue (stored at −80°C) was used for evaluating antioxidant activities. LPO, superoxide dismutase (SOD) activity, GSH, catalase (CAT), and protein content were determined by the method of Mihara and Uchiyama,[7] Robak and Gryglewski,[8] Ellman,[9] Sinha,[10] and Lowry et al.[11] respectively.

Statistical analysis

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Research Paper

Thermodynamic and thermoeconomic analyses of two stage hybrid absorption compression refrigeration system

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HIGHLIGHTS

- Hybrid absorption compression refrigeration system employing LiBr-H_2O is proposed.
- It requires lower generator temperature than conventional two stage system.
- Parametric analysis is performed to investigate the effects of operating variables.
- The size and cost of the hybrid system are estimated.
- Thermoeconomic optimization is done to minimize total annual plant operation cost.

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ABSTRACT

In this paper a two stage hybrid absorption compression refrigeration system utilizing LiBr-H_2O as working fluid is proposed. The hybrid system is compared thermodynamically with the conventional two stage absorption refrigeration system and it is found that the former can be operated at lower generator temperature and performs better than the latter. The effects of various operating parameters on thermodynamic and thermoeconomic performance indices like exergetic efficiency, area of heat exchangers and cost of the system are also studied. The heat exchangers are designed to estimate the size and cost of the system. The objective of thermoeconomic optimization is the minimization of annual cost of system, which includes investment costs and exergy fuel costs. The optimized hybrid system has COP of 0.43 and exergetic efficiency of 11.68%. The optimization results in the reduction of heat exchangers area from 79.61 m^2 to 71.96 m^2 and annual cost of operation of hybrid system by 5.2%.

1. Introduction

The energy and environmental issues associated with conventionally employed electricity driven vapor compression refrigeration (VCR) systems have paved the way for vapor absorption refrigeration (VAR) systems primarily because of latter's ability to harness renewable energy and recover waste heat without damaging the environment. However, on the performance front VAR systems lag far behind VCR systems and therefore, integration of these two technologies is looked upon as a potential alternative. This allows the retention of merits and rejection of shortcomings of both VAR and VCR technologies.

There are several studies which suggests that absorption compression hybrid refrigeration systems perform better than conventional VAR systems. Boer et al. [1] studied a hybrid absorption compression refrigeration system in which compressor was integrated between the evaporator and the absorber of a double effect VAR system. The COP of the hybrid cycle was reported to be 15–50% higher than the standard double effect VAR cycle without compressor. Kim et al. [2] reported that the generator temperature can be appreciably lowered by integrating a compressor in a triple effect vapor absorption refrigeration cycle. Zheng and Meng [3] found that the presence of a mechanical compressor between the evaporator and the absorber of a single effect VAR system can lower the required generator temperature and heat input. Kang et al. [4] found that using compressor between the evaporator and the absorber, the COP of GAX refrigeration cycle can be improved by 24% and by employing compressor between the generator and the condenser generation temperature can be lowered from 190–200 °C to 164 °C.

Most of the studies on absorption compression hybrid refrigeration systems involves single/double/triple effect VAR

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Towards Formalizing Adaptive Software Services

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***Abstract*—More and more complex, distributed and software-intensive systems are built using independently developed services. Due to various reasons, such as changes in the execution environment, these systems may need to adapt their behavior. Although, adaptation at the system level has been extensively studied, developing adaptive services to start-with has not received any significant attention. This paper describes a framework for formalizing the concept of adaptation at the service level, leading to the "service adaptation by construction" approach. Hence, the proposed work will help software developers in identifying the important adaptation categories at the service level.**

Keywords—services; formalism; adaptation; taxonomy.

I. Introduction

Adaptation can be considered as a key factor for the survival of species in nature. Similar to the natural species, current and future distributed, complex, and software-intensive systems (henceforth referred as "*DCS systems*") will also need to adapt their behaviors – due to various reasons such as changes in the requirements and execution environments, demands for reuse and potential economic benefits. Such DCS systems are often composed as an ensemble of independently developed and deployed software services, thus, these individual services also need to be adaptive. Software Adaptation is widely recognized as an important problem in software engineering [1, 2]. It offers benefits such as high degree of flexibility, low maintenance cost, reliability and dependability and improved Quality of Service (QoS) [3].

Despite of its importance, adaptation in most cases is considered as an afterthought. Such an ad-hoc approach generally involves the use of wrappers or adapters on the top of existing services or DCS systems to enable the desired adaptation. Such approaches can significantly increase the risk of unintended behavior of a DCS system or a service as they might not operate as desired. Also, such a service or a DCS system would not be properly tested as it might not be possible to test all adaptation scenarios when they are considered as an afterthought. Although, adaptation at the level of DCS systems has been extensively studied, developing adaptive services to start-with has not received any significant attention. The current methods and techniques are not powerful (see the next section) to develop such services using the "adaptation by construction approach".

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Hence, there is a need for a formalized approach towards software service adaptation – this requires a systematic study of the nature of adaptations that are applicable for software services and their appropriate categorization. Such a formalization and associated taxonomy will not only be crucial but also helpful for the developer of an adaptive service (and hence, an adaptive DCS system). In this paper, we focus on the adaptation by construction for individual services and not on their composed DCS systems. This paper describes a framework for formalizing the concept of adaptation at the service level, leading to the "service adaptation by construction" approach.

The rest of the paper is organized as follows: next section briefly discusses prominent related efforts; Section 3 presents the details of the proposed approach and illustrates the proposed approach by indicating a few examples; the paper concludes with lessons learnt and an outline of future efforts.

II. Related Works

Many frameworks have been proposed to support different types of software adaptations. In FUSION framework [4], a learning-based approach is presented for run-time software adaptation in which the adaptation decisions are learned to make them more accurate. The adaptive behavior of the system is analyzed and tuned for unanticipated changes. In [5], the concept of control data is introduced and the relationship between the behaviors of a component with the control data is identified. Change of the control data triggers change in behavior which is viewed as adaptation. [6] describes a framework which is based on a model-driven middleware based approach for adapting applications and services dynamically. In [7], an architectural model based approach to self-adaptation is presented in which system level properties and constraints are exposed with the help of the model. A majority of these approaches are focused on system-level adaptation or adaptation at run-time – they do not consider a formal notion of adaptation while developing individual services, as advocated by our approach.

In literature, a few taxonomies have also been proposed in the past. For example, in [8], a classification scheme has been described for self-adaptive systems. Five major characteristics have been defined, namely, origin, activation, system-layer, operation and controller distribution. In [9], the authors propose another taxonomy for self-protecting systems which can detect and tackle security threats at runtime. A signature level taxonomy is proposed in [10], which describes the

Tree Structured Data Processing on GPUs

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***Abstract*—In order to reduce the computing time for processing large tree-structured data sets, parallel processing has been used. Recently, research has been done on parallel computing of tree-structured data on Graphics Processing Units (GPUs). GPU device cannot directly access the tree structured data on hard disks which is commonly stored as objects or linked-lists. So, it is required to copying this tree structured data from hard disk to device memory for the computation and copying tree structured data in its normal structure is very costly because of lots of pointers overhead. Existing tree data structures on GPUs are commonly applied to storing a particular kind of tree, and support limited types of tree traversals. In this work, a tree data structure is proposed to store different kind of trees as a linear data structure (fast in copying). The proposed data structure is applied on general trees and binary trees and supports four common types of tree traversals: pre-order, post-order, in-order and breadth-first traversals. Therefore, most of the tree algorithms can be implemented on GPUs by using this proposed data structure. The results show that the proposed data structure is successfully implemented for all the traversals for binary as well as general trees.**

***Index Terms*—Tree traversals, GPU, binary tree, general tree, CUDA, parallel processing.**

I. Introduction

Tree-structured data are used in many applications such as glycan tree structures in biology [1], B-trees in file systems [2], balanced search trees in routing algorithms [3], tree similarity measuring applications [4]. To reduce the computing time for processing large tree-structured data sets, parallel processing has been used [5] [6]. Recently, many researchers have used GPUs for parallel computing of various applications including trees. The majority of these applications are developed for tree searches [7] [8] [9] [10] and others to process tree-structured data [11] [12]. Recently, a demonstration of general-purpose techniques on several tree traversal algorithms, achieving speedups of up to 38x over 32-thread CPU versions is given in [13]. Also, a novel spatial decomposition based data structure, called shell, which completely avoids hierarchical search for ray traversal is introduced in [14]. GPU parallel N-body tree traversal with simulated wide-warp is also introduced in literature [15]. Commonly, a special kind of tree structure is used in a particular field, such as B-trees used in file systems and octrees used in partitioning a three dimensional space.

Although GPUs have shown their advantages in multi-threaded parallel computing, there are still some strong restrictions for GPU programming. GPU programs are not able to access the hard disks directly; data which are read from hard disks or generated on CPUs need to be copied to GPU global memory for processing. In some applications, data can be generated on GPUs [11]. But copping a data from hard disk to device memory in the form of tree, it is very time consuming process because of lots of pointers in tree data structures are to be handled. It is very crucial issue in the GPU computing.

To improve the performance of GPU with respect to the issue as mentioned, a data structure is proposed which can be applied to store any kind of tree (binary or general tree) as a linear data structure. As a fact linear data structure is very faster to be copied from one memory to another. To verify its correctness and effectiveness with respect to tree data structure requirements on GPU, we have carried out our experiments on an NVIDIA Tesla K10 GPU [16] [17]. In our experiments, GPU devices are used as accelerators to process tree-structured data, and the initial data are stored on hard disks as XML/HTML files. For the experiments, basic operation on tress i.e. traversal (which is primarily required to perform most of the operation on the trees) is considered for the processing. With an assistance of GPU thousands of trees can be traversed/processed at the same time which are commonly required for various computational applications like Similarity computation and matching[]. Results proved that the proposed tree data structure supports four common types of tree traversals [18]: pre-order, post-order, breadth-first traversals for general trees and in-order traversal for binary trees successfully.

II. Tree Data Structure Requirements on GPUs

This paper explores processing tree-structured data on GPUs in general; threads are activated to process trees independently. We would like to design a data structure that meets the following the requirements:

- R1 - the capability to store a set of trees as linear data structures,
- R2 - the capability to store any kind of trees, that is capability to store general trees,
- R3 - the support for breadth-first traversal and three types of depth-first traversals (pre-order, post-order traversals for general trees and in-order traversal for binary trees).

In order to develop a data structure that meets our requirements, we have studied tree data structures proposed for GPUs. In GPUs, the shared memory size is small, and shared by all

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Understanding the role of internal microstructure in capsule-based healing of polymeric composites

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ABSTRACT: The efficacy of microcapsules possessing varied internal microstructure toward introducing extrinsic self-healing functionality in epoxy has been compared. Unsaturated polyester was encapsulated in microcapsules by adopting different methodologies. Microcapsules formed using dispersion polymerization exhibited "reservoir" microstructure while solvent evaporation led to the formation of "monolithic" microcapsules. Theoretical model was developed to predict the amount of healant released in the event of microcapsule rupture, which clearly highlighted the benefits associated with reservoir type microcapsules, especially at lower core contents. At larger core contents ($\geq$50% vol/vol), all the micro-droplets within the monolithic structure coalesced to form a healant reservoir. Self-healing composites were prepared by introducing both types of microcapsules in an epoxy matrix and the healing efficiency was quantified. In line with the theoretical predictions, reservoir type microcapsules led to much higher healing efficiencies in comparison to monolithic microcapsules. © 2017 Wiley Periodicals, Inc. J. Appl. Polym. Sci. **2017**, *134*, 45471.

KEYWORDS: composites; theory and modeling; thermosets

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INTRODUCTION

Self-healing polymers belong to the category of smart responsive materials, which possess an inbuilt ability to recover their properties. These materials are finding increasing usage as products in wide class of industries like coatings, electronics, energy, and transportation.

What renders this approach particularly attractive is envisioning the repair process in the absence of the crack detection step. In this context, one of the approaches of extrinsic self-healing is particularly interesting, where the healing agent is dispersed within the polymeric matrix in different containment structures i.e., hollow glass tubes,[1] micro-vascular networks,[2] and microcapsules,[3–6] with the latter being most extensively studied. It is to be noted, however, that at increased loadings of microcapsules, the composite may exhibit inferior mechanical properties, which can actually reduce the lifetimes. The process of repair is initiated by the rupture of containment structure resulting from crack propagation. The mending monomer is released into the crack plane, and subsequently undergoes polymerization to re-establish its structural integrity.

Considering a microcapsule-based healing system, the method of encapsulation defines its internal microstructure, which in turn affects the self-healing efficiency. Conventionally, healant encapsulated microcapsules are prepared using dispersion polymerization route wherein the hydrophobic healant remains encapsulated within a spherical fragile shell. During the dispersion polymerization process, the shell wall constituents undergo condensation reaction within the aqueous phase to form a low-molecular-weight pre-polymer, which deposit preferentially over the healant on the oil–water interface i.e., urea or melamine with formaldehyde. Eventual crosslinking within the chains forms a spherical solid wall around a liquid core forming a "reservoir" of healant.

Another relatively less complex methodology, which almost routinely employed for the encapsulation of drugs for pharmaceutical applications, is "solvent evaporation."[7] Interestingly, the use of this process for healant encapsulation is not so popular, but has garnered a lot of attention lately.[8–12] It is to be noted that for the purpose of healant encapsulation, the essential criteria reduces to the compatibility of the fragile microcapsule shell wall with the base resin, and other features like biocompatibility and degradability can be dispensed, which are an absolute necessity for pharmaceutical applications. Solvent evaporation leads to the formation of a monolithic structure, where the

Additional Supporting Information may be found in the online version of this article.

A Multimodal Approach to Predict Social Media Popularity

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Abstract

Multiple modalities represent different aspects by which information is conveyed by a data source. Modern day social media platforms are one of the primary sources of multimodal data, where users use different modes of expression by posting textual as well as multimedia content such as images and videos for sharing information. Multimodal information embedded in such posts could be useful in predicting their popularity. To the best of our knowledge, no such multimodal dataset exists for the prediction of social media photos. In this work, we propose a multimodal dataset consisiting of content, context, and social information for popularity prediction. Specifically, we augment the SMP-T1 dataset for social media prediction in ACM Multimedia grand challenge 2017 with image content, titles, descriptions, and tags. Next, in this paper, we propose a multimodal approach which exploits visual features (i.e., content information), textual features (i.e., contextual information), and social features (e.g., average views and group counts) to predict popularity of social media photos in terms of view counts. Experimental results confirm that despite our multimodal approach uses the half of the training dataset from SMP-T1, it achieves comparable performance with that of state-of-the-art.

1. Introduction

Huge volumes of social media content are produced by platforms such as Twitter, Facebook, Instagram, among others. People often respond to such content by viewing, liking, commenting, and sharing due to the social nature of these platforms. Predicting the popularity of a photo on being posted in a social media platform can find significant uses in the domains of content recommendation, advertisement, information retrieval, among others. Modeling the prediction of popularity of photos have attracted a lot of attention in research community. ACM Multimedia Conference, 2017 presented a social media prediction task (SMP-T1) in the form of a grand challenge. Several contributions [11, 24, 9, 7] were submitted in this challenge. However, most of them just focused on information provided in the SMP-T1 dataset which includes average counts for views, comments, tags, groups, members, and lengths of title and description. Since one modality might not be enough to solve a complex problem like popularity prediction, some of the submissions [5, 12] also used image content. Motivated by such work, first, we propose a new dataset, called *multimodal-SMP-dataset*, by augmenting the existing SMP-T1-dataset with additional contextual information such as titles, descriptions, and tags of social media photos in addition to crawling image content (actual photos). Next, we propose a multimodal technique for social media popularity prediction by exploiting multimodal information.

In SMP-T1 task, researchers need to provide their solutions to predict popularity of Flickr photos based on the information (first 11 fields) provided in Table 1. URLs of photos are also provided. Approximately half of the image links are broken in the original SMP-T1-dataset. Therefore, we use only 200K Flickr photos out of 432K photos in training but keep the same test set for a fair comparison with the state-of-the-art systems. Moreover, since SMP-T1-dataset (with 432K photos) does not provide much content and contextual information, we add *tags*, *title*, and *description* in addition to image content in the proposed multimodal-SMP-dataset (with 200K photos). This will help researchers who would like to leverage multimodal information in solving social media popularity prediction problem.

In order to predict the popularity of a social media post,

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Real Time State Observer based Controller for Stochastic Robotic Manipulator

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***Abstract*—In this paper, a generalized linear feedback matrix controller is investigated for the state of n-link robot to track the desired trajectory in the presence of stochastic noise. The novel feature of the control algorithm is that it is based on $Ito's$ stochastic calculus for the minimization of the conditional expectation of the instantaneous tracking error energy differential with respect to the feedback matrix subject to energy constraints. The proposed control algorithm enables the adaptive features for tracking of the robotic manipulator. Additionally, the effects of feedback coefficients and parametric uncertainty on the error energies of the system are also studied using sensitivity analysis. Finally, the experimental results conducted using the "Phantom Omni^{TM}Bundle" robot manipulator demonstrate and validate the potential application of the proposed control algorithm on a real system.**

***Index Terms*—Robotic Manipulator, State Observer, Parameter Uncertainty, Process Noise, Measurement Noise, Proportional Derivative Extended Kalman Filter (PDEKF)**

I. INTRODUCTION

Tracking control and stability are the traditional issues of investigation in robotics. In the absence of noise, the techniques such as robust control, adaptive control, nonlinear PID control, H_∞ control, sliding mode control, etc. have been implemented to meet these issues [1]-[7]. However, in physical system, noise is an inherent part of measurand and need to be considered while designing the controller [8]-[15]. Artificial intelligent techniques are used to develop the controllers using input-output data of the process when model is not available or uncertainties are present in the system [16]-[18]. He and Dong [19] has developed a fuzzy neural network based control strategy so that the tracking error and impedance error remain bounded [19]. They have shown that a quadratic Lyapunov function of the tracking error, auxiliary state, and the neural weight vector has a negative rate of increase, thereby, guarantees asymptotic stability. When stochastic disturbances are present in the robot state model as well as in the output measurement model, it would be interesting to study the response of a feedback controller. The approach of [19] can be adopted, however, the rate of change of Lyapunov function may use $Ito's$ formulae for stochastic calculations. The result of [19] shows bounded tracking error, but in the presence of noise, there could be sparsely located random spikes in this error. In the proposed work, the controller takes into account the stochastic disturbances which would smoothen out these spikes and this may improve the results. In [20], an adaptive fuzzy neural network learner of state constraints of a robot has been discussed. The learner requires lesser data for learning about the uncertainties and also, it learns about the robot-environment interaction. The effects of state constraints i.e. inequality constraints on tracking error are learned and control law has been designed to ensure stability in accordance with a Lyapunov function. In this proposed work, the authors have developed state model in the form of stochastic differential equation (SDE). It may be modified by considering such inequality constraints when an error is smaller or greater than a threshold value. Chen et al. [21],[22] have studied the uncertainties present in the system using a modified bounded Lyapunov function known as Nussbaum function. They have also developed an adaptive control of a multivariable system for asymptotic stability by adjusting a single control parameter ensuring bounded tracking error [23].

In the presence of noise and uncertainty, state observer based control has become an alternate approach [24]-[26]. It has the advantage that the error feedback to a controller is based on the observer output rather than the actual state incorporating noise. In state observer based control, the dynamics of the controller is generated by the observer. The state of the present dynamical system is defined by position and velocity at any given time. Velocity signal is achieved either by direct measurement or by differentiating the measured position signal, which may add cost, weight, and noise. This degrades the performance of the system [27]. In this present work, the authors have, therefore, estimated the states using Extended Kalman Filter (EKF). Here, position estimates $(\widehat{q})$ and velocity estimates $(\widehat{\dot{q}})$ are used to implement computed torque control (CTC) for the tracking control of n-link robotic manipulator. EKF requires less information of the system in the controller design for the uncertain systems [28]. This approach further avoids double differentiation to get velocity signal that may result in more spikes and infinite memory in case of PI observer-based controller [29]-[31]. Convergence of observer is the main concern while designing an observer for the nonlinear system. The issues involved in the design of the observers for the nonlinear system along with the possible solutions have been discussed in [32]-[33].

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A Synergistic Transcriptional Regulation of Olfactory Genes Drives Blood-Feeding Associated Complex Behavioral Responses in the Mosquito Anopheles culicifacies

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Abstract

Decoding the molecular basis of host seeking and blood feeding behavioral evolution/adaptation in the adult female mosquitoes may provide an opportunity to design new molecular strategy to disrupt human-mosquito interactions. Although there is a great progress in the field of mosquito olfaction and chemo-detection, little is known about the sex-specific evolution of the specialized olfactory system of adult female mosquitoes that enables them to drive and manage the complex blood-feeding associated behavioral responses. A comprehensive RNA-Seq analysis of prior and post blood meal olfactory system of An. culicifacies mosquito revealed a minor but unique change in the nature and regulation of key olfactory genes that may play a pivotal role in managing diverse behavioral responses. Based on age-dependent transcriptional profiling, we further demonstrated that adult female mosquito's chemosensory system gradually learned and matured to drive the host-seeking and blood feeding behavior at the age of 5–6 days. A time scale expression analysis of Odorant Binding Proteins (OBPs) unravels unique association with a late evening to midnight peak biting time. Blood meal-induced switching of unique sets of OBP genes and Odorant Receptors (Ors) expression coincides with the change in the innate physiological status of the mosquitoes. Blood meal follows up experiments further provide enough evidence that how a synergistic and concurrent action of OBPs-Ors may drive "prior and post blood meal" associated complex behavioral events. A dominant expression of two sensory appendages proteins (SAP-1 & SAP2) in the legs of An. culicifacies suggests that this mosquito species may draw an extra advantage of having more sensitive appendages than An. stephensi, an urban

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Alfven Wave Instability with Streaming Electrons in Magnetized Dusty Plasma

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Abstract

Alfven waves are observed in the solar wind and may be responsible for generation of the parallel electric fields in the aurora. In the present work, we investigate the electromagnetic Alfven waves in three component dusty plasmas. The negative ions streaming through magnetized dusty plasma drive Alfven waves to instability via Cerenkov interaction. The presence of charged dust grains and streaming electrons modify the dispersion relation of low frequency Alfven waves. The charge and number density of dust grains and external magnetic field significantly modify the dispersion properties of these waves. The impact of the electron streaming velocity and the thermal electron speed on the growth of the instability is studied analytically. The Alfven modes with phase velocity comparable to the electron streaming velocity possess a large growth rate. The maximum value of growth rate increases with an increase in thermal electron speed or electron temperature. However, the maximum value of growth rate decreases with an increase in dust grain number density. Numerical calculations are done using the plasma parameters suitable for the earth's magnetosphere. The results of the proposed theory are applied to understand some of the experimental observations.

Previous Next

Keywords

Dispersion; Growth rate; Cerenkov; Ion speed

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FULL LENGTH ARTICLE

Algae personification toxicity by GC–MASS and treatment by using material potassium permanganate in exposed basin

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KEYWORDS

Algal toxins;
Potassium permanganate;
Treatment;
Biomass;
Chlorophyll

Abstract This study was conducted to address algal toxins using potassium permanganate through the control of biomass growth of algae under following conditions value 25 ± 1 °C illumination intensity value 245 microeinstein/m^2/s, using the culture media Chu-10 Modified for the purpose of development algae. We treated algal toxins belonging to groups of Neurotoxins, Hepatotoxins, Pyriproxyfen, Emodin, Brevetoxins-10 (A) and Cytotoxins using concentrations of potassium permanganate represented by 2, 4, 8 and 16 mg/l with alum concentration for each concentration of 30 mg/l, as the removal rate reached to 100% of the toxin blooms in concentrations of 8 and 16 mg/l respectively, through the examination of algal toxins mediated by GC–MASS compared to the standard, which diagnosed a range of algal toxins with $C_2H_3C_{12}NO$ formulas of synthetic $C_9H_{13}NO_2$, $C_{18}H_{27}NO_3$, $C_{11}H_{12}N_2O_6$, $C_{11}H_{17}N_3O$, $C_{10}H_{17}N_3O$, $C_9H_{15}Br_2NO$, $CH_4N_2O_2$, $C_{11}H_{17}NO_2$, $C_{13}H_9BrN_2O_3$, $C_3H_7NO_4S$, $C_{20}H_{29}NO_3$, $C_{15}H_{10}O_5$, $C_4H_8O_2$ and $C_2H_2C_{13}NO$ the concentrations 2 and 4 mg/l turned toxic compounds into non-toxic compounds represented by $C_7H_6O_2$, $C_5H_6N_2O$, $C_{12}H_{11}ClO_4$, $C_6H_6O_2$, $C_{12}H_{10}O_4$, $C_{10}H_{17}N$, $C_4H_6O_2$ and $C_5H_6N_2O$. The results showed reduced primary productivity of algae chlorophyll a result of substance to stop chloroplast for vital activity through the influence of the concentration of potassium permanganate values 0.571, 1.142, 0.583 and 1.713 mg/l respectively, compared to the standard of 114.2 mg/l. As diagnosed types of Algae producing toxins are represented by *Microcystis aeruginosa, Microcystis flosaquae, Oscillatoria amoena, Oscillatoria amphibian, Oscillatoria boryana, Oscillatoria limnetica, Oscillatoria perornata, Phormidium ambiguum, Lyngbya digueti, Lyngbya major, Lyngbya nordgaa-*

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Aluminium metal matrix composites: A retrospective investigation

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Aluminium matrix composites (AMMCs) are considered to be new generation potential materials for many engineering applications. Different kinds of reinforcement have been infused into the aluminium matrix in order to improve hardness, toughness, stiffness, wear resistance, fatigue properties, electrical properties and thermal stability as compared to their conventional unreinforced counterparts. The characteristics of AMMCs depend largely upon the type of reinforcement materials, interface bonding and processing parameters. In this article we have attempted to investigate the development of aluminium metal matrix composites (AMMCs) along with associated challenges and significant application areas.

Keywords: Metal matrix composites, Discontinues reinforcements, Preform, Hybrid composites

1 Introduction

Metal matrix composites have been able to fulfill all the desired conceptions of the component designers in order to cater the specific demands of different engineering applications[1]. In metal matrix composites, the hard reinforcements are infused into the soft metal matrix to achieve a combination of enhanced physical, mechanical and electrical properties. For development of metal matrix composites, various metals used are titanium, magnesium, copper, nickel and aluminium. But the most widely used base metal is aluminium due to its light weight, strength, excellent thermal and electrical properties, good reflective properties, impermeability and cost effectiveness[2,3]. Aluminium alloys as metal matrix have always attracted material scientists because of some more additional attributes such as better corrosion resistance and high damping capacity. Depending upon the chemical composition of aluminium alloys also, the composites exhibit a variation in their properties for making engineering components executable. Since the automobile, aerospace and sports industries require various aluminium based composites components, to be used in diverse conditions, hence rigorous research has been done in past recent years with different aluminium alloys combined with various reinforcements[4]. Wide applications of AMMC's result into drastic improvement in product design and development with reduced weight, thus offering economically viable alternatives[5]. Main aim of developing metal matrix composites is to achieve desired properties by varying matrix phase, reinforcement shape and size, synthesis route, volume fraction and processing parameters. The available literature shows that adequate investigations have been done to interpret the development mechanism and characteristics analysis depending upon reinforcement content, reinforcement size and process parameters.

By using suitable kind of reinforcement with aluminium matrix, the properties of aluminium metal matrix composite can be altered[6]. In order to estimate the mechanical properties of composites such as density, stiffness and fracture strength etc. following model can be considered[7,8]:

$$P_c = P_m V_m + P_r V_r \qquad \dots (1)$$

For thermal coefficient of expansion the rule of mixtures is as given below:

$$\alpha_c = \frac{\alpha_m V_m K_m + \alpha_r V_r K_r}{V_m K_m + V_r K_r} \qquad \dots (2)$$

where P is property, V is volume fraction and K is thermal conductivity. Subscript c, m and r indicate composite, matrix material and reinforcement, respectively. AMMCs exhibit some phenomenal properties posing tough competition to their monolithic counterparts[9]. Some of the significant mechanical properties of aluminium metal matrix composites properties are discussed below[10].

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An Aggregative Machine Learning Approach for Output Power Prediction of Wind Turbines

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***Abstract*— Accurately forecasting power output of renewable sources is a necessity in operation of today's grid in order to achieve optimal energy utilization and carbon-free ecosystem. This study devises a stable, effective and accurate model for dayahead prediction of wind turbine power output through use of an aggregative approach. The method involves two types of Artificial Neural Network (Radial Basis and Conventional Feedforward Networks), Adaptive Neuro-Fuzzy Inference System (ANFIS) and Support Vector Machine (SVM) techniques. It is targeted at comparing the prediction models for their individual performances and finally coming upon an aggregative approach which outperforms the individual models through a strategic combination of them. Three techniques of combining (Simple Averaging, Regression and Outperformance) were tested. Though the individual models showed satisfactory performance by themselves, the combination techniques were able to outperform the individual models. Regression technique of combining was seen to be the most effective of all. The predicted output power through this technique was seen to greatly fit with the measured data with an NMSE of 1.03% for the test year. The combination techniques have also demonstrated more stable performance than the individual models while tested with the extreme cases of windy and less windy weeks.**

Keywords—ANFIS, BPNN, Prediction, RBNN, SVM

I. Introduction

The energy generation mixture has been mostly dominated by fuel based conventional sources until recently. The worrying signs of climate change and a huge number of scientific findings relating the change to use of such energy sources have forced the international community to appreciate the treats and look for options. Renewable sources of different types have started to gain considerable attention. Wind power is one of the most widely applied of those renewable sources accounting the largest share of new installations in recent years. The intermittent nature of most of renewable sources has however caused eyebrows to be raised over security of renewables-led transformation of the power sector. Improved methods of forecasting would improve power security as well as enable efficient utilization of the sources.

This study focuses on predicting the power output from a wind turbine based on weather parameters such as wind speed and air density and power output of the previous hour. It may be suggested that applying the turbine manufacturer's power curve should be good enough. The manufacturer's power curve, however, offers an idealized power output as a function of wind speed by assuming specific air density conditions and a minimal amount of turbulence and wind shear across the blade span [1]. The issue of inertia which enables a spinning turbine to produce power at a lower wind speed than a turbine starting from a standstill is also another factor. Those factors make it impossible to draw a simple one-to-one relationship between wind speed and power outputs. Hence, power output of a turbine can often deviate substantially from the manufacturer's power curve, which can lead to significant forecasted power error.

There is a wide range of perdition techniques employed for renewables' power output prediction. They can grossly be classified as statistical and physical models. The comparatively less complex and older statistical techniques are autoregressive moving average (ARMA/ ARIMA) models. They, however, lack the required level of accuracy in most cases and hence are being replaced by machine learning techniques such as neural networks, Fuzzy systems and support vector machines which employ different mechanisms to learn the pattern and relation of parameters.

Different literatures are available on the applicability and success stories of machine learning approaches in wind power prediction. Artificial Neural Network is the most widely used of the techniques and it has been reported to be an effective tool by [2] [3] while [4] utilized it in combination with SVM and [5] hybridized it with evolutionary algorithms such as GA claiming to find improved forecasts. There were favorable results reported in achieving higher forecast accuracy through use of

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Analysing the interaction of factors for resilient humanitarian supply chain

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Emergencies and disasters place an exceptional demand on the managerial skills of the humanitarian aid community. Most of the developing countries lack in such kind of resilience and effective humanitarian supply chain. Therefore, the purpose of this paper is to identify and analyse the factors to develop the resilience in the humanitarian supply chain. Based on the literature review, total 12 factors related to resilient humanitarian supply chain have been identified. Some of these factors are process oriented and some are result oriented. Interpretive structural modelling with Fuzzy MICMAC analysis is used to develop structural relationships among these factors and to find the driving and the dependence power of these factors. Government support, strategy and capacity planning; and continuous assessment of project progress have emerged as the major drivers for the development of resilient humanitarian supply chain. By managing these driving factors, humanitarian aid programme can be made resilient and agile. The findings will be useful for the humanitarian aid agencies to develop effective and sustainable aid relief programme.

Keywords: supply chain coordination; supply chain resilience; fuzzy logic; resilience management; supply chain management

1. Introduction

A successful humanitarian relief operation is very critical, because there is a life dependency on the effectiveness of the programme. The area where humanitarian supply chains are setup, generally have disturbed logistics and infrastructure network. Moreover, the area may be politically and militarily unstable (Pettit and Beresford 2009). Furthermore, the uncertainty of the disaster makes the demand further unpredictable in the humanitarian supply chain. Kovács and Spens (2010) have observed that usually many of the actors in the humanitarian supply chains compete for the same financial resources (donations). Therefore, cooperation as well as competition, i.e. competition, is evident features in relief supply chains. Therefore, to decrease the impact of the disaster in unstable environment, the supply chain should not only be agile and efficient, but also resilient i.e. it should be able to regain back its original configuration, if confronted by some disruption (Dubey et al. 2014; Oloruntoba and Kovács 2015).

Developing a resilient supply chain is considered as the most appropriate goal for the post-disaster longer term reconstruction phase (Oloruntoba and Kovács 2015). Disaster resilient community can be developed by learning from the experiences, supporting the sustainable development policies and by demanding the implementation of effective policies. Understanding the critical success factors of humanitarian supply chains is very important. It has been observed that if critical factors are not well identified, then the organisation might fail. In case of humanitarian supply chain, failure means the loss of life and property. Earlier very less priority was given to develop a continuous humanitarian supply chain. It was considered as a set of discrete activities disconnected from each other having a weak connection between each stage, which lead to large amounts of waste (Pettit and Beresford 2009).

For analysing the factors for humanitarian supply chain, concepts of commercial supply chain can be used as building blocks. But due to some differences between the two supply chains, the concepts of commercial supply chain can't be directly applied to the humanitarian supply chain. The major differences are that humanitarian aid process operates as a contributor of labour and finance, where the end consumer is not involved in any commercial transaction. Fundamental chain of humanitarian supply chain is still not different from the commercial supply chains. This similarity can be used in analysing the critical factors, which are common to most industries and have relevance to humanitarian supply chain (Pettit and Beresford 2009). This can help in increasing the effectiveness of humanitarian organisations.

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Arabidopsis SKP1-like protein13 (ASK13) positively regulates seed germination and seedling growth under abiotic stress.

Rao V[1], Petla BP[1], Verma P[1], Salvi P[1], Kamble NU[1], Ghosh S[1], Kaur H[1], Saxena SC[1], Majee M[1].

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Abstract
SKP1 (S-phase kinase-associated protein1) proteins are key members of the SCF (SKP-cullin-F-box protein) E3 ligase complexes that ubiquitinate target proteins and play diverse roles in plant biology. However, in comparison with other members of the SCF complex, knowledge of SKP1-like proteins is very limited in plants. In the present work, we report that Arabidopsis SKP1-like protein13 (ASK13) is differentially regulated in different organs during seed development and germination and is up-regulated in response to abiotic stress. Yeast two-hybrid library screening and subsequent assessment of in vivo interactions through bimolecular fluorescence complementation analysis revealed that ASK13 not only interacts with F-box proteins but also with other proteins that are not components of SCF complexes. Biochemical analysis demonstrated that ASK13 not only exists as a monomer but also as a homo-oligomer or heteromer with other ASK proteins. Functional analysis using ASK13 overexpression and knockdown lines showed that ASK13 positively influences seed germination and seedling growth, particularly under abiotic stress. Taken together, our data strongly suggest that apart from participation to form SCF complexes, ASK13 interacts with several other proteins and is implicated in different cellular processes distinct from protein degradation.

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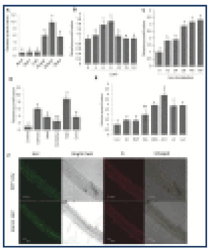

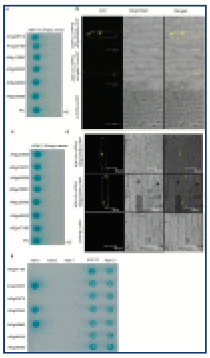

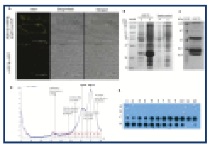

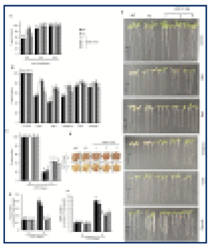

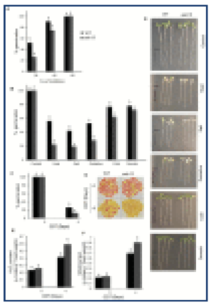

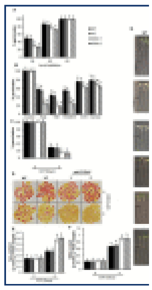

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Aromatic versus Aliphatic: Hydrogen Bonding Pattern in Chain-Extended High-Performance Polyurea

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Polyurea, a reaction product of functional isocyanates and amines, is finding increasing application in the field of protective coatings, especially for retrofitting purposes. The properties of polyurea can be tuned by the prudent choice of reactants, specifically chain extenders. In this work, an experimental study into the consequences of chain extension of a representative polyurea formulation with different type of chain extenders (aromatic and aliphatic) has been undertaken, with an aim to gain an insight into their role in improving properties. Rheological studies were performed to understand the effect of their inclusion on the processing conditions and quantification of the gelation time. Aromatic chain extenders are far more reactive than their aliphatic counterparts, which lead to significantly short 'gel-time' as quantified by rheometry. The degree of H-bonding was qualitatively established by the red-shift associated with N–H and >C=O bands in the FTIR spectra of the polymer. Introduction of either type of chain extender lead to remarked processability of polyurea formulations through spray coating technique. An optimal aromatic: aliphatic chain extender ratio was found to result in optimal H-bonding, which in turn reflected in terms of mechanical properties. Dynamic studies were performed and all formulations were found to exhibit sub-ambient T_g which is appreciably affected by the type of chain extender used. Higher aromatic: aliphatic chain extender ratio was found to result in higher storage modulus and lower dissipation potential.

1. Introduction

Polyurea is an elastomeric polymer formed by the step growth polymerization of a difunctional isocyanate (–N=C=O) with amines.[1] This class of elastomer has attracted a lot of attention by both academia as well as industry, in view of its ability to exhibit a wide range of mechanical properties, which in turn is an indirect manifestation of its composite microstructure.[2] Polyurea is finding interesting applications in specialized fields, especially as linings in personnel-protective gear,[3] retrofits for unreinforced structures[4] and as ballistic-penetration resistant metallic armor.[5]

Polyureas are extensively H-bonded, which lead to its segregation into separate domains.[6] The micro-structure of polyurea comprises of two distinct domains: "hard" realms formed by hydrogen bonded polar urea linkages (–NH–CO–NH–) and "soft" domains comprising of long aliphatic polyether chains.[2a,7]It is this phase-segregated structure, which is responsible for its unusual properties (i.e, enhanced modulus, high extensibility and resiliency).[8] The N–H group in polyurea serves as proton donor, and the carbonyl (>C=O) and/or adjacent oxygen atom of ether in the soft segment acts as the acceptor.[9] Bidentate H-bonding within the urea linkages lead to formation of nanometer-sized hard segments, which operate as physical crosslinks between the macromolecules.[10] Improved phase separation in polyurea in-turn strengthens H-bonding in the hard segments and leads to improved physical properties.[11]

In view of the fast reaction kinetics, the most important concern associated with the processing of polyurea is the requirement of rapid mixing of reactants; which held back its commercialization till the late 1980s.For all practical applications, polyurea coatings are processed by using reactive spraying where, the isocyanate and amine are stored separately and are forced to react in the mixing-module, just prior to being pushed out of the orifice under pressure.[12] A general schematic of the setup is presented in the supplementary section (Section S1). It is to be noted that the physical properties of the polyurea are strongly dependent upon the processing conditions, and most commercial formulations are sprayed at elevated temperatures (≥70 °C) and pressures ~2000 psi or higher.

In general, both aromatic as well as aliphatic chain extenders are commonly included in polyurea formulations, however in view of the commercial nature, there are no guidelines to delineate their optimal amounts which can result in the prime performance of the material. The inclusion of chain extender in the formulation increases the vicinity of the urea groups, which increases the probability of the urea groups

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Full Length Article

As-pyrolyzed sugarcane bagasse possessing exotic field emission properties

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A B S T R A C T

The present study aims to demonstrate the application of sugarcane bagasse as an excellent field emitter. Field emission property of as-pyrolyzed sugarcane bagasse (p-SBg) before and after the plasma treatment has been investigated. It has been observed that electronic nature of p-SBg transformed from semiconducting to metallic after plasma treatment. Maximum current and turn-on field defined at 10 $\mu A/cm^2$ was found to be 800 $\mu A/cm^2$ and 2.2 V/μm for as-pyrolyzed sugarcane bagasse (p-SBg) and 25 $\mu A/cm^2$ and 8.4 V/μm for H_2-plasma treated p-SBg. These values are found to be better than the reported values for graphene and activated carbon. In this report, pyrolysis of bagasse has been carried in a thermal chemical vapor deposition (Th-CVD) system in inert argon atmosphere. Scanning electron microscopy (SEM), X-ray Diffraction (XRD), High-resolution transmission electron microscopy (HRTEM) and X-ray photoelectron spectroscopy (XPS) have been used to study the structure of both pre and post plasma-treated p-SBg bagasse's sample. HRTEM study reveals that carbonaceous structures such as 3D-nanographene oxide (3D-NGO), graphite nanodots (GNDs), carbon nanotubes (CNTs), and carbon onions are present in both pre-treated and plasma-treated p-SBg. Hence, we envision that the performed study will be a forwarding step to facilitate the application of p-SBg in display devices.

1. Introduction

Despite, being a promising raw material for various products such as generation of electric power [1], pulp and paper production [2], nanocellulosic fiber [3], carbon tubules [4], carbon quantum dots (CQDs) [5] and for products based on fermentation such as glucose, xylose and biofuel (ethanol) [6–8], sugarcane bagasse is generally considered as an environmental hazard due to emission of greenhouse gasses during its burning either in agriculture fields or in sugar/jaggery plants for generation of power and heat, respectively [1]. Moreover, recently sugarcane cultivation has assumed great importance for the world economy, especially due to large demand for ethanol production, although it presents a high risk impact for environment. In recent report, about 279 million metric tons (MMT) of bagasse production annually throughout the world was mentioned by Anuj K. Chande *et al.* in 2011 [9] and it is causing severe pollution in the environment due to effluent greenhouse gases as well as emission of aerosols and nano-sized carbon particulates in the atmosphere during its burning. So, in future its proper utilization is highly desirable.

Structurally, sugarcane bagasse (SBg) is composed mainly of cellulose and lignin [9]. Hence, it might be a promising resource for production of as-pyrolyzed and post chemically treated activated carbon (AC). This could offer the combined benefits to diminish emissions of greenhouse gasses as well as offers high commercial value by producing activated carbon. It is reported that activated carbon (produced from agricultural waste) has high carbon and low ash contents, high adsorption capacity, high density and considerable good mechanical strength which is highly required to create porous structures in the activated carbon matrix [10].

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Assessment of CSR based supply chain performance system using an integrated fuzzy AHP-TOPSIS approach

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ABSTRACT
The objective of this research was to identify Corporate Social Responsibility (CSR) criteria as well as propose and prioritise the alternatives to improve the supply chain performance system of an organisation. To meet the objective, firstly, CSR-based criteria, sub-criteria and alternatives were identified based on the literature review and discussion with the field experts, taken from automobile industries located at the Delhi region of India. Then, kappa statistics has been applied to check the internal consistency between identified criteria and sub-criteria. After finding the evidence of internal consistency, a hierarchical-type model has been developed and analysed using a multi-criteria decision-making as an integrated fuzzy analytical hierarchy process (AHP) and a fuzzy technique for order performance by similarity to the ideal solution (TOPSIS) approach. To make the results more robust and feasible, a sensitivity analysis has also been performed.

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Corporate Social Responsibility; supply chain; fuzzy AHP; fuzzy TOPSIS

1. Introduction and background

In the past few years, it has been observed that companies that demonstrate their commitment to social and environmental causes are known to have a better reputation than the companies whose Corporate Social Responsibility (CSR) endeavours are non-existent. Employees like to work for the betterment of the company if they have a feeling of belongingness towards the company. With the growing awareness of the stakeholders associated with the organisation, the biggest question that the automobile sector faces in India today is 'What is an organisation doing for the society?' Investors who are pouring money into the company are always concerned whether their funds are used effectively. The companies that demonstrate a commitment not only to employees and customers, but also to causes and organisations that impact the lives of others is likely to attract more investors. Philanthropically minded corporates would definitely attract skilled officials and would be able to retain them for a longer time as they feel engaged and productive when they walk into work each day. Nowadays, even the consumer feels good shopping at an institution that helps the community. There are numerous non-profit organisations that provide food, shelter, clothing, etc. to the old, poor and needy and rely solely on individual donations for support. Collaboration and partnerships with such organisations have proved to be a great step towards CSR. The increasing impact of press and media has also contributed to the increasing pressure on the corporates to integrate CSR practices in their working. One should always remember that how much good a company can do in the local communities, or even beyond that, is CSR. The better the benefits, the better the media coverage. Unfortunately, the bad news spreads quicker than the good news, i.e. if a

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Automatic Static and Cyclic Shear Testing Machine under Constant Normal Stiffness Boundary Conditions

Reference

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ABSTRACT

Dynamic loads, including earthquake, blasting, and vibration loads, induce cyclic shear loads along the joints in rock masses; hence, the risk of failure increases on the joints due to changing shear resistance. On the other hand, joints are under different boundary conditions: constant normal load (CNL) and constant normal stiffness (CNS). Normal stiffness increases on the joints with increasing depth, and it can affect shear resistance. For an accurate assessment of joint shear resistance under varying normal stiffness and number of cycles, advanced laboratory shear apparatus is essential for the shear test. Conventional direct shear apparatuses have limitations such as boundary conditions, working under monotonic (static) shear loads only, or cyclic shear loads with no change of frequency and amplitude of shear loads. Therefore, a new large-scale servo-controlled direct shear testing machine was developed to conduct cyclic shear test (as well as monotonic shear test) under CNL and CNS boundary conditions with varying normal stiffness at different frequencies and amplitudes of shear loads. In the present study, the cyclic shear tests were conducted on nonplanar joints under varying normal stiffness. Moreover, the effects of different frequencies and amplitudes of shear loads were investigated. The test results indicate that peak shear stress increases with increasing normal stiffness at the first cycle, but the influence of normal stiffness decreases with an increase in the number of shear cycles. The frequency of shear load influences peak shear stress, i.e., peak shear stress increases with increasing frequency. The number of cycles does not affect peak shear stress on the joints at low shear amplitude, but peak shear stress decreases with higher amplitude.

Keywords

shear behavior, shear apparatus, cyclic loads, constant normal stiffness, regular and irregular joints, frequency, amplitude, joint dilation

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ORIGINAL RESEARCH

Availability analysis of mechanical systems with condition-based maintenance using semi-Markov and evaluation of optimal condition monitoring interval

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Abstract Maintenance helps to extend equipment life by improving its condition and avoiding catastrophic failures. Appropriate model or mechanism is, thus, needed to quantify system availability vis-a-vis a given maintenance strategy, which will assist in decision-making for optimal utilization of maintenance resources. This paper deals with semi-Markov process (SMP) modeling for steady state availability analysis of mechanical systems that follow condition-based maintenance (CBM) and evaluation of optimal condition monitoring interval. The developed SMP model is solved using two-stage analytical approach for steady-state availability analysis of the system. Also, CBM interval is decided for maximizing system availability using Genetic Algorithm approach. The main contribution of the paper is in the form of a predictive tool for system availability that will help in deciding the optimum CBM policy. The proposed methodology is demonstrated for a centrifugal pump.

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Keywords Condition based maintenance · Availability · Semi-Markov process · Degraded states · Mechanical repairable systems

List of symbols

A_s	System availability
A_{pump}	Pump availability
D_i	ith degraded state, $i \in \{1, 2, 3, \ldots, n\}$
D_{x_i}	ith degraded state for CM metric x_i
F_r	Random failure state
$F_{ij}(t)$	CDF of the time spent in state i before moving to state j, $(i, j \in \Omega)$
$\bar{F}_{ij}(t)$	Complement of the $F_{ij}(t)$
F_i	CDF for CM interval for state i, where $i \in \{D_{x_1}, D_{x_2}, \ldots, D_{x_n}\}$
$\bar{F}_i$	Complement of the CDF for CM interval for state i, where $i \in \{D_{x_1}, D_{x_2}, \ldots, D_{x_n}\}$
im_p^r	Imperfect repair state where repair carried out to pth degraded state leads to rth better degraded state, $p \in \{3, \ldots, n\}$, r = 1, 2, 3, …, p-2
$K(t)$	SMP Kernel matrix
$k_{ij}(t)$	Element of the kernel matrix, $K(t)$ in ith row and jth column, $i, j \in \Omega$
l_i	Lower bound of CM metric for ith degraded state
ma_k	Major repair state, where repair carried out at kth degraded state and leads to first degraded state, D_1, $k \in \{2, 3, \ldots, n\}$
mi_j	Minimal repair state corresponding at jth degraded state and maintenance leads to current degraded state, where $j \in \{1, 2, 3, \ldots, n\}$
n	Number of degradation states for the system
N	Total number states in the SMP model of the system
p_{ij}	(i, j)th element of one step transition probability matrix, Z

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Benchmarking the logistics management implementation using Delphi and fuzzy DEMATEL

Purpose: From last few decades, Logistics Management (LM) constitutes a global concern among organization's supply chain to improve their business effectiveness. This contribution aims to uncover and analyze the critical factors (CFs) related to the implementation of effective LM concept and benchmark the supply chain performance.

Design/methodology/approach: The most common (sixteen) CFs were identified and selected through literature and use of the Delphi method. Subsequently, the selected most common CFs were analyzed to distinguish their causal relations using the fuzzy Decision Making Trial and Evaluation Laboratory (DEMATEL) technique under unclear surroundings. A case example of Indian Logistics Company is also discussed to reveal the practical applicability of the research.

Findings: 'Provision of the effective information communication and technological developments in the system' and 'Management dedication, support and involvement CFs are found to have the top most influences in the effective implementation of LM. This paper also groups the CFs into cause and effect relationship which provides valuable insights for analyzing the factors in successful implementation of LM.

Practical implications: This work attempts to understand the different critical factors, their relative position and the importance rating in the system, due to which, managers can differentiate the factor which greatly affects the concepts of implementing LM, and thus, improvements can be made accordingly.

Originality/value: First, this work offers sixteen CFs to LM implementation from a supply chain scenario. Second, in the context of contributing to the theory, the combined Delphi and fuzzy DEMATEL based model is provided that helps in managing the logistic related issues effectively.

Keywords: Critical factors, Logistics Management, Supply Chain Management, Competitive Advantage, Delphi, Fuzzy DEMATEL.

CbdA: Cloud Computing Based DMIS on ANEKA

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Abstract. A cloud computing application possesses the ability to have its processing tasks divided into small independent work units. These work units (in the form of tasks, threads etc.) are made to execute in parallel with complete independence from each other over the cloud. The proposed disaster management information system (DMIS) can be potentially used by amateurs, bureaucrats, technocrats and professionals working in the field or in the disaster affected area to handle any record based information, archive it, analyze it and use it even for forecasting the occurrence of disaster. Designing and deploying such an application over the cloud have given DMIS benefit of wide reach coupled with high performance, high reliability and better security.

Keywords: Cloud · Disaster · Disaster management · Aneka · PaaS · Information system · Task model · Cloud application

1 Introduction

Aneka [1–3] basically provides us a platform for developing cloud based application. There are three types of cloud computing service levels which are infrastructure-as-a-service (IaaS), platform-as-a-service (PaaS), and software-as-a service (SaaS). From the three services which are provided by cloud; Aneka serves as platform-as-service. It is used to build the customized applications and deploying them on either private cloud or on the public cloud. It is a .NET based Application PaaS. It provides an environment where it enables the user to design a customized application using any one of the several models provided by Aneka. Aneka provides its own set of API and libraries which users, if required can use directly. The Aneka integrates the applications which are designed and developed on other platforms. Aneka enables the simultaneous execution of multiple applications in parallel to each other. Aneka provides a runtime environment to the users though which they can create private and public clouds as well as they can create other application by using the several API provided by Aneka.

The key feature of Aneka PaaS is that it preserves the resources on public cloud like Amazon EC2 and on the another side it also provides public cloud resources which can be used for delivering data on the end user desktop.

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Charge injection in large area multilayer graphene by ambient Kelvin probe force microscopy

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ABSTRACT

This study demonstrated an in situ method for quantitative characterization of nanoscale electrostatic properties of as-grown multilayer-graphene (MLG) sheets on nickel by a combination of atomic force microscopy (AFM) and Kelvin probe force microscopy (KPFM). Large area epitaxial MLG sheet were grown on nickel by Hot Filament-Thermal chemical vapor deposition (CVD) technique. The high crystalline MLG sheets on nickel were confirmed by Raman spectroscopy that revealed average G-bandwidths in the range of $\sim$20 cm^{-1}. Herein, for the first time, the charge injection as well as subsequent charge diffusion over time on the MLG/nickel surface was demonstrated. The results unveiled that: (i) MLG surface can be either positively or negatively charged through injection process using Pt coated Si-based AFM probes; (ii) the charges accumulated and eventually reached to saturated concentrations of +4.45 ($\pm$0.1) μC/m^2 and $-$1.3 ($\pm$0.1) μC/m^2, respectively; (iii) the charge diffusion coefficients on graphene surface were measured to be 1.50 ($\pm$0.05) $\times$ 10^{-16} m^2/s and 0.64 ($\pm$0.05) $\times$ 10^{-16} m^2/s for the positive and the negative charges, respectively. The discovery of charge injection in MLG may pave the way for designing a new class of energy harvesting devices. Additionally, our study demonstrated a technique for nano-patterning/charge lithography of surface charges by contact electrification, which could be a promising application to create charged nanostructures for next generation graphene based nanoelectronic devices.

1. Introduction

From both scientific and technological point of view, charge injection on insulating films has been of great interest in the development of multiple devices including triboelectric nanogenerators for building self-powered portable electronics, large-scale energy harvesting, and also to develop data storage devices [1]. In particular, a charge injection combined with Kelvin probe force microscopy (KPFM) technique was reported to be a *state-of-the-art* tool to study the electrostatic properties of objects at the nanoscale level [2]. Determination of the interface in carbon nanotubes (CNTs) based devices or distinguishing the metallic and semiconducting nature of CNTs with the same diameters, silicon nanoparticles, and semiconducting quantum nanorods are the major examples of the application of KPFM technique. In addition, KPFM has also been used to study the different charge states of single metal atoms, molecules, atomic point defects, and imaging of the charge percolation pathways in two-dimensional quantum dot arrays [3]. Recently, KPFM was used for imaging the charge distribution in different complex systems such as semiconducting quantum dots, carbon nanotubes, graphene on SiO_2 substrates, organic molecules, and even bacterial protein filaments [4–16].

Besides the KPFM measurements, researchers have also performed nanolithography and manipulation of graphene by using AFM. For example, conductive atomic force microscopy [16] has been used to analyze the local current mapping and patterning of reduced graphene oxide. Sibel et al. used electrostatic force microscopy (EFM) technique for elucidating the charge transport property in reduced graphene oxide [17]. With the given highlighted measurement types it is possible to correlate the detailed morphology of graphene (e.g., wrinkles, multilayer regions, and local defects) with its nanoscale electrical characteristics, reading/writing charges on graphene, and local electronic behavior at graphene–metal interface.

In this particular direction, for the first time the present study demonstrated the charge injection (both positive and negative)

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Coefficient Bounds for Certain Analytic Functions

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Abstract Let φ be an analytic function with the positive real parts, $\varphi(0) = 1$ and $\varphi'(0) > 0$. Let $f(z) = z + a_2z^2 + a_3z^3 + \cdots$ be an analytic function satisfying the subordination $\alpha f'(z) + (1-\alpha)zf'(z)/f(z) \prec \varphi(z)$, $(f'(z))^{\alpha}(zf'(z)/f(z))^{(1-\alpha)} \prec \varphi(z)$, $(f'(z))^{\alpha}(1+zf''(z)/f'(z))^{(1-\alpha)} \prec \varphi(z)$, $(f(z)/z)^{\alpha}(zf'(z)/f(z))^{(1-\alpha)} \prec \varphi(z)$, or $(f(z)/z)^{\alpha}(1+zf''(z)/f'(z))^{(1-\alpha)} \prec \varphi(z)$. For these functions, the bounds for the second Hankel determinant $a_2a_4 - a_3^2$ as well as the Fekete–Szegö coefficient functional are obtained. Our results include some previously known results.

Keywords Second Hankel determinant · Fekete–Szegö coefficient functional · Subordination · Functions with positive real part

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Co-liquefaction of Whole *Jatropha curcas* Seed and Glycerol using Deep Eutectic Solvents as Catalysts

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Abstract

Bioenergy is the only renewable carbon energy source and can contribute to future sustainable energy. This paper presents: I) the whole Jatropha curcas seed liquefaction to produce bio-crude oil, using (Na_2CO_3) as conventional catalyst; and II) co-liquefaction of glycerol and whole Jatropha curcas seed to produce bio-crude oil, using deep eutectic solvents (choline chloride-p-toluene sulphonic acid) as novel catalyst. The effects of process parameters, including reaction temperature, catalyst concentration, and biomass loading were observed. Temperature was the predominant factor. High yield of bio-crude oil (32.87 wt%) was obtained for the liquefaction (I) as compared to yield of bio-crude oil (8.99 wt%) for the co-liquefaction (II). The optimum glycerol addition was 30 wt%. The bio-crude oil I had moisture (6.47 ± 0.27 wt%) and bio-crude oil II was (6.04 ± 0.42 wt%). The oxygen content in bio-crude oil I was (28.15 ± 0.88 wt%) while bio-crude oil II had reduced (21.58 ± 0.70 wt%) oxygen content. The HHV of the bio-crude oil II (31.73 ± 0.69 MJ/kg) is higher than that of bio-crude oil I (28.80 ± 1.32 MJ/kg). Acidic deep eutectic solvents deterred co-liquefaction yield. In conclusion, co-liquefaction decreased the product yield but improved its quality.

Keywords: Bio-crude oil, Co-liquefaction, Glycerol, Liquefaction, and Yield.

1.0 Introduction

Hydrothermal liquefaction (HTL), is one of the biomass conversion technologies, and has got the required research attention, recently. This is because water is used as the solvent in this process, and

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Compositional dependence of red luminescence from Eu^{3+} ions doped single and mixed alkali fluoro tungsten tellurite glasses

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ABSTRACT

Trivalent europium ions doped single and mixed alkali fluoro tungsten tellurite glasses have been prepared via melt quenching method and characterized by using Raman, optical absorption, excitation, emission and time resolved spectral measurements to understand their utility in visible red emission. Raman spectrum is used to identify different functional groups present in the as prepared glasses. The optical absorption spectra recorded for all the glasses show six bands corresponding to the transitions $^7F_0\rightarrow{}^6D_2$, $^7F_0\rightarrow{}^6D_1$, $^7F_1\rightarrow{}^6D_1$, $^7F_0\rightarrow{}^6D_0$, $^7F_0\rightarrow{}^7F_6$, and $^7F_1\rightarrow{}^7F_6$. An excitation spectrum is used to measure the electron-phonon coupling strength 'g' and phonon energy of the glass host 'hω'. The photoluminescence (PL) spectra measured under 464 nm excitation show eight luminescence peaks related to the transitions $^5D_1\rightarrow{}^7F_0$ (509 nm), $^5D_1\rightarrow{}^7F_1$ (537 nm), $^5D_1\rightarrow{}^7F_2$ (556 nm), $^5D_0\rightarrow{}^7F_0$ (580 nm), $^5D_0\rightarrow{}^7F_1$ (592 nm), $^5D_0\rightarrow{}^7F_2$ (614 nm), $^5D_0\rightarrow{}^7F_3$ (652 nm) and $^5D_0\rightarrow{}^7F_4$ (701 nm) in all the glasses under investigation. Utilizing the Judd-Ofelt (J-O) parameters evaluated from the PL spectra, various radiative properties have been evaluated. From the decay spectra, experimental lifetimes were measured which are in turn used to evaluate the quantum efficiencies and non-radiatve decay rates in the as prepared glasses. The branching ratios, stimulated emission cross-section, quantum efficiency, colour co-ordinates and confocal images captured to confirm the suitability of these glasses for visible red luminescent devices.

1. Introduction

The necessity of developing solid-state optoelectronic devices, optoelectronic communication devices and white Light Emitting Diodes (w-LEDs) have escalated the research interest in rare earth (RE) ions doped glasses [1–5]. Especially, the demand for materials which are aptly suitable for w-LEDs are increasing day by day as they are playing a crucial role in solid state lighting applications. At present, RE doped phosphors are vigorously used in the production of w-LED. But they are not quite suitable for the excitation of InGaN-based LED chips in near-UV to blue region which finally leads to the low efficiency. Due to this reason, instead of Single w-LED, lots of w-LEDs are required to gain sufficient brightness for general lighting. To unravel this difficulty, so many studies have been done to enhance the output power of LED chips. But due to the increase in the chip temperature, the luminous efficiency and lifetime of the LED's decreases [6]. To avoid this problem, new phosphors without resin such as Ce-doped YAG glass ceramics are proposed [7]. Up to now, the major problem is lack of excellent red phosphors. To get efficient w-LED's, red phosphor is highly required in economic range [8]. But it is very intricate to get bright red colour emitting phosphors because of the sudden drop in quantum yield with increasing Stokes shift.

Europium ions are commonly used RE ions in several devices that can be used for lighting and displays. Europium ions can exist in several oxidation states and is a well-known activator with simple electronic transitions. A very interesting point in europium is, it gives strong visible luminescence in both the oxidation states

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Corroborating the Spin Gapless Character of Ti_2Mnal Inverse Heusler Alloy: A study of Strains Effect

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Abstract

Nowadays, In the present study, inverse Heusler alloy based spin-gapless semiconductor (SGS), Ti2MnAl is investigated using full potential linearized augmented plane wave (FPLAPW) method implemented in WIEN2k crystal programme. Our investigation reveals that this alloy behaves as SGS, with zero total magnetic moment, for equilibrium lattice constant (6.23 Å). Further, it keeps its spin gapless state within -15% to 10% uniform strain. On the other hand, for -5% of tetragonal strain, the system behaves as SGS whereas the positive 5% tetragonal strain completely destroys the spin-gapless character of Ti2MnAl Heusler alloy. The up-spin band gap for Ti2MnAl is 0.55 eV and 0 eV for spin down channel for equilibrium lattice constant. It varies up to a maximum value of 0.31 eV and 0.36 eV for positive and negative uniform strain, respectively. The value of this gap for -5% and 5% of tetragonal strain is 0.51 eV and 0.46 eV, respectively. Our calculations provide an exhaustive data to be compared with future experiments and advocate the future applications of this alloy in spintronic applications.

Keywords: Heusler Alloys, Spin-Gapless Semiconductors, FPLAPW Method

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Design, development and characterization of MEMS silicon diaphragm force sensor

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ABSTRACT

The aim of the paper is to describe the design, development and experimental characterization of a MEMS silicon diaphragm based force sensor. In the presented design, a unique combination of a thin single crystal silicon diaphragm has been used as a mechanical sensing element. The force sensor is based on the principle of conversion of applied force to an electrical quantity (e.g. voltage) consists of four piezoresistors in a Wheatstone-bridge configuration. The sensor has been modeled with the help of modern CAD tools and, after several iterations, the diaphragm size and thickness have been optimized to obtain a high sensitivity against an applied load in the designed range. The finite element analysis (FEA) has been carried out for computational investigations to have an approximate evaluation in regard of mechanical design and features. The important parameters like stress, strain and deflection are found to be within permissible limits. The fabricated sensor has been characterized by its metrological capabilities. The relative error due to repeatability is found to be < 1% in the working range of the sensor. The sensitivity has been found to be in order of 0.35–0.40 mV/V/N for 10 N–50 N force range.

1. Introduction

For many decades various type of force sensors have been used for force measurement in different industrial applications such as steel, cement, defense, space, railways, aviation, shipping, heavy industries and serve as force standards for disseminating the unbroken chain of measurement traceability from the National Metrology Institute (NMI) to the various manufacturing of industrial products (production hub). Various different force transducer analogous force proving rings or elliptical shaped bow dynamometer, standardizing box, tuning fork type, Hall effect and strain gauge type have been used over the years based on different principles and have different grades of uncertainty. In the Indian scenario about 60–70% analogous ring shaped force transducers are more commonly used despite their many inherited demerits such as non linearity, required temperature correction, limited use for specific points only, inability to interpolate, or, cannot be used for automation purposes. All these demerits are overcome by a strain gauge force transducer which employs strain gauges arranged in the form of Wheatstone bridge and their output is recorded through suitable digital indicators. Some Commercially available force transducers of make GTM-Germany, Interface Inc.-USA, HBM-Germany among others, are available in the market. Machining of these complex elements along with their strain gauging are a very difficult task, which is a critical barrier to the development of such force transducers at laboratory level [1–4]. There is practical constraint found with the analogous and the strain gauged force transducers in the Newton and sub-Newton lower force range.

A new class of force sensors based on Micro-electro mechanical systems (MEMS) has also come up during last one and half decades as new generation devices which have high sensitivity, are small in size and cost effective. With the evolution of this kind of technology; one can combine several techniques in the fabrication of a force sensing chip which is able to measure a wide range of forces. These force sensors utilize the mechanical properties of single crystal silicon as the load or force sensing element and the piezoresistive properties of mono-crystalline or that of polycrystalline Si for the transduction of the stress generated during the sensing of the force. The biggest advantage of this kind of force sensors is that the Gauge Factor of the Si piezoresistors is as high as 200, leading to high sensitivity [5–10].

The present paper discusses the design, development and characterization of a circular shaped MEMS diaphragm load sensor. The force sensor has been developed for a capacity of 50 N and analytical as

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Detection of Power Quality Event using Histogram of Oriented Gradients and Support Vector Machine

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Abstract:

This paper proposes a new method to distinguish power quality events based on the Histogram of oriented gradients (HOG) and Support Vector Machine (SVM). We examine energy quality events such as sag, interruptions, swell, harmonic, transient, notch and flicker. The proposed method calculates numerous power quality disturbances such as flickering with harmonics, intrusion with harmonics, and sagging with harmonics. It has less processing time than the previous methods due to multiple events occurring at same time. Numerical experiments performed on a real database of power quality disturbances show that there is less calculation in the proposal in comparison with the wavelet change, S-transform and Hilbert change. Recognition with the assistance of HOG gives better and precise outcome in time area with faster reaction.

Keywords: Power Quality (PQ); Event detection; Histogram of oriented gradients (HOG); Support vector machine (SVM).

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ORIGINAL PAPER

Development and Characterization of a Diaphragm-Shaped Force Transducer for Static Force Measurement

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Abstract: There are different types of force transducers, used over the years, comprising of different principles and have different grades of uncertainty. Force transducers may be analog or digital and may be strain gauged, tuning fork type, piezoresistive type, Hall Effect based etc. Though different types of force transducers have been developed in last few decades, still strain gauged force transducers are used over the larger scale due to practical viability and reliability for force measurement. The paper describes low-cost indigenous development of a force transducer, which has been developed for a nominal capacity of 5 kN with ease of design and manufacturing. It has strain gauges applied at suitable locations to form a Wheatstone bridge. The force transducer has been calibrated according to the standard calibration procedures based on *ISO 376* and *IS 4169* standards. Measurement results and an uncertainty analysis have been presented. The uncertainty of measurement of the force transducer is found up to 0.06%. The paper also discusses the implications of applying multiple strain gauges at a single location in series to enhance the sensitivity of the force transducer. Two strain gauges are arranged in series for the given location and the sensitivity of the force transducer is enhanced. It also indicates that the uncertainty of measurement of the force transducer in such case is enhanced up to 0.05% or better to make force transducer suitable for most of metrological and industrial applications.

Keywords: Force transducer; Diaphragm; Uncertainty of measurement; Metrological characteristics

1. Introduction

Force measurement has been very useful for various scientific and industrial applications, from verification of material testing machines to the cutting force in machining processes. Force transducers have been used to measure force for many decades. They also serve as force transfer standards and are used to establish traceability chains from force standard machines to force calibration and material testing machines. There are several types of force transducers, including the dial gauged, strain gauged, and tuning fork types. However, the strain gauged type is the most wide type of force transducers utilized for the precise measurement of force and as a force transfer standard. Force transducers with measurement uncertainties of up to 0.10% are used for various metrological purposes, but our focus is on force transducers with uncertainties smaller than 0.05%.

Force measuring devices like proving ring, elliptical dynamometers have been used for many decades, but they have inherent shortcomings when compared to strain gauged force transducers. The dial gauged force transducers are utilized for specific types of force measurement but their poor resolution and stability leads to large measurement uncertainties. The ring shaped force transducers have been suitably modified into other shapes and results have been reported, but such developments are limited to specific applications [1–3]. Other types of force transducers, such as tuning fork type force transducers, have been reported upon and employed as force transfer standards, but their large scale suitability has yet to be established [4].

Strain gauged transducers, now a day's are developed indigenously for various measurement related applications like pressure, force, torque etc. to promote in-house research and development. Such developments are prompt

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Development and Evaluation of Low Phytic Acid Soybean by siRNA Triggered Seed Specific Silencing of *Inositol Polyphosphate 6-/3-/5-Kinase* Gene.

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Abstract

Soybean is one of the leading oilseed crop in the world and is showing a remarkable surge in its utilization in formulating animal feeds and supplements. Its dietary consumption, however, is incongruent with its existing industrial demand due to the presence of anti-nutritional factors in sufficiently large amounts. Phytic acid in particular raises concern as it causes a concomitant loss of indigestible complexed minerals and charged proteins in the waste and results in reduced mineral bioavailability in both livestock and humans. Reducing the seed phytate level thus seems indispensable to overcome the nutritional menace associated with soy grain consumption. In order to conceive our objective we designed and expressed a inositol polyphosphate 6-/3-/5-kinase gene-specific RNAi construct in the seeds of Pusa-16 soybean cultivar. We subsequently conducted a genotypic, phenotypic and biochemical analysis of the developed putative transgenic populations and found very low phytic acid levels, moderate accumulation of inorganic phosphate and elevated mineral content in some lines. These low phytic acid lines did not show any reduction in seedling emergence and displayed an overall good agronomic performance.

KEYWORDS: Agrobacterium-mediated transformation; RNAi silencing; inositol polyphosphate 6-/3-/5-kinase; low phytic acid; seed-specific; soybean

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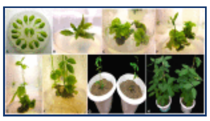
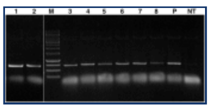
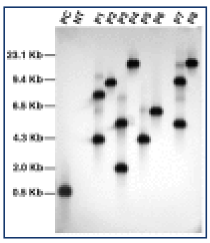
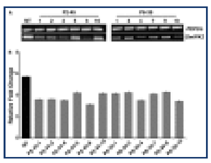
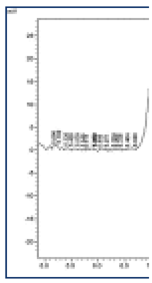

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Direct Power Neuro-Fuzzy Controller Scheme of Three-Phase PWM Rectifiers for Power Quality Improvement

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Abstract

This paper investigates the design of an improvement scheme of direct power control (DPC) based on adaptive neuro-fuzzy inference system (ANFIS) for mitigation of power quality problems. The proposed control technique is performed using two ANFIS blocks. The first ANFIS block uses the grid voltage vector position, the errors of the instantaneous active and reactive powers. The second ANFIS block utilizes the dc link voltage error and its change. The purpose of the proposed control algorithm is to regulate perfectly dc link voltage, to control directly the instantaneous powers, near-sinusoidal source current waveforms and unity power factor (UPF) operation. The regulation method has been developed and simulated using MATLAB/Simulink environment. The numerical simulation results confirm the validity of the proposed control technique for three-phase PWM rectifiers and have proved excellent robustness and performance.

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Disassembly Index Evaluation of Automotive Systems Using Graph Theory and AHP

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Abstract — **The paper proposes a methodology for the evaluation of disassembly features of an automotive system and constructs an overall metric called the Disassembly Index. For this, various attributes related to design, cost, etc. are considered. The methodology is illustrated using the case study of an automobile clutch system. It is envisaged that this will help in redesigning the system(s) with an overall objective of reducing time, effort and expenditure involved in the automobile servicing process.**

Keywords — **Disassembly Index, Graph Theory, AHP, Automotive System Maintenance, Disassembly Factors**

I. INTRODUCTION

The past decade has seen a rapid growth in the number of automobiles. The number of service centres has not grown proportionately. This has necessitated the need to reduce the response time of automobile servicing. Automobile servicing or the maintenance of it involves: a combination of all technical and administrative actions, including supervision, intended to retain an item in, or restore it to, a state in which it can perform the required function [1]. Automobile servicing involves time, effort and cost, etc., therefore, study of these attributes for improved designs is the need of the hour.

Disassembling a system for servicing is one of its primary features, because it consumes a significant amount of total service time and all design efforts must focus on its reduction [2]. However, there is a dearth of literature that encompasses the disassembly features and indicates as to how good or bad the system design is through a single numerical metric. This was the primary motivation for this work. In this paper, an attempt has been made to analogize actual and ideal conditions of disassembly of the automobile and to arrive at a suitable metric. This will help the designers in comparing their designs and choose the best among the possible alternatives, which in turn will ensure that, the service centres turn around the automobiles efficiently and quickly to ensure customer delight.

Graph Theoretic Approach (GTA) is a mechanism that has been used for various decision making tasks. A review of the literature showed that limited work has been done in evaluating disassembly index using this approach. One of the early works of using digraph approach for evaluating maintainability index of mechanical systems in the tribological domain was conducted by Wani and Gandhi [3]. The basic principles to attain better maintainability of the overall system were discussed by Tjiparuro and G. Thompson [4]. The efficiency of disassembly and reassembly of automobiles was evaluated on the basis of a survey of disassembly parameters, such as: working ambience, tools, fasteners, and the force experienced by the system [5]. Moreover, researchers calculated disassembly effort index, using a weighted estimation of qualitative evaluation of factors [6]. These studies mainly focussed on the complexity and design features of the disassembly of the system. Some more studies that used GTA and disassembly features have been summarized in Table I.

Most of the previous work has been limited to factors concerning system design, machine tools, working conditions and, human resource requirements, etc. Factors, such as, costs and extent of damage were not considered and these need to be examined explicitly. Therefore, determination of disassembly index (DI) has been attempted in this paper which will aid in the reduction of disassembly time, effort and cost. By considering factors like unfastening methods, ergonomics and accessibility has provided the research a wider outlook and more precise results.

TABLE I
Summary of Literature on disassembly factors

Considered Factors
Geometric characteristics of parts and joints [7]
Economic and environmental aspects [8]
Design characteristics of the equipment and their maintenance [9]
Digraph matrix method to develop methodology [10]
Working posture and temperature [11]
Personal competency and support system [12]

II. DISASSEMBLY FACTORS

The eight disassembly attributes considered for modelling are: System Complexity (SC), Cost Incurred (CI), Extent of Damage (ED), Accessibility (AC), Unfastening Methods

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Journal of Biomedical Semantics

RESEARCH Open Access

Drug target ontology to classify and integrate drug discovery data

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Abstract

Background: One of the most successful approaches to develop new small molecule therapeutics has been to start from a validated druggable protein target. However, only a small subset of potentially druggable targets has attracted significant research and development resources. The Illuminating the Druggable Genome (IDG) project develops resources to catalyze the development of likely targetable, yet currently understudied prospective drug targets. A central component of the IDG program is a comprehensive knowledge resource of the druggable genome.

Results: As part of that effort, we have developed a framework to integrate, navigate, and analyze drug discovery data based on formalized and standardized classifications and annotations of druggable protein targets, the Drug Target Ontology (DTO). DTO was constructed by extensive curation and consolidation of various resources. DTO classifies the four major drug target protein families, GPCRs, kinases, ion channels and nuclear receptors, based on phylogenecity, function, target development level, disease association, tissue expression, chemical ligand and substrate characteristics, and target-family specific characteristics. The formal ontology was built using a new software tool to auto-generate most axioms from a database while supporting manual knowledge acquisition. A modular, hierarchical implementation facilitate ontology development and maintenance and makes use of various external ontologies, thus integrating the DTO into the ecosystem of biomedical ontologies. As a formal OWL-DL ontology, DTO contains asserted and inferred axioms. Modeling data from the Library of Integrated Network-based Cellular Signatures (LINCS) program illustrates the potential of DTO for contextual data integration and nuanced definition of important drug target characteristics. DTO has been implemented in the IDG user interface Portal, Pharos and the TIN-X explorer of protein target disease relationships.

Conclusions: DTO was built based on the need for a formal semantic model for druggable targets including various related information such as protein, gene, protein domain, protein structure, binding site, small molecule drug, mechanism of action, protein tissue localization, disease association, and many other types of information. DTO will further facilitate the otherwise challenging integration and formal linking to biological assays, phenotypes, disease models, drug poly-pharmacology, binding kinetics and many other processes, functions and qualities that are at the core of drug discovery. The first version of DTO is publically available via the website http://drugtargetontology.org/, Github (http://github.com/DrugTargetOntology/DTO), and the NCBO Bioportal (http://bioportal.bioontology.org/ontologies/DTO). The long-term goal of DTO is to provide such an integrative framework and to populate the ontology with this information as a community resource.

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Effects of transition metal ion dopants (Ag, Cu and Fe) on the structural, mechanical and antibacterial properties of bioactive glass

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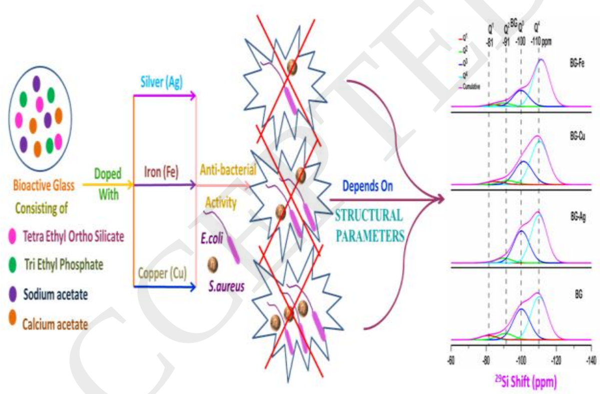
Graphical Abstract



Abstract

In this investigation, an attempt has been made to provide comparative insight into the structural integrity, mechanical strength and anti-bacterial properties of three different transition metal ions

Electronic Band-offsets across $Cu_2O/BaZrO_3$ Heterojunction and its Stable Photo-Electro-Chemical Response: First-principles Theoretical Analysis and Experimental Optimization

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Abstract:
Cu_2O has been shown to be highly active as a cathode in photo-electro-chemical (PEC) reduction of water to generate hydrogen fuel using sunlight. However, Cu_2O is susceptible to photo-corrosion when exposed to an electrolyte and needs to be protected by an over-layer of a suitable material, and its performance depends sensitively on its interface with the over-layer, and hence to the method of deposition. Here, we use first-principles theoretical analysis of the electronic structure of $Cu_2O/BaZrO_3$interface, and show that valence and conduction bands are favourably aligned to absorb light and catalyse the Hydrogen Evolution Reaction. We then present experiments with spray pyrolytically deposited Cu_2O films and spin coated over-layer of $BaZrO_3$, and optimize its PEC performance with thickness of Cu_2O film. We find a maximum photocurrent density of1.25mA/cm^2 at 0.95 V/SCE for an overall thickness of 458 nm, and demonstrate that the photocurrent remains stable over a long period of time. Demonstration of scalable and cost effective deposition of Cu_2O and $BaZrO_3$with stable PEC performance and understanding of the mechanism of charge separation across the$Cu_2O/BaZrO_3$ interface developed here should facilitate further optimization of $Cu_2O/BaZrO_3$ films for realistic PEC applications.

Keyword: Heterojunction, Photoelectrochemical, Density Functional Theory, Effective mass, Band offsets

1. Introduction:

Generation of hydrogen by photoelectrochemical (PEC) water splitting using sun light illumination is simpler and environmentally friendlier than the catalytic reforming of hydrocarbon fuels[1-2]. Although considerable research within the past decade has been devoted into PEC water splitting, fabrication of a stable and efficient photo-electrode with Solar to Hydrogen (STH) efficiency of more than 10% required for practical applications still remains

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Employing X-ray absorption technique for better detector resolution and measurement of low cross-section events

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Keywords:
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One-electron-one-photon transitions
Two-electron-one-photon transition
Low cross section processes
Lifetime measurements

ABSTRACT

The versatility of X-ray absorption technique is experimentally employed for enhancing the detector resolution and to rejuvenate the low probable transitions obscured in the pile-up region, during a beam-foil spectroscopy experiment. The multiple aluminum absorber layers (10 μm each) are used to suppress the pile-up contribution drastically and to restore a weak transition which is about 1.38×10^4 times weaker than a one-electron-one-photon transitions viz. K_α and K_α^h. The weak line is possibly originating from a two-electron-one-photon transition in He-like Ti. Further, the transitions, which were obscured in the spectra due to high intensity ratio, are revived by dissimilar line intensity attenuation using this technique. The measured lifetimes of K_α line with and without intensity attenuation match well within error bar. The present technique finds potential implications in understanding the structure of multiple-core-vacant ions and other low cross section processes in ion-solid collisions.

1. Introduction

The formation of two K-shell vacancies either in the target atoms or the projectile ions is often seen in the energetic heavy ion-solid collisions [1]. These two vacancies are mostly filled sequentially by emitting a $K_{\alpha h}$ or $K_{\beta h}$ (hypersatelite) line and another K_α or K_β line [2]. However, there is a small probability that the two vacancies can be filled simultaneously by two electrons resulting in an emission of a single photon of nearly twice the energy of K_α or K_β [2–5] line. Therefore, the signature of the two-electron-one-photon (TEOP) transitions ($K_{\alpha\alpha}$, $K_{\alpha\beta}$) is mostly buried in the spectral region affected by the pile-up phenomenon. Several pile-up rejection techniques such as pulse shape discrimination [6], pile-up rejection circuits, reduction of the counting rates [7–9], and use of selective filters [10–14] are well known. The relative yield for $K_{\alpha\alpha}/K_\alpha$ is of the order of 10^{-4} in Ar atom [15]. This ratio improves for the lighter atoms and deteriorates further for the heavier atoms [3]. Therefore, the detection of such processes requires sufficiently high **count** rate of TEOP transitions, which can be enhanced by increasing the number of incident ions. However, this will further increase the one-electron-one-photon (OEOP) transition count rate leading to more pile-up events in the spectrum. As a solution, the techniques capable of handling high counting rates and elimination of pile-up simultaneously, can only be used for such experiments. Nevertheless, the commonly used electronic techniques [7–9] cannot completely reject the pile-up contributions. Rate of pile-up rejection depends on $n^2\tau$, where n is the true counting rate and τ is the system dead time, which has certain limiting value. Thus, an elegant method of solving the problem requires limited event rate in the detector even though count rate is high in the experiment. The absorption technique abruptly decreases the count rate of intense X-ray transitions (which is main cause of the pile-up) on low energy side, but barely attenuates the low intensity transitions lying on the high energy side. Hence, it increases the effective count rate for the low intensity processes by decreasing the pile-up contributions to an extreme limit.

The maximum resolution of any detector is characterized by least overlapping of the peaks. This overlapping can be minimized by either, (i) increasing the spectral separation between the peaks or (ii) improving the spectral width of the transition. This overlapping depends on the intensities of the adjacent peaks and minimum for the identical intensities. Therefore, it is possible that the two transitions existing within the resolution of the detector may not be experimentally resolved. The high resolution spectroscopy method [17] help resolving them, but it requires absorber with specific K or L absorption edge. Note that such transitions can be resolved in a delayed spectrum [16] if the lifetimes of the excited levels corresponding to the different lines differ significantly. In this paper, we have used the absorption technique to validate our earlier theoretical studies (i) to improve the resolution for closely separated transitions having different intensities and (ii) to

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Energy and exergy analyses of a solar powered multi-effect cooling cycle

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Abstract: This study aims to assess the thermodynamic performance of a novel solar powered multi-effect cooling cycle through the cascaded utilisation of energy and exergy. The effects of parameters such as: direct normal irradiation (DNI), turbine inlet temperature, turbine back pressure, and evaporator temperature of ERC were ascertained on the energetic and exergetic performance of the cycle. Exergy destruction occurs throughout the plant components is quantified and illustrated using an exergy flow diagram, and compared to the corresponding energy flow diagram. The exergy efficiency of the cycle was significantly less than its corresponding energy efficiency. Computational analysis further revealed that the maximum exergy losses of more than 34% occur in the solar field followed by 7.25% and 6.75% in the components of ARC and CRC, respectively. Percentage of these exergy losses indicates the sites where the efforts should be made to improve the real performance of proposed cooling cycle.

Keywords: solar; refrigeration; efficiency; ejector; absorption.

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ORIGINAL PAPER

Energy, exergy, environment and economic analyses and optimization of two-stage absorption–compression combined refrigeration system

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Abstract In the present paper, integration of a two-stage absorption refrigeration system with a compression refrigeration system is proposed for utilizing low-temperature heat and reducing electric energy consumption. The proposed system is analyzed and compared with vapor compression system from the viewpoint of energy, exergy, environment and economics. The proposed system reduces the electricity consumption by 89.3% and CO_2 emission from 112.6 to 12.1 ton/year. The size and cost of the system are determined by designing the heat exchangers. The optimization is also performed with the objective of minimizing the annual cost of plant operation which includes fuel exergy cost, initial investment and maintenance cost and environmental damage cost due to CO_2 emission. The annual cost of its operation is 21.6% less than equivalent vapor compression refrigeration system which is further reduced by 18.2% through system optimization.

Keywords Absorption · Cost · Environment · Exergy · Optimization · Refrigeration

List of symbols

A	Area (m^2)
c_{CO_2}	Cost of unit carbon dioxide emission (\$/ton)
c_{el}	Cost of unit electricity (\$/kWh)
$\dot{C}_{env}$	Annual environment damage cost (\$/year)
$\dot{C}_{op}$	Annual operational cost (\$/year)
$\dot{C}_{plant}$	Annual cost of plant operation (\$/year)
COP	Coefficient of performance
CRF	Capital recovery factor
$\dot{E}$	Exergy flow rate (kW)
$\dot{ED}$	Rate of exergy destruction (kW)
h	Specific enthalpy (kJ/kg)
HP	High pressure
HPA	High-pressure absorber
HPG	High-pressure generator
HPSTV	High-pressure solution throttle valve
i_r	Rate of interest (%)
LMTD	Log mean temperature difference
LP	Low pressure
LPA	Low-pressure absorber
LPG	Low-pressure generator
LPSTV	Low-pressure solution throttle valve
LiBr	Lithium bromide
$\dot{m}$	Mass flow rate (kg/s)
m_{CO_2}	Annual emission of carbon dioxide (ton)
n	Life span of the refrigeration plant
p	Pressure (kPa)
PR	Pressure ratio
$\dot{Q}$	Heat transfer rate (kW)
ref	Refrigerant
RTV	Refrigerant throttle valve
s	Specific entropy (kJ/kg/K)
SCR	Solution circulation ratio
STV	Solution throttle valve
SHE	Solution heat exchanger
T	Temperature (°C or K)
$T_{cond,VAR}$	Absorption section condenser temperature (°C)

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Enhanced Reactive H_2S Adsorption Using Carbon Nanofibers Supported with Cu/Cu_xO Nanoparticles

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Enhancement in thermoelectric performance of SiGe nanoalloys dispersed with SiC nanoparticles

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Abstract

SiGe is one of the most widely used thermoelectric material for radioisotope thermoelectric generator applications for harnessing waste-heat at high temperatures. In the present study, we report a simple experimental strategy for enhancing the thermoelectric and mechanical properties of n-type SiGe nanoalloys by dispersing SiC nanoparticles in SiGe nanoalloy matrix. This strategy yielded a high value of figure-of-merit (ZT) ~1.7 at 900ºC in SiGe/SiC nanocomposite, which is nearly twice than that reported for its pristine bulk counterpart and ~ 15% higher than pristine SiGe nanoalloys. This significant enhancement in the ZT primarily originates from a reduction in the lattice thermal conductivity, owing to a high density of nano-scale interfaces, lattice-scale modulations and mass fluctuations, which lead to extensive scattering of heat-carrying phonons. The dispersion of SiC nanoparticles also significantly enhances the mechanical properties of the resulting SiGe/SiC nanocomposite, including, fracture toughness and hardness. The enhancement in thermoelectric and mechanical properties of SiGe/SiC nanocomposites has been correlated with their microstructural features, elucidated employing X-ray diffraction, scanning and transmission electron microscopy.

Keywords: *Thermoelectrics, SiC nanoparticles, thermoelectric performance, SiGe nanocomposite, spark plasma sintering, figure-of-merit.*

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Enhancing the processibility of high temperature polymerizing cardanol derived benzoxazines using eco-friendly curing accelerators

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Epoxy-glass Microballoon Syntactic Foams for Blast Mitigating Applications

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ABSTRACT

Polymeric syntactic foams refer to a class of cellular material created using preformed hollow spheres bound together with a polymeric matrix. These cellular materials possess exceptional ability to respond against high impact dynamic loads. This paper is an attempt to fabricate polymeric syntactic foams of epoxy containing hollow glass microballoon at varying loading (40 % - 60 %) and explore their potential towards blast mitigation. The tensile, compressive and flexural strength were found to be inversely proportional to the microballoon loading in the quasi-static regime. The strain rate sensitivity of the foams was confirmed by performing high strain rate studies using split hopkinson pressure bar. The flow stress of these foams was found to increase with increasing strain rates. The syntactic foams were subjected to controlled transient blast loadings using a shock tube. The samples remained intact and no strain was observed on the strain gauge, even under a blast load of ~ 90 psi, which clearly highlight their potential as core materials for blast mitigating applications.

Keywords: Syntactic foams; High strain rate; Blast load; Shock tube

1. INTRODUCTION

Syntactic foams belong to a subclass of composite cellular materials prepared by dispersing hollow micro balloons in a matrix of polymer, ceramic or metal[1,2]. The presence of a large proportion of gaseous phase in these composites lead to significant weight reduction, and impart special mechanical properties which vastly differs from the bulk materials. These cellular composites are finding diverse applications ranging from deep sea to space vehicles[3] especially as energy absorbing core materials in sandwiched structures[4]. The presence of soft condensed matter helps reduce the damage arising from impact and other transient loads[5]. Although, both open and closed cell foams have been effectively utilised in their ability to resist blast/dynamic loads[6,7], the latter owing to the presence of entrapped air, forbears additional deformation at high strain rates and increase the compressive strength and energy absorbing ability of the foams[8].

Glass microballoons have been extensively used for syntactic foam manufacturing because of their high strength and low density[9]. Additionally, these microspheres act as independent energy absorbing loci on being subjected to compressive loads. Potential applications of syntactic foams as core materials, utilising their ability to act as energy absorbers, include them being used in the underbelly of tanks to attenuate the blast effects arising out from anti tank mines or other such applications where the ability to mitigate the effects of explosion are vital. Sandwich cores have found place in the literature[8,10], most important of them being balsa and foam cores in various naval applications such as surface ship deck structures and in boat hulls[11,12].

Rigid polymeric foams, usually prepared by the chemical reaction of isocyanates with polyols, are not strong enough to withstand blast loads and therefore mandate reinforcement[13]. Also, the processing of polymer-based foams is an involved process with interfacial phenomena and fluid dynamics being very critical[14,15]. In the field of defence technologies, in view of their excellent mechanical properties syntactic foams have been reported to withstand dynamic loads[16]. It is worth mentioning that blast effects, fall into the category of high impact dynamic loading which are characterised by the occurrence of high amplitude and high frequency waves which act on the structures for a very short period of time[17].

The aim of this study is to develop epoxy based syntactic foams and evaluate their behaviour both at quasi static and high strain rates using a Split Hopkinson pressure bar. Further, their response on being subjected to controlled transient loading has been studied on a shock tube facility. The aim is to explore the potential of these syntactic foams as core materials for energy absorbing applications.

2. EXPERIMENTAL

2.1 Materials and Methods

Cycloaliphatic epoxy resin (Ciba Geigy, Araldite CY 230; epoxy equivalent 200 eq g^{-1}), hardener (HY 951; amine content 24 eq kg^{-1}) and Hollow glass microballoons (K46, 3M) were used for the preparation of syntactic foams. The HGMs used have a true particle density of 0.46 g/cm^3, mean diameter of 40 μm (wall thickness 1.29 μm) and isostatic

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Estimation of structure and stability of MurE ligase from *Salmonella enterica* serovar Typhi

Running head: Structural characterization of MurE

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Highlights

- MurE ligase is essential for cell wall synthesis in bacteria and is an important drug target
- Conformational changes associated GdmCl- and urea-induced denaturation of MurE ligase were investigated using Circular Dichroism and fluorescence spectroscopy.
- Thermadynamic parameters calculated for both denaturants are comparable.
- GdmCl and urea induced denaturation of MurE follow two-state process.

ABSTRACT

MurE ligase catalyzes the assembly of peptide moiety, an essential component of bacterial cell wall. We have explored the conformational stability and unfolding equilibrium behaviour of the protein MurE ligase by determining the conformational free energy, entropy and enthalpy parameters under stress conditions. MurE from *Salmonella enterica* Serovar Typhi was cloned, expressed and purified. Conformational changes associated with increasing concentration of GdmCl- and urea-induced denaturation of MurE were monitored using Circular Dichroism (CD) and fluorescence spectroscopies. The secondary structural content of protein estimated by CD experiment is in close agreement with the predicted MurE ligase structure by homology

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EVALUATION OF PARAVALVULAR LEAKAGE IN NOVEL MECHANICAL HEART VALVE

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ABSTRACT

We developed a new mechanical heart valve prototype with a unique mechanism for attachment to cardiac tissue. The development of novel prosthetic heart valve systems requires careful assessment of paravalvular leaks – leakage of fluid that takes place between the valve and the cardiac tissue it is attached to. Traditional methods of testing paravalvular leaks in flow chambers are not ideal for novel devices and may underestimate its true extent. In this paper we developed a novel method of quantifying paravalvular leaks involving the use of 3D printed prototype heart valves and cadaveric bovine hearts, and compared the results with those from commercially available Medtronic ATS mechanical bileaflet valves. The average leak in our final prototype heart valves were found to be 0.13 ml/sec, compared to 0.33 ml/sec in the ATS valve.

INTRODUCTION

Calcific aortic stenosis is a disease that affects one in every eight adults above the age of 75 and 2% of all adults under the age of 65 [1]–[4]. The incidence of aortic stenosis is higher in patients who have congenital bicuspid aortic valves, a disease that in itself has a prevalence of 1% in all births [5]. Left untreated, aortic stenosis can progress to heart failure and death.

The definitive treatment for this condition is surgical replacement of the degenerating valve with a prosthetic replacement: either carbon based mechanical valves, or biological valves derived from porcine or bovine tissue. Mechanical heart valves have shown exceptional durability, yet a major drawback is the need of lifelong warfarin therapy which has led to its decline in popularity over the years [6]. Patients implanted with tissue valves don't require anti-coagulation in most cases, but these valves are not durable and require re-intervention after 7-10 years [7], [8]. This limits their use in younger patients and renders it unsuitable for use in the pediatric population. The increasing burden of young patients from low and middle-income countries, in part due to the high prevalence of rheumatic heart disease in these regions, along with increasing accessibility to healthcare services, means that a heart valve that can combine durability with freedom from anticoagulation is needed now more than ever [6], [9].

All modern mechanical heart valves make use of a cylindrical housing, surrounded by a fabric ring of a substantial thickness which allows the valve to be sutured to the heart tissue [Fig. 1]. The fabric ring is held to the housing by bands or a titanium stiffening ring. During implantation of the valve, a stenosis or 'shelf' in the path of blood flow is created along with a distal expansion zone because of the method employed in suturing the

Figure 1: Assembly of the Medtronic ATS Valve

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Evidence of circular Rydberg states in beam-foil experiments: Role of the surface wake field

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PACS 34.35.+a – Interactions of atoms and molecules with surfaces
PACS 34.90.+q – Other topics in atomic and molecular collision processes and interactions
PACS 34.50.Fa – Electronic excitation and ionization of atoms (including beam-foil excitation and ionization)

Abstract – We have employed the concept of the surface wake field to model the formation of the circular Rydberg states in the beam-foil experiments. The experimental studies of atomic excitation processes show the formation of circular Rydberg states either in the bulk of the foil or at the exit surface, and the mechanism is explained by several controversial theories. The present model is based on the interesting fact that the charge state fraction as well as the surface wake field depend on the foil thickness and it resolves a long-standing discrepancy on the mechanism of the formation of circular Rydberg states. The influence of exit layers is twofold. Initially, the high angular momentum Rydberg states are produced in the last layers of the foil by the Stark switching due to the bulk wake field and finally, they are transferred to the circular Rydberg states as a single multiphoton process due to the influence of the surface wake field.

Introduction. – The electronic states of excited ions, atoms or molecules are classified into two broad categories, *viz.* penetrating and non-penetrating. These two classes differ from each other concerning the penetration of the excited electron through the effective charge region of the inner electronic core and the nucleus. The electrons orbiting with the maximum angular momentum ($l_{max} = n - 1$) and the maximum magnetic quantum number ($|m| = n - 1$), are not allowed to penetrate the core due to high centrifugal barrier $l_{max}(l_{max}+1)/r^2$ and, therefore, the electrons are almost in an isolated state from the core resulting in the reduced perturbation and increased lifetime of the excited states [1]. The electrons in such high l states are much less perturbed by the nuclear charge and, therefore, decay according to the selection rules for $E1$ transitions, *i.e.*, $\Delta l = \pm 1$ (with negligible configuration interaction). The penetration to the core of these states is small, and the quantum defects are usually less than 0.1 [2]. For such states, "l" is a good quantum number for describing the properties of an electron which is forced to follow a circular path and thereby, are called circular Rydberg states (CRS) [3]. The nuclear size correction is almost negligible for the high l states and zero for the CRS, which provides us with precise measurement of the Rydberg constant and energy levels. Besides, the quantum electrodynamic effects [4], fundamental constants such as nuclear mass [5], and predictive power of a theory [6] can also be deduced with high accuracy.

A lot of theoretical studies and many experimental approaches were employed for populating the electrons in the CRS. Freemen and Kleppner [7] proposed a Stark switching method to transfer the electrons to the high angular momentum states. Koch and Martin [8] used laser excitation of the collisionally excited Rydberg atoms. Hullet and Kleppner [9] proposed and used the adiabatic rapid passages of the time varying microwave fields. Afterward, an RF-optical technique was suggested for the formation of the CRS [10], which has not been realized yet. Later, Delande and Gay [11] proposed a new theoretical scheme, which was based on the application of crossed weak magnetic and electric (time varying) fields [12]. Liang *et al.* [13] and Cheret *et al.* [14] used this cross-fields method for the formation of CRS up to $n = 30$. Brecha *et al.* [15] detected the CRS around $n = 67$. In 1994, the CRS were produced by the incidence of a circularly polarized microwave field [16] on Na atoms.

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Experimental and Theoretical Analysis of Connector Offset Optical Fiber Refractive Index Sensor

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Abstract In this paper, a high sensitive connector offset optical fiber sensor is employed to detect the refractive index of liquid. The configuration chosen for this experiment is formed by lateral core offset fusion splicing of no-core fiber (NCF) between the single mode fibers (SMF) and cladding modes are excited by misalignment. The sensing principle for refractive index detection is based on Mach-Zehnder Interferometer (MZI) principle and the experiment is carried out by immersion of device in NaCl solutions of different refractive indices. Such refractive index sensor exhibits high sensitivity 197.33 nm/RIU for the surrounding refractive index variation from 1.333 to 1.380, and the result shows the excellent agreement with theoretical analysis. Compared to other sensors, the proposed device has the potential to provide high sensitivity, ease of fabrication, low cost, compact size, and linear response. Thus, it can be used in many applications such as bio-sensors, chemical sensor, temperature sensor, and pressure sensor.

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Keywords No core fiber · Core-offset · Mach-Zehnder interferometer · Refractive index

Introduction

Various biological, chemical and physical parameters require refractive index detection. Thus, for refractive index measurement, fiber optic refractive index sensors, like interferometeric sensors [1–6] and sensors based on long-period gratings [7], tilted fiber Bragg gratings [8], tapered fiber [9], Surface plasmon resonance [10] and photonic crystal fiber [11, 12], have been of great interest due to various desirable advantages. Optical fiber-based refractive index possesses many advantages of small size, easy fabrication, high sensitivity and light weight. The measurement of refractive index sensing is very much important in the variety of applications including the inspection of solute concentration and quality control in the monitoring of food engineering processes. The measurements of refractive index of liquids imply its applications in optical, physical, chemical and biological fields. Numerous structures have been proposed for refractive index sensing using various configurations such as double cladding [13], core offset splice [14, 15], concatenating tapers [16] and peanut-shaped structures [17]. The in-line MZIs are fabricated by a splitter, combiner to observe the coupling and recouping of core-cladding modes. These kinds of sensors have been widely used to investigate the temperature [18, 19], strain [20], refractive index [21–23], and liquid level [24]. Compared to other sensors, the sensor based on the core offset structure is more economic owing to low cost and its ease of fabrication.

In this letter, we present a highly sensitive connector lateral core offset optical fiber refractive index sensor based on MZI. The sensing result depends on the

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Fast Deformable Model for Pedestrian Detection with Haar-like Features

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***Abstract*—This paper proposes a novel Fast Deformable Model for Pedestrian Detection (FDMPD) to detect the pedestrians efficiently and accurately in the crowded environment. Despite of multiple detection methods available, detection becomes difficult due to variety of human postures and perspectives. The proposed study is divided into two parts. First part trains six Adaboost classifiers with Haar-like feature for different body parts (e.g., head, shoulders, and knees) to build the response feature maps. Second part uses these six response feature maps with full-body model to produce spatial deep features. The combined deep features are used as an input to SVM to judge the existence of pedestrian. As per the experiments conducted on the INRIA person dataset, the proposed FDMPD approach shows greater than 44.75 % improvement compared to other state-of-the-art methods in terms of efficiency and robustness.**

***Index Terms*—Pedestrian, Adaboost, Multi-view, Deformable part model**

I. INTRODUCTION

Pedestrian detection is a powerful technique in the field of computer vision. In recent decades, it has received wide consideration for its extensive applications, ranging from intelligent transportation and robotics to security surveillance. Although the question of how to detect pedestrians has been thoroughly investigated [1], primarily due to the intra-class variation of pedestrians in clothing and articulation, the problem still remains challenging and continues to attract research.

Viola and Jones [2] developed a cascaded method for fast detection, computing a calculus map with Haar-like [3] features and automatically selecting features with Adaboost. In 2005, Dalal and Triggs [4] proposed histogram of oriented gradients (HoG) features, which are fed to a linear support vector machine (LSVM) to improve the performance. Their report indicates that HoG features contain more object information, thus contributing to higher detection rate. Those local features and classifiers will lay a solid foundation to further improve pedestrian detection.

Regarding pedestrian detection, the HoG feature collection is one of the most popular local feature collections and exhibits a low miss rate with various classifiers. Instead of using common general descriptors (e.g., Haar-like features, local binary patterns, HoG), some specific features are designed according to the attributes of pedestrian. Zhang et al. [5] proposes informed Haar-like features to describe the appearance of the up-right human body. Combination of different features also achieves impressed performance. Dollar et al. [6] introduces ChnFtrs detector which adopts HoG, gradient and color information as Integral Channel Features. ChnFtrs can achieve state-of-the-art performance for single part template detection. However, using mixed features may lead to high computational cost. Therefore, determination of an effective solution without limiting to local features is the hitch for researchers. The key problem involves the detection strategy rather than the combination of classifiers and features used.

In recent years, part based models [7]–[13] for pedestrian detection have received wide consideration. In contrast with full-body methods [3], [14]–[19], part-based models jointly learn distinct parts and their interrelationships to make a judgement. On one hand, this approach is more effective and robust in detecting jointed objects such as animals and robots that appear with various postures and collusion. On the other hand, part-based models are successful in well-known challenges, e.g., PASCALVOC (the Pattern Analysis, Statistical Modeling and Computational Learning Visual Object Classes). Felzenszwalb et al. [11], [12] utilizes HoG features and a latent variable support vector machine (LatSVM) to train the pedestrian part model, which suppresses the disturbance caused by varying pedestrian postures and multi-views. Ouyang et al. [20] proposes a deep model which considers the visible parts as hidden variables, through a probabilistic framework to learn the relationships among various parts.

Inspired by popular part-based methods, this study proposes a Fast-Deformable Model for Pedestrian Detection (FDMPD). Learning six distinct components together (e.g., head, shoulders, and knees) to build the response feature maps with Adaboost classifiers, the proposed method takes these feature maps as input to generate spatial second layer features to train a support vector machine (SVM) as classifier. The performance

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Filled-carbon nanotubes: 1 D nanomagnets possessing uniaxial magnetization axis and reversal magnetization switching

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Magnetic switching

A B S T R A C T

The present study aims to control the direction of magnetization in Fe_3C, Co and Ni nanorods filled inside carbon nanotube (CNT). This control has been achieved during growth by modifying thermal chemical vapor deposition (CVD) system. As-grown *in situ* filled-CNTs were found to exhibit permanent magnetization. These CNTs have been characterized by using scanning electron microscopy (SEM), X-ray diffraction, Raman spectroscopy and transmission electron microscopy (TEM). Afterwards, direction of magnetization in Fe_3C, Co or Ni nanorod filled inside CNT has been further probed by using magnetic force microscopy (MFM). MFM measurements reveal that nanorod exhibits single domain behavior and direction of magnetization, instead of being controlled either by shape or magneto crystalline anisotropy, has been found to be influenced by magnetic field gradient, produced in modified thermal CVD system. Direction of magnetization has been found either along tube axis in vertical grown CNTs or in radial direction i.e. perpendicular to the tube axis in randomly grown CNTs. Besides investigated structural and magnetic properties, plausible growth model of *in situ* filling as well as mechanism to understand unique magnetization behavior has been proposed.

1. Introduction

The accomplishment of filling of carbon nanotube core with various materials has stimulated a large excitement as well as boosted research interest in various areas of nanotechnology such as magnetic resonance imaging [1], catalyst & energy storage [2], photothermal [3] and nano-biotechnological applications [4]. This has been attributed to the fact that in filled-CNT, tube-walls not only protect the filled nanomagnets against harsh environment but also prohibit coalescence and enhance the physical, chemical, magnetic or electronic properties of host nanotube as well as filled-nanomaterials. In recent reports, CNTs filled with magnetic materials have been proposed as a novel material and successfully demonstrated in innumerable potential applications in the thrust areas of research such as MFM tips [5,6], selective drug delivery [7,8], spintronics [9] and magnetic data storage devices [10]. In addition to CNT-related research activity, one-dimensional, well-aligned and separated magnetic nanostructures exhibit numerous potential applications such as labelling and magnetic separation of cells [11], cancer treatment [12], sensing [13], data storage [14] and so on. Specifically, in data storage device well-ordered magnetic structures with either in or out of plane magnetization are highly desirable. In order to have nanostructures which possess out of plane magnetization, vertical aligned-CNTs were found to be promising. Generally, in filled-CNT, direction of magnetization might be either along or perpendicular to tube axis, depending on the dominance of shape or magneto crystalline anisotropy,

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FlavorDB: a database of flavor molecules

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ABSTRACT

Flavor is an expression of olfactory and gustatory sensations experienced through a multitude of chemical processes triggered by molecules. Beyond their key role in defining taste and smell, flavor molecules also regulate metabolic processes with consequences to health. Such molecules present in natural sources have been an integral part of human history with limited success in attempts to create synthetic alternatives. Given their utility in various spheres of life such as food and fragrances, it is valuable to have a repository of flavor molecules, their natural sources, physicochemical properties, and sensory responses. FlavorDB (http://cosylab.iiitd.edu.in/flavordb) comprises of 25,595 flavor molecules representing an array of tastes and odors. Among these 2254 molecules are associated with 936 natural ingredients belonging to 34 categories. The dynamic, user-friendly interface of the resource facilitates exploration of flavor molecules for divergent applications: finding molecules matching a desired flavor or structure; exploring molecules of an ingredient; discovering novel food pairings; finding the molecular essence of food ingredients; associating chemical features with a flavor and more. Data-driven studies based on FlavorDB can pave the way for an improved understanding of flavor mechanisms.

INTRODUCTION

Flavor is a complex, multi-sensory human experience with a rich evolutionary history (1). Molecules form the chemical basis of flavor expressed primarily via gustatory and olfactory mechanisms. The perception of flavor arises from interaction of flavor molecules with the biological machinery and could be perceived as an emergent property of a complex biochemical system. While some components of this puzzle have been unearthed, a holistic view of this phenomenon still eludes us (2–5). Taking a data-centric approach can provide a systems perspective of flavor sensation by offering ways to discern its key features.

Flavors derived from natural sources have shaped culinary habits throughout human history. Analogous to variations in regional languages, cultures have evolved variations in the way they cook. Traditional recipe compositions encode ingredient combinations that are not only palatable but appetizing. Heuristic associations between molecular properties and perception of flavors provide indications towards its chemical basis (1). For example, combinations of aliphatic esters play a major role in many fruit flavors. Ketones are known to impart metallic flavors in oxidized butter, and monoterpenoids provide the characteristic flavors of many herbs and spices. However, such knowledge remains largely unstructured and incomprehensive.

FlavorDB was created with the aim of integrating multidimensional aspects of flavor molecules and representing their molecular features, flavor profiles and details of natural source (Figure 1). FooDB, one of the efforts in similar direction, compiles molecules from food ingredients; although its focus is not on chemical basis of flavor or flavor pairing (http://foodb.ca). Flavornet is another resource, which provides a list of flavor molecules and their odor

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Improved Hierarchical Decision Making Policy for Reliable and Green Electricity Grid

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***Abstract*—The electricity grid is a complex network and making it reliable is a challenging task. This becomes even more challenging when we consider the dynamic environment compromising of fluctuations due to the renewable energy based power plants and transmission line failures. In some cases, the grid needs to be operated in a controlled manner in order to reduce the cost or CO_2 emission and hence, an intelligent decision making policy (DMP) is desired. In this work, we employ hierarchical reinforcement learning based DMP to make the electricity grid reliable and environment-friendly, i.e. green. The proposed DMP switches the appropriate number of power plants on an hourly basis to meet the demand reliably even when one or more transmission line fails. The selection of the power plants can be done either to minimize the cost or to minimize the CO_2 emission without compromising on the reliability of electricity grid. The simulation results over small size network validate the functionality of the proposed DMP. We also demonstrate the trade-off between the reliability and CO_2 emission for an electricity grid.**

I. Introduction

Electricity grid network has been going through the revolutionary changes over the last decade due to advancements in paradigms such as renewable energy-based power plants, their integration with conventional power plants, demand response based intelligent distribution approach and Internet of Things (IoT) [1], [2]. In addition, the electricity grid network is expanding at an exponential rate in developing countries like India where thousands of houses are getting connected to the grid every month. Though the design, development, and management of such large-scale electricity grid network is itself a complex task, reliability of such network cannot be ignored due to its adverse effects on the economy of any region [1]–[3]. Thus, the design of reliable electricity grid is challenging task and focus of the proposed work.

In addition, conventional power plants are not environment-friendly due to large CO_2 emission but still preferred over other plants due to lower operational cost. However, increasing pollution levels has forced the governments worldwide to identify an efficient alternative to these power plants. Though complete replacement of conventional power plants is not feasible at the moment, efforts are needed to increase the contribution of renewable energy based power plants to reduce the CO_2 emission and make the grid environment-friendly, i.e. green. However, the intermittent nature of renewable energy demands artificial intelligence-based decision making policy (DMP) to integrate them in the conventional grid. Such DMP should also be able to adapt the grid to reduce the CO_2 emissions when needed, for example, when pollution levels are high and reduce the cost when pollution levels are normal.

In this work, we employ hierarchical reinforcement learning based DMP to make the electricity grid reliable and environment-friendly, i.e. green. The proposed DMP switches the appropriate number of power plants on an hourly basis to meet the demand reliably even when one or more transmission line fails. The selection of the power plants can be done either to minimize the cost or to minimize the CO_2 emission without compromising on the reliability of electricity grid. The simulation results over small size network validate the functionality of the proposed DMP. We also demonstrate the trade-off between the reliability and CO_2 emission for an electricity grid. The assumed electricity grid network model, proposed work and simulation results are discussed in Section II, Section III and Section IV, respectively.

II. Electricity Grid Network Model

We consider a 5-bus electrical grid as shown in Fig. 1. It consists of multiple loads and generators attached to six electrical nodes, referred to as buses. Here, the loads can be either industrial or residential type while generators are conventional coal power plants or renewable power plants. Buses are connected through the transmission lines which can transfer only a limited amount of electricity before getting damaged. The generator outputs need to be controlled in such a way that the current demand is met reliably, i.e. without exceeding the capacity of the transmission lines.

In Table 1, we have listed out the values of various properties of 5 generators which will be used for simulation

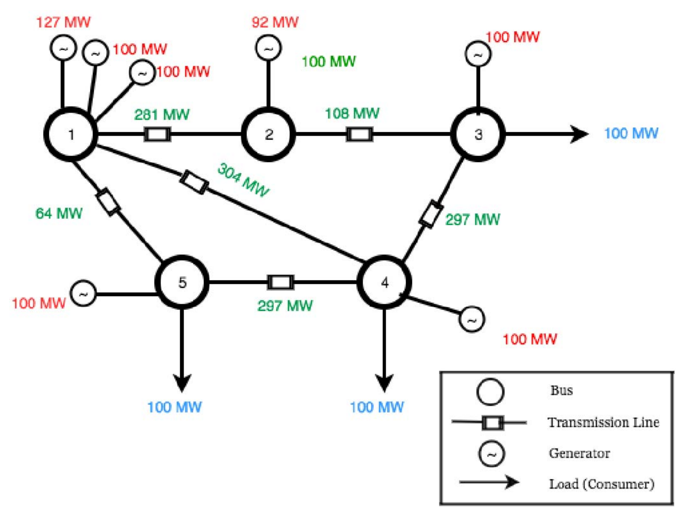

Fig. 1. Assumed electricity grid network model.

Improved Hierarchical Decision Making Policy for Reliable and Green Electricity Grid

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***Abstract*—The electricity grid is a complex network and making it reliable is a challenging task. This becomes even more challenging when we consider the dynamic environment compromising of fluctuations due to the renewable energy based power plants and transmission line failures. In some cases, the grid needs to be operated in a controlled manner in order to reduce the cost or CO_2 emission and hence, an intelligent decision making policy (DMP) is desired. In this work, we employ hierarchical reinforcement learning based DMP to make the electricity grid reliable and environment-friendly, i.e. green. The proposed DMP switches the appropriate number of power plants on an hourly basis to meet the demand reliably even when one or more transmission line fails. The selection of the power plants can be done either to minimize the cost or to minimize the CO_2 emission without compromising on the reliability of electricity grid. The simulation results over small size network validate the functionality of the proposed DMP. We also demonstrate the trade-off between the reliability and CO_2 emission for an electricity grid.**

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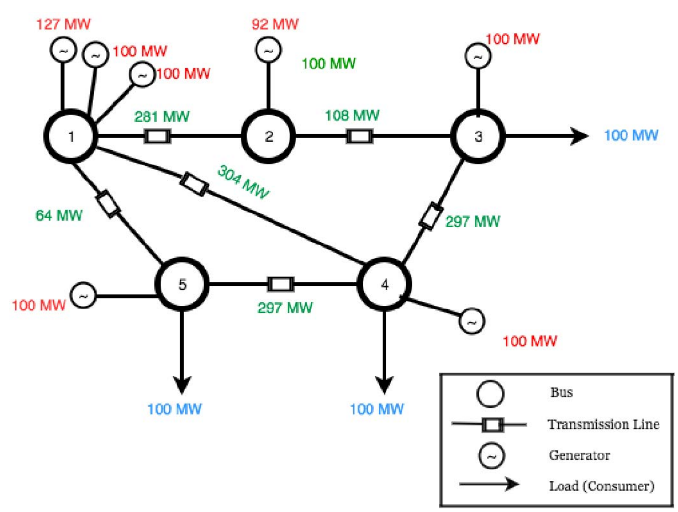

Fig. 1. Assumed electricity grid network model.

Influence of fabrication processes on transport properties of superconducting niobium nitride nanowires

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Fabrication of niobium nitride (NbN) superconducting nanowires based on focused ion beam (FIB) milling and electron beam lithography (EBL) is presented. The NbN films were deposited using reactive magnetron sputtering. Argon-to-nitrogen ratio turned out to be a crucial factor in synthesizing high quality superconducting NbN. Critical temperatures (T_c) of around 15.5 K were measured for films with a thickness of around 10 nm. Zero-field-cooled magnetization was measured to optimize the superconducting properties of ultra thin NbN films. The transport behaviour was studied using conventional resistance vs temperature and current-voltage characteristics down to 2 K. Effect of gallium contamination on superconducting properties has been discussed. Whereas the various processing steps of standard EBL route do not have any significant impact on the superconducting transition temperature as well as on the transition width of nanowires, there is significant degradation of superconducting properties of nanowires prepared using FIB. This has been attributed to gallium ion implantation across the superconducting channel. Although the effect of gallium implantation may have technological limitations in designing fascinating single photon detector architectures, it provides some interesting low-dimensional superconducting properties.

Keywords: DC magnetron sputtering, EBL, FIB, niobium nitride, superconducting nanostructure, thin films.

ALTHOUGH research initiatives towards single photon detection are not new, the demand for detector performance that goes beyond the performance of conventional single photon detectors has increased significantly over the past years, and is expected to grow due to current interest in the emerging field of quantum information processing[1–17]. In the light of recent developments in the field of quantum information technologies, it is absolutely essential to redefine candela, the SI unit of luminous intensity in terms of number of photons as well. Quantum metrology towards photon-based standards for optical radiation demands exploring newer and better single photon detection system[18]. Photomultiplier tubes (PMT) and solid state single-photon avalanche photodiodes (SPAD) are widely being used for detection of a single photon in many applications in the visible wavelength range due to their reasonable performance matrices and also due to their ambient/moderate operating temperatures. Between these two, SPAD is better in many ways due to its better detection efficiency (η), low dark count rate (DCR) and low time jitter (Δt). The figure of merit ($\eta/(D\Delta t)$) for InGaAs-SPAD is four orders of magnitude better than that of PMT at 1550 nm wavelength[3]. However, the major drawback of both these detectors in contemporary photon-counting technologies such as, quantum key distribution (QKD) and quantum computation which exploit telecommunication wavelengths (1310 and 1550 nm) is that their device performance deteriorates significantly in near infrared wavelength range. Relatively new classes of detectors based on superconductors hold promise over conventional semiconductor detector technologies due to their single photon counting capability spanning from the visible to infrared range. The superconducting transition edge sensors (TES) offer very high detection efficiency (more than 90%) and almost negligible dark counts[19]. However their slow response (100s of kHz count rate) and milli Kelvin (mK) operating temperature raise questions on their successful implementation in quantum information and quantum optical experiments. On the other hand, despite low detection efficiency in general, due to low DCR and picoseconds time jitter the superconducting nanowires single photon detectors (SNSPDs) are better or comparable to the best TES. Moreover, due to its GHz clock rate and relatively high operating temperature (few

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ORIGINAL ARTICLE

Integrated scheduling of part and tool in a flexible manufacturing system using modified genetic algorithm

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Abstract Scheduling problems in an FMS have been considered as complex optimization problems whose solution by conventional techniques requires a great deal of efforts and time. In this paper, a simultaneous loading and scheduling of part and tool has been proposed for a flexible manufacturing system which has identical machines and a common tool magazine. All the tools are stored in the common tool magazine, and shared among the different machines through a material handling system. Each tool type is single in number. A modified genetic algorithm (MGA) with three parent crossover and a mutation operator is used to find the optimal solution of the loading and scheduling problem. The MGA uses an algorithm which is based on Giffler and Thompson procedure with a heuristic approach to resolve the job conflict and generate an active feasible schedule. The performance of the proposed algorithm is analyzed by comparing the makespan results with the results existing in literature. It is observed that the MGA yields better results than the algorithms reported so far. Furthermore, efficiency of MGA improves as the problem size increases.

Keywords Loading · Scheduling · Flexible manufacturing system · Modified genetic algorithm

Abbreviations

FMS	Flexible manufacturing system
AGVs	Automated guided vehicles
ASRS	Automated storage and retrieval system
PDRA	Priority dispatching rules algorithm
CTM	Central tool magazine
GA	Genetic algorithm
GADG	Genetic algorithm with dominant genes
ACO	Ant colony optimization
PNs	Petri nets
ASMEA	Symbiotic evolutionary asymmetric multileveled algorithm
WIP	Work in process
SAA	Simulated annealing algorithm
FMC	Flexible manufacturing cell

List of symbols

est_{ik}	Earliest start time of kth operation of ith job
eft_{ik}	Earliest finishing time kth operation of ith job
DT	Datum time
N	Number of jobs
K	Number of operations
t_{ik}	Processing time of kth operation of ith job
IP	Initial population size
s	Population size of the selection pool A
J_i	Job number ($i = 1$ to n)
J_{ik}	kth operation of ith job
COJ	Conflict of jobs
M_j	Machine number ($j = 1$ to m)
m	Number of machines
MT	Makespan time
p	Mutation probability
MGA	Modified genetic algorithm
$MAXGEN$	Maximum number of generations for MGA
$P.O.J$	Processed operation of job
JA	Job assigned

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Ion irradiation-induced, localized sp^2 to sp^3 hybridized carbon transformation in walls of multiwalled carbon nanotubes

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ABSTRACT

In this report, ion irradiation-induced localized sp^2 to sp^3 hybridized carbon transformation in multiwalled carbon nanotubes (MWCNTs) was observed after irradiating MWCNTs with high-energy Au^{+8} ions (100 MeV). The used MWCNTs were grown using cobaltocene and benzene as catalyst and carbon source, respectively by the thermal CVD technique and consist of both unfilled and Co-filled tubes. Prior to irradiation, the MWCNT sample was characterized using scanning electron microscope and micro-Raman and photoluminescence spectrometers. The effect of ion fluence on MWCNT walls and transformation of sp^2 to sp^3 sites was analyzed by Raman spectroscopy, X-ray photoelectron spectroscopy, and high-resolution transmission electron microscopy. We found that as the fluence increased, the localized transformation from sp^2 to sp^3 sites occurred in the walls of MWCNTs, which was evident by the emergence of peak at approximately 1543 cm^{-1} associated with the G peak in tetrahedral amorphous carbon (ta-C) and the vanishing of 2D band (2700 cm^{-1}). Furthermore, we observed broadening in D and G, with slight shift in their positions and consistent decrease in 2D band intensity, as fluence increased.

1. Introduction

Carbon can exist in all three hybridizations sp^3, sp^2 and sp and exhibit distinct characteristics depending on its bonding structure in the allotropes such as graphite, graphene, carbon nanotubes (CNTs), diamond, diamond-like carbon (DLC), activated carbon, hydrogenated DLC, and tetrahedral amorphous carbon (ta-C). Among these allotropes, CNT exhibits threefold coordinated sp^2 configuration, whereas diamond exhibits sp^3 configuration made of tetrahedrally coordinated carbon atoms. The extraordinary physical properties of diamond such as wide band gap, large bulk modulus, and high atomic density derive from strong bonding between sp^3 coordinated C atoms [1,2]. In recent past, the coexistence of sp^2 and sp^3 bonded carbon was reported with large fraction of sp^3 bonding and referred as tetrahedral amorphous carbon [3–5]. Tetrahedral amorphous carbon (ta-C) has some properties almost similar to diamond and has great advantages for many applications especially in electrochemical, anticorrosion, and minimal electrical conductivity which can be achieved with doping [4]. It was reported that ta-C possesses quite different properties (hardness, gap, thermal stability, heat and electric conduction, and work function) depending on its structure and sp^2/sp^3 ratio with hydrogen content too [4,6]. However, the application of ta-C is limited because of the low adhesion and high stress. These limitations of ta-C can be overcome by locally transforming sp^2 sites to sp^3 in CNT walls. Therefore, apart from various methods to deposit such diamond-like ta-C films having large fraction of sp^3 content [7–9], it is interesting to transform the sp^2 into sp^3 sites. Al-Harthi et al. demonstrated the transformation of sp^2 into sp^3 sites in few-layer graphene by low-energy Ar^+ ion irradiation [10]. Irradiation introduces defects; bond breaking and reconstruction of bonds in irradiated material through energy transfer and carbon nanotubes have always been a matter of interest for irradiation-induced modification because of its sp^2-bonded one-dimensional structure, which consists of a hollow core [11]. Because of the hollow core structure, damage formation in MWCNTs is quite different from other solids. New bonds around the defects restructure the lattice by creating a modified network, which results in structural changes. First, the

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L_1 Adaptive Droop Control for AC Microgrid With Small Mesh Network

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***Abstract*—The proposed paper is mainly focused on achieving stable operation of microgrid having reconfigurable architecture leading to huge variation in network parameters. The variation in network parameters may not be easily handled by conventional droop controllers, which are mainly designed while assuming fixed network configuration. However, these assumptions become invalid for a microgrid having small mesh network with reconfigurable structure. Therefore, it is most important for a microgrid to remain stable not only during various changes in droop characteristics but also during dynamic topological changes. The L_1 controllers are well known for their robustness under wide parametric variations. Therefore, a novel L_1 adaptive controller has been designed to achieve enhanced stability of microgrid under the varying network configuration and variable droop controller characteristics. The proposed method is simulated in MATLAB/ Simulink and verified on field programmable gate array (FPGA)-based real world hardware platform.**

***Index Terms*—Adaptive control, droop control, field programmable gate array (FPGA), microgrid.**

I. Introduction

THESE days microgrid concept is gaining lot of popularity due to their capability of integrating various type of renewable energy sources (RES) and feeding the local loads confined to small geographical location. The microgrids are also having the ability to get them connected/disconnected to main grid depending on the situation [1]–[3]. The localized use of RES in the form of microgrid has lot of advantages in terms of reduced carbon emission and increased efficiency of transmission network.

As RES have a varied characteristic therefore cannot be connected directly to common interface in a microgrid. Power electronics based converters (i.e., dc/dc, dc/ac, ac/dc, etc.) then become the most common interface to integrate all kind of these RES. These converters also have higher efficiency and same time smaller footprints.

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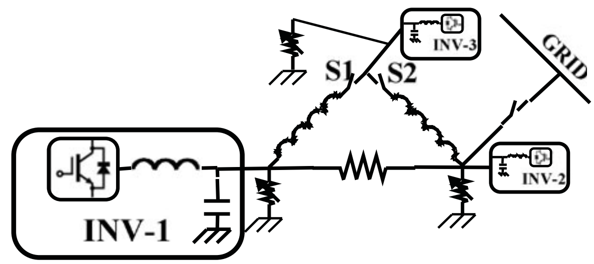

Fig. 1. Microgrid with small mesh network.

Power electronics interface like voltage source inverter (VSI) in ac-microgrid does not have any rotating mass and forms an inertia less system [4]–[6]. The conventional control methods used in power system are designed to work with high inertia sources. Therefore, transient power sharing is naturally controlled by the inertia of the system. However, in case of low inertia system, the master–slave and virtual droop control methods are most commonly used [7]–[9]. Both these types of methods have their own merits and demerits. The master–slave approach requires high bandwidth communication among the sources, and therefore system reliability will depend on the performance of communication channel [10], [11]. Moreover, due to the increased cost of high bandwidth communication channels, they are rarely used for long distances. However, for small distance master–slave methods have greater accuracy than other methods. On the other hand, droop method does not require communication among sources. Therefore, the system becomes more economical and reliable [12], [13].

Considering many advantages of the droop methods over others, it is widely accepted by researchers for microgrid application [14]–[16]. The majority of droop methods assume that the transmission line is purely inductive or resistive in nature [17], [18]. This assumption leads to a linear droop characteristics where active power sharing depends on either frequency or voltage magnitude.

A microgrid network generally works on low voltage level, which makes network impedance to be varying in wide range from purely inductive to purely resistive [19]. Many times the sources as well as the networks may become redundant. This changes the network impedance whenever a branch or source is disconnected in a microgrid, as shown in Fig. 1. Therefore, the active and reactive power cannot be totally decoupled. These changes affect the power sharing among the sources and reduce the stability of the microgrid for any disturbance [20]. The power sharing and stability can be improved by incorporating

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Mechanical Characterization and Machining of Squeeze Cast AZ91D/SiC Magnesium based Metal Matrix Composites

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Abstract

In the present work composite material is prepared by a combination of two or more constituent's materials using squeeze casting process. Magnesium based metal matrix composites are casted using magnesium alloy reinforced with various volume fractions of silicon carbide particulates. A squeeze casting process has been employed under an inert atmosphere to produce magnesium matrix composites and this process leads to a complete wetting of silicon carbide particulates in the molten magnesium. Further, the synthesized magnesium based metal matrix composites are machined by computer numerically controlled lathe. Surface roughness and Metal Removal Rate of the composites are measured and their variation in performances are studied using orthogonal array, Also the mechanical behavior of the composites are determined and also evaluated by comparing the results with the unreinforced magnesium alloy.

Peer-review under responsibility of the scientific committee of the 2nd International Conference on Materials Manufacturing and Design Engineering.

Keywords: Mechanical Characterization; Machining; Squeeze Casting, Metal Matrix Composites

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Mechanistic insights into the anticancer mode of action of an herbal drug

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Abstract

Medicinal plants are a vast repository of natural compounds with therapeutic effects against various ailments. Bioactive compounds of these plants have shown to possess anticancer activities. Cancer is one of the fatal diseases causing premature deaths across the world. Two important metabolites, serpentine, a major secondary metabolite of *Rauwolfia serpentina*, and amarogentin, isolated from *Swertia chirata*, are found to possess anticancer properties. A comparable in silico analysis of the two anticancer agents serpentine and amarogentin has been done to evaluate their ability to inhibit two potential molecular targets for cancer, nuclear factor-κB (NF-κB) and cyclo-oxygenase-2 (COX-2). The least binding energies of amarogentin with NF-κB and COX-2 are −7·173 and −7·649, respectively, which are better than that of serpentine. The molecular simulation of amarogentin and serpentine suggests that amarogentin has better binding affinities with both cancer targets. Amarogentin is thermodynamically more stable with COX-2 than with NF-κB. Amarogentin is a potent anticancer agent as evidenced by the inhibition of COX-2. This finding would be beneficial to people with cancer.

Keywords: computational studies; natural materials; protein

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Metallurgical Investigations of Microstructure and Micro hardness across the various zones in Synergic MIG Welding of Stainless steel

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Abstract

Experimental study was carried out to analyze the effects of various welding parameters such as Welding current, Welding speed, Plate thickness and Gas flow rate on bead geometry features; such as bead reinforcement height, bead width and bead penetration of synergic welding through voltage transients for 304L stainless steel. Various thicknesses have been examined with 75% Argon and 25% CO_2 as the shielding gas. The mechanical strength of welds is influenced by the composition of metal, weld bead geometry and shape relationship. The study of weld bead geometry and shape relationship is important as these dimensions and ratios decide the load bearing capacity of weldments. Metallurgical investigations determine the variation of micro-hardness across the weld metal zone, heat affected zone and the base metal. Knoop's micro hardness is carried out to determine the hardness values of the metal at various zones. Also the microstructure of the resultant welded metal was correlated with the process variables.

Selection and peer-review under responsibility of Committee Members of International Conference on Advancement in Aeromechanical Materials for manufacturing (ICAAMM 2016).

Keywords: Synergic Welding, Bead Geometry, Knoop's microhardness, Microstructure.

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Original Article

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Modelling and evaluation of the hunting behaviour of a high-speed railway vehicle on curved track

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Vivek Kumar[1], Vikas Rastogi[2] and PM Pathak[3]

Abstract

Nowadays, rail transport is a very important part of the transportation network for any countries. The demand for high operational speed makes hunting a very common instability problem in railway vehicles. Hunting leads to discomfort and causes physical damage to carriage components, such as wheels, rails, etc. The causes of instability and derailment should be identified and eliminated at the designing stage of a train to ensure its safe operation. In most of the earlier studies on hunting behaviour, a simplified model with a lower degree of freedom were considered, which resulted in incorrect results in some instances. In this study, a complete bond graph model of a railway vehicle with 31 degrees of freedom is presented to determine the response of a high-speed railway vehicle. For this purpose, two wheel–rail contacts grounded on a flange contact and Kalker's linear creep theory are implemented. The model is simulated to observe the effects of suspension elements on the vehicle's critical hunting velocity. It is observed that the critical hunting speed is extremely sensitive to the primary longitudinal and lateral springs. Other primary and secondary springs and dampers also affect the critical speed to some extent. However, the critical hunting velocity is insensitive to vertical suspension elements for both the primary and secondary suspensions. Also, the critical speed is found to be inversely related to the conicity of the wheel.

Keywords

Railway vehicle, lateral stability, hunting speed, bond graph, curve track

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Introduction

Nowadays, rail transport is a very important part of the transportation network for any countries. Around the world, it is used to move both goods as well as people across different places.[1] Railway transportation has been used for more than a century, but in the last few decades, a large number of researches have been carried out with an aim to increase the speed, safety and comfort. With the increase in the operational speed of railway vehicles, engineers are focusing on attaining higher critical hunting speed of vehicles. There is a continuous requirement to accurately predict the critical velocity of a vehicle operating on a particular track at the design stage itself to avoid accidents and discomfort.

Hunting is one of the very common instabilities observed in rail vehicles running at high speeds. Vehicles' running stability or hunting is a phenomenon associated with conically shaped wheels, and friction or creep forces, which in turn are the function of the forward speed of the vehicle. With the increase in speed, the creep force increases and reaches a value at which the sustained periodic oscillations are set up. The speed at which the sustained periodic oscillations are observed is called the critical speed and the corresponding state is called hunting.[2] Hunting leads to discomfort and physical damage to wheels and rails and even derailment in extreme cases. A train must be designed to ensure safe operation by identifying and eliminating the causes of stability and derailment. Maintaining the hunting stability at a high speed has always been a challenge for vehicle designers and engineers.

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Molecular characterization, modeling, and docking analysis of late phytic acid biosynthesis pathway gene, *inositol polyphosphate 6-/3-/5-kinase*, a potential candidate for developing low phytate crops.

Punjabi M[1,2], Bharadvaja N[1], Sachdev A[2], Krishnan V[2].

Author information

Abstract

The coding sequence of *inositol polyphosphate 6-/3-/5-kinase* (*GmIPK2*) gene was identified and cloned from popular Indian soybean cultivar Pusa-16. The clone was predicted to encode 279 amino acids long, 30.97 kDa protein. Multiple sequence alignment revealed an inositol phosphate-binding motif, PxxxDxKxG throughout the IPK2 sequences along with other motifs unique to inositol phosphate kinase superfamily. Eight α-helices and eight β-strands in antiparallel β-sheets arrangement were predicted in the secondary structure of GmIPK2. The temporal analysis of *GmIPK2* revealed maximum expression in the seed tissues during later stages of development while spatially the transcript levels were lowest in leaf and stem tissues. Endosperm-specific cis-regulatory motifs (GCN4 and Skn_1) which support high levels of expression, as observed in the developing seeds, were detected in its promoter region. The protein structure of GmIPK2 was modeled based on the crystal structure of inositol polyphosphate multikinase from *Arabidopsis thaliana* (PDB:4FRF) and subsequently docked with inositol phosphate ligands (PDB: 5GUG-I3P and PDB: 4A69-I0P). Molecular dynamics (MD) simulation established the structural stability of both, modeled enzyme and ligand-bound complexes. Docking in combination with trajectory analysis for 50 ns MD run confirmed the participation of Lys105, Lys126 and Arg153 residues in the formation of a network of hydrogen bonds to stabilize the ligand-receptor interaction. Results of the present study thus provide valuable information on structural and functional aspects of *GmIPK2* which shall assist in strategizing our long-term goal of achieving phytic acid reduction in soybean by genetic modification of its biosynthetic pathway to develop a nutritionally enhanced crop in the future.

KEYWORDS: Glycine max; Homology modeling; Inositol polyphosphate 6-/3-/5-kinase (IPK2); Low phytate crops, spatiotemporal expression; Molecular docking; Molecular dynamics simulation; Phytic acid

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ORIGINAL CONTRIBUTION

Multiobjective Economic Load Dispatch in 3-D Space by Genetic Algorithm

N. K. Jain[1] · Uma Nangia[1] · Iqbal Singh[2]

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Abstract This paper presents the application of genetic algorithm to Multiobjective Economic Load Dispatch (MELD) problem considering fuel cost, transmission losses and environmental pollution as objective functions. The MELD problem has been formulated using constraint method. The non-inferior set for IEEE 5, 14 and 30-bus system has been generated by using genetic algorithm and the target point has been obtained by using maximization of minimum relative attainments.

Keywords MELD · Non-inferior set · Maximization of minimum relative attainments · Target point

List of Symbols

$a_i, b_i, c_i,$	Fuel cost coefficients of the ith generator
$d_i, e_i, f_i,$	Pollution coefficients of ith generator
P_D	Total load demand
P_i, P_j	Real power injections at the ith, jth generator
P_{gi}	Real power generation of ith generator
$P_{gi\min}$	Minimum real power generation of ith generator
$P_{gi\max}$	Maximum real power generation of ith generator
F_C	Total cost of generation in \$/h
F_E	Environmental pollution in kg/h
E_i	Amount of pollution in terms of oxides of nitrogen emissions for the ith generator
F_L	System transmission losses
B_{ij}	Loss coefficients
Z	Multiobjective function
τ_i	Minimum relative attainment of ith objective
$Z_{iatZ(i+k)}$	Worst feasible value of ith objective
NG	Total number of generators
$g_i(X)$	Inequality constraint

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Introduction

Economic load dispatch [1, 2] allocates loads to plants at minimum cost while meeting the constraints. It is an optimization problem which minimizes the total fuel cost of all committed plants while meeting the demand and losses. The optimal power system operation is achieved when various objectives of power systems simultaneously attain their minimum values. In this paper, three objectives of power systems—cost of generation (F_c), system transmission losses (F_L), environmental pollution (F_E) have been considered. These are conflicting in nature and cannot be handled by single objective optimization techniques. Single objective optimization techniques give optimal solution in respect of a single aspect but the values of other objectives may be intolerably bad. Therefore, the way out lies in multiobjective approach [3–6] to problem solving. Recently, Genetic Algorithm (GA) has been implemented to solve various power systems problems-economic load dispatch, multiobjective economic load dispatch, optimal power flow etc. genetic algorithm is an intelligent optimization technique and is capable of locating the global optima. Some authors [7] made the review on the current development techniques in Genetic Algorithm. In this paper, the authors have explained the theoretical aspects of

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Multiple therapeutic effect of endothelial progenitor cell regulated by drugs in diabetes and diabetes related disorder.

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Abstract

BACKGROUND: Reduced levels of endothelial progenitor cells (EPCs) counts have been reported in diabetic mellitus (DM) patients and other diabetes-related disorder. EPCs are a circulating, bone marrow-derived cell population that appears to participate in vasculogenesis, angiogenesis and damage repair. These EPC may revert the damage caused in diabetic condition. We aim to identify several existing drugs and signaling molecule, which could alleviate or improve the diabetes condition via mobilizing and increasing EPC number as well as function.

MAIN BODY: Accumulated evidence suggests that dysregulation of EPC phenotype and function may be attributed to several signaling molecules and cytokines in DM patients. Hyperglycemia alone, through the overproduction of reactive oxygen species (ROS) via eNOS and NOX, can induce changes in gene expression and cellular behavior in diabetes. Furthermore, reports suggest that EPC telomere shortening via increased oxidative DNA damage may play an important role in the pathogenesis of coronary artery disease in diabetic patients. In this review, different type of EPC derived from different sources has been discussed along with cell-surface marker. The reduced number and immobilized EPC in diabetic condition have been mobilized for the therapeutic purpose via use of existing, and novel drugs have been discussed. Hence, evidence list of all types of drugs that have been reported to target the same pathway which affect EPC number and function in diabetes has been reviewed. Additionally, we highlight that proteins are critical in diabetes via polymorphism and inhibitor studies. Ultimately, a lucid pictorial explanation of diabetic and normal patient signaling pathways of the collected data have been presented in order to understand the complex signaling mystery underlying in the diseased and normal condition.

CONCLUSION: Finally, we conclude on eNOS-metformin-HSp90 signaling and its remedial effect for controlling the EPC to improve the diabetic condition for delaying diabetes-related complication. Altogether, the review gives a holistic overview about the elaborate therapeutic effect of EPC regulated by novel and existing drugs in diabetes and diabetes-related disorder.

KEYWORDS: Diabetes; EPC; Metformin; NOX; ROS; eNOS

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New scheme for underwater acoustically wireless transmission using direct sequence code division multiple access in MIMO systems

Rajiv Kapoor[1] · Rashmi Gupta[2] · Raghavendra Kumar[3] · Le Hoang Son[4,5] · Sudan Jha[6]

Abstract

This paper proposes a new technique based on Direct Sequence Code Division Multiple Access for underwater acoustically wireless transmission with excessive transmission rate. Environment of subsea is challenging for wireless communication because the medium in which waves are propagating is not air. In fact, it is propagated through fractions of water having different densities. Finding out various techniques for multipath access targeting the physical layer of Acoustic Sensor Networks is indeed necessary. The recent approaches have suggested that coded modulation techniques with exploited diversity are highly preferred in order to enhance the dependability of the acoustic link in different multipath channels. The proposed technique divides the channel into sub ones and transmits information via those sub channels. In variety-spectrum, a signal in a bandwidth is unfold within frequency domain and broad bandwidth. Experimental results show that Bit Error Rate (BER) of this method is better than that of channel equalization in the respective systems.

Keywords Magnetic · Induction · Wireless communication · Channel model · Underwater wireless communication networks (UWCNs) · Underwater acoustic communications · CDMA · Bit error rate (BER)

1 Introduction

In the past decades, the most widely used communication technique for the *Underwater Wireless Communication Network* (UWCN) was *acoustic communication* defined in the physical layer for long distance communication [1]. However, it has poor performance in shallow water and other disadvantages such as air bubbles in water and low temperature gradients due to speed of transmission [2]. Another technique namely *Optical underwater communication* has high bandwidth (gigabits per second) and low manufacture cost; yet it still remains disadvantages in line-of-sight communication and tight alignment of nodes [3]. This type of communication does not cross water/air boundary and also affects particles, marine fouling, soil and rock. *Electromagnetic wireless communication* is the third option with high bandwidth at very short range [4]. Nevertheless, it suffers from high path loss and fading as well as having large antenna size and dynamic channel condition [5].

The radio waves propagating requires high scaled antennae with huge transmission power, subjected to the condition that they are passed through the salted water at

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Performance analysis of a transcritical N_2O refrigeration cycle with vortex tube

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ABSTRACT

In the present study, vortex tube is used in transcritical vapour compression cycle as expansion device to improve the coefficient of performance (COP). The thermodynamic analysis has been performed using nitrous oxide in transcritical cycle with vortex tube (TCVT) and its results are compared with those of a transcritical cycle with expansion valve (TCEV). The evaporator and the gas cooler temperatures have been varied between −55°C and 5°C and between 35°C and 60°C, respectively, for the analysis. The COP of the TCVT improves by 1.72–27.01% compared to TCEV. A decrease in evaporator temperature and an increase in gas cooler exit temperature result in a decrease in COP. The increase in cold mass fraction brings a negligible increase in maximum COP. The performance comparison of N_2O and CO_2 in TCVT shows that maximum cooling COP for N_2O is higher than for CO_2, but the optimum pressure required for N_2O is lower than for CO_2.

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KEYWORDS
Vortex tube; expansion valve; refrigeration cycle; nitrous oxide; COP improvement

List of symbols

COP	Coefficient of performance
h	Specific enthalpy (kJ kg^{-1})
P	Pressure (MPa)
q	Cooling effect (kJ kg^{-1})
t	Temperature (°C)
TCEV	Transcritical cycle with expansion valve
TCVT	Transcritical cycle with vortex tube
x	Dryness fraction

Greek letters

μ	Cold mass fraction
η_c	Compressor isentropic efficiency
η_d	Vortex tube nozzle efficiency
ε_d	Effectiveness of desuperheater

Subscripts

b	Cycle with expansion valve
c	Gas cooler outlet
e	Evaporator
m	Cycle with vortex tube
opt	Optimum
r	Improvement (%)
w	water inlet to desuperheater
1–9	State points of refrigerant

1. Introduction

The main components of a conventional vapour compression system consist of compressor, condenser, expansion valve and evaporator. The expansion process is isenthalpic, which results in loss of useful energy. The loss of useful energy can be overcome by using the vortex tube in place of expansion valve in a refrigeration cycle to improve the cycle performance (Christensen et al. 2001).

The vortex tube is a simple device which separates a high pressure gas flow into two low pressure flows at different temperatures, that is, high and low temperatures. It works on the principle of Ranque–Hilsch effect. Numerous modelling and experimental works have been reported in the literature on vortex tube (Eiamsa-ard and Promvonge 2008). Initially the vortex tube was mainly used for producing temperature difference in a gas but the recent research shows that it can be used for liquid and vapour separation with one inlet and three outlets (Christensen et al. 2001). It is reported that the COP improved by using vortex tube as expansion device with refrigerants R22, R134a, propane, ammonia and carbon dioxide in vapour compression refrigeration system (Christensen et al. 2001). The use of vortex tube in a transcritical CO_2 cycle improved the system performance by 37% over the isenthalpic expansion process for evaporator and gas cooler exit temperatures of 5°C and 40°C, respectively (Li et al. 2000). Sarkar (2009) analysed a vortex tube-based transcritical CO_2 refrigeration cycle with two cycle layouts based on the Maurer and Keller models and showed that the COP improved in comparison to transcritical CO_2 refrigeration cycle with expansion valve. The effect of vortex tube on optimum discharge pressure was also studied. Xie et al. (2011) and Liu and Jin (2012) theoretically analysed CO_2 transcritical two-stage compression refrigeration cycle with vortex tube and reported 2.4–16.3% improvement in COP compared to expansion valve.

Nowadays, natural refrigerants are regaining their importance due to their zero ozone layer depletion potential and low

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Performance Analysis of Combined Biogas-Diesel Run Dual-Fuel Engine

Diwakar Gurung, Ankur Rajvanshi, S. Lalhriatpuia and Premendra Mani Pradhan

Abstract The demand for the energy and power has shown stunning growth in the past decade costing drastic increase in pollution and other environmental hazards. Biogas, a new renewable source of energy has been emerged as new confidence in dealing with such problems. In this paper, an experimental investigation on the performance of combined Biogas-Diesel run Dual-fuel engine is prosecuted through several experiments conducted in a modified engine. The performance was evaluated for an equal power output of both diesel and dual-fuel engine. This type of evaluation approach can decide the feasibility of a dual-fuel engine run by using both biogas and diesel.

Keywords Biogas · Dual-fuel engine · Volumetric efficiency

1 Introduction

One of the most serious problems that the world is being confronted is the use of limited fossil fuel such as petrol, diesel, etc., which has severely harmed the environment. So, these days' alternative to this fossil fuel so-called renewable

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Performance analysis of dynamic voltage restorer using modified sliding mode control

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ABSTRACT

Voltage sag is a major issue of power quality among utility and end users. Critical load is sensitive to voltage variation at its terminal. This happens when voltage variation is introduced as voltage sag in the source voltage to which the load is connected. In this paper, the authors have proposed a modified sliding mode control (SMC) method to control the voltage injection by the dynamic voltage restorer (DVR) for regulating the terminal voltage of the critical load to restore its pre-sag value. SMC being independent of system parameters is a robust control. The paper discusses the design and working of control algorithm based on synchronous reference frame theory to generate reference voltages for DVR control. The performance results are obtained and validated by simulating the system in MATLAB software using Simulink and Power System Blocksets.

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KEYWORDS
Power quality; critical load; voltage sag; dynamic voltage restorer; sliding mode control; synchronous reference frame theory

I. Introduction

Power quality is extensively studied due to its severe impact on sensitive loads and diverse effects on power system in which reduction in root mean square value of source voltage is one of them and is known as voltage sag (Bollen, 2000; Errabelli, Kolhatkar, & Das, 2006b; Ghosh & Ledwich, 2002; Singh, Chandra, & Al-Haddad, 2015). Voltage sag is a serious problem of degrading the quality of manufactured product and comes under the umbrella of power quality problems (Bollen, 2000; Ghosh & Ledwich, 2002; Singh et al., 2015). Dynamic voltage restorer (DVR) is one of the most popular, series connected power electronic custom power device to mitigate the voltage sag problem of sensitive loads (Ghosh & Ledwich, 2002; Nagesh Kumar & Chowdary, 2008; Piatek, 2005; Singh et al., 2015; Yazdani & Iravani, 2010). DVR is used to regulate the load terminal voltage to its rated value under pre-sag condition (Bollen, 2000; Castilla, Garcia De Vicuna, Guerrero, Matas, & Miret, 2005; Ghosh & Ledwich, 2002; Singh et al., 2015) and protect the sensitive loads from poor quality of the source voltage and consequent loss by injecting voltage in series with the feeder line through injection transformer.

Sliding mode control (SMC) technique is used as controller to control the DVR along with guidelines to tune the controller parameters (Biricik & Komurcugil, 2016; Lopez-Santos, Martinez-Salamero, Garcia, Valderrama-Blavi, & Sierra-Polanco, 2014; Slotin & Li,

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Full Length Article

Performance and emission characteristics of a stationary diesel engine fuelled by Schleichera Oleosa Oil Methyl Ester (SOME) produced through hydrodynamic cavitation process

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A B S T R A C T

In this study, the performance and emission characteristics of biodiesel blends of 10, 20, 30 and 50% from Schleichera Oleosa oil based on hydrodynamic cavitation were compared to diesel fuel, and found to be acceptable according to the EN 14214 and ASTM D 6751 standards. The tests have been performed using a single cylinder four stroke diesel engine at different loading condition with the blended fuel at the rated speed of 1500 rpm. SOME (Schleichera Oleosa Oil Methyl Ester) blended with diesel in proportions of 10%, 20%, 30% and 50% by volume and pure diesel was used as fuel. Engine performance (specific fuel consumption and brake thermal efficiency) and exhaust emission (CO, CO_2 and NOx) were measured to evaluate the behaviour of the diesel engine running on biodiesel. The results show that the brake thermal efficiency of diesel is higher and brake specific fuel consumption is lower at all loads followed by blends of SOME and diesel. The performance parameter for B10, B20, B30 and B50 were also closer to diesel and the CO emission was found to be lesser than diesel while there was a slight increase in the CO_2 and NOx. SOME produced by using hydrodynamic cavitation seems to be efficient, time saving and industrially viable. The experimental results revel that SOME-diesel blends up to 50% (v/v) can be used in a diesel engine without modifications.

1. Introduction

Biodiesel is a clean burning alternative fuel was produced from renewable resources like virgin or used vegetable oils, both edible and non-edible [1]. Biodiesel is obtained from the chemical transformation of oils (triglycerides) by a transesterification process and many oleaginous vegetable species [2]. However, biodiesel produced from edible oils raised the concerns of feedstock competing with food supply in the long-term [3]. Therefore, non-edible oils resources are gaining worldwide attention as it is easily available in many parts of the world especially wastelands that are not suitable for food crops [4]. Besides, the use of biodiesel in diesel engines results in substantial reduction of harmful emission such as unburned hydrocarbons, carbon monoxide and particulate matters [15,16,5,17–20]. There are many ways and procedures to biodiesel fuel from vegetable oil such as pyrolysis, dilution, micro emulsion and transesterification [7,9,14]. All processes are time consuming with high labor cost. Thus, we need a new process i.e. cavitation process for biodiesel production which reduces the reaction time and production cost as well as save the energy. There are four types of cavitation e.g. hydrodynamic, acoustic, optical and particle induced [21]. Hydrodynamic cavitation (HC) has been widely used in waste water treatment and the shipping industry, i.e. ship propellers, pumps and hydrofoils, but only a few works has been reported in the biodiesel field. However, no work has been focused on performance and emission of diesel engine fuelled by Schleichera Oleosa biodiesel.

In this study, biodiesel from Schleichera Oleosa was produced in a HC reactor via transesterification under optimized conditions, such as oil to methanol molar ratio of 1:6 in the presence of 0.75wt% potassium hydroxide as the alkali catalyst at 60 °C operating temperature. Furthermore different blending ratios of SOME, i.e. B0, B10, B20, B30 and B50 were used in the diesel engine in order to study the performance and emission characteristics on

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Photoluminescence investigations on Sm^{3+} ions doped borate glasses for tricolor w-LEDs and lasers

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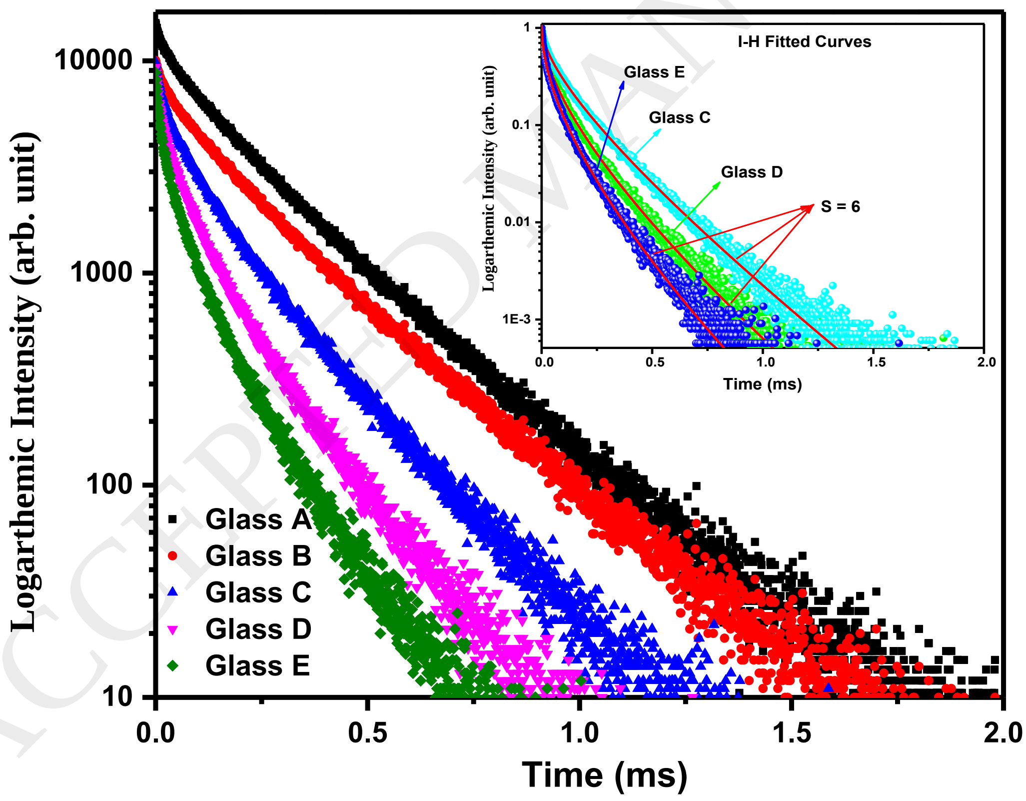
Graphical abstarct



Highlights

- Borate glasses with Sm^{3+} ions were synthesized by melt quenching technique.
- Under 402nm excitation Borate glasses show reddish orange luminescence.

Pragmatic Insights: Live UIs for Agent-based Modelling in Pharo

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Abstract

Object-oriented programming has had a long-standing history with simulation systems in terms of human-computer interaction [1] dating back to Simula and early versions of Smalltalk-72 and Smalltalk-76. These frameworks were based on discrete, event-based simulations as revealed by the classic simulation examples of Smalltalk-80 Blue-book [2]. Nevertheless present time trends have pivoted towards agent-based modelling and abstractions, with systems like NetLogo capturing a sizeable following and heed. Two of the widely known agent-based modelling (ABM) platforms in Smalltalk (MobiDyC and CORMAS) have recently begun experimenting with porting their systems to Pharo. The rationale behind this choice is to allow modern re-imagination of the platforms that can take advantage of developments in: agile visualization, moldable tools, domain-specific languages (DSLs) and so on. This work focuses on the salient user interface component of these platforms, namely the spatial interface, which empowers a user to visualize the evolution of the system through time. We start with a concise analysis of the state-of-the-art for spatial interfaces and their platforms (MobiDyC, NetLogo, GAMA and CORMAS), scrutinizing in terms of programming flexibility, extensibility, portability, scalability, and interaction. Subsequently we highlight our on-going efforts in building an open-source extension for CORMAS' spatial interface in Pharo. In closing, we detail the pragmatic experience gained in the course of our work and present future perspectives.

Keywords Agent-based Modelling; Simulation; Spatial Interface; MobiDyC; NetLogo; GAMA; CORMAS; Pharo; Open Source

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1. Introduction

Object-orientation originated alongside simulation systems in Simula, owing to changes in programming culture and advances in programming technology. With unified concepts facilitating the creation of discrete event systems, programming languages like Simula and early versions of Smalltalk-72 and Smalltalk-76 have provided an across the board foundation for simulation systems. Latter-day modelling systems established on the principal constituent of hierarchy of classes representing agents topped with utilitarian methods have emerged to furnish potent techniques for exploration and evaluation of intricate spatial systems. Common uses of ABM and simulations comprise social or biological system simulations such as crowd behaviour, urban simulation or disease propagation. Encompassing the elements of game theory, complex emergence, computational sociology and evolutionary programming, these ABM systems predominantly include intuitive spatial interfaces to vividly visualize and partially control the evolution of the systems they describe.

With temporal concerns getting complex with each passing point in time, ABM has manifested as a fine computational modelling mechanism enabling the simulation of actions of heterogeneous entities and interactions between them in a collective spatial environment. ABMs are conceptualized as a micro-scale model [3] that simulates the simultaneous operations and reciprocal influences of multiple agents in an attempt to re-create and predict the appearance of the complex phenomena in question. ABMs thus provide explicit views to follow each agent individually and to understand the consequences of multiple interactions in the system as a whole [4].

Many modern ABMs supporting visually robust spatial user interfaces, NetLogo for instance, have been widely adopted both for research and education purposes. Simplistic ABMs like NetLogo make it easier to dip into the simulation sphere with sparse programming skills yet leading to quality outcomes by exploring connections between micro-level behaviors of individuals and macro-level patterns that emerge from their interactions [5]. Dynamically evolving, graphically lucid and adaptive tool-kits with functionalities dispensing live-exploration, time saving simulation rendering along-with enhanced scalability are looked forward to in this era of multiplexity along with the flexibility to mould the source code.

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Probing Charge-Transfer and Short-Lived Triplet States of a Biosensitive Molecule, 2,6-ANS: Transient Absorption and Time-Resolved Spectroscopy

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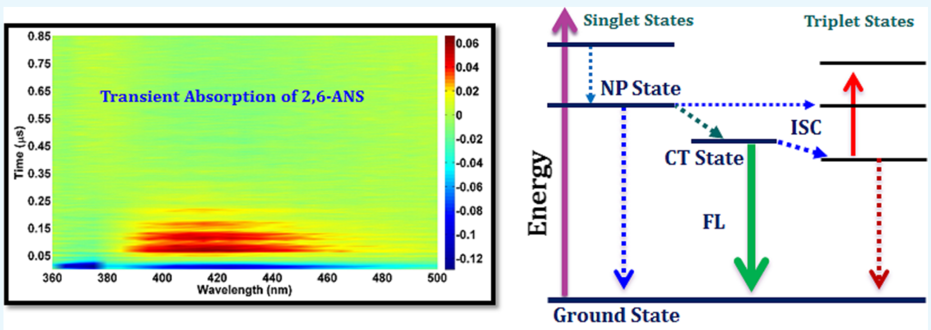
S *Supporting Information*



Transient absorption and Energy level diagram of 2,6-ANS

ABSTRACT: We report the existence of a short-lived triplet electronic state of 2,6-ANS (2-anilinonaphthalene-6-sulfonic acid), which, together with nonplanar (NP) and planar [charge-transfer (CT)] states, is produced following photoexcitation; these results are based on nanosecond transient absorption and time-resolved decays. The short-lived triplet state has a lifetime of ~126 ns and is observed via triplet−triplet (T−T) transitions after exciting 2,6-ANS with a pump laser pulse of 355 nm (probe wavelength range of 360−500 nm). Moreover, the CT state, which is very close to the NP state produced from the locally excited state/NP state, emits active fluorescence with a lifetime of ~11 ns. The solvent plays a major role in the rotation of the phenylamino group during the conversion of the NP state to the CT state, and vice versa. Intersystem crossing occurs from the CT state. Thus, investigating the triplet state together with the CT/NP states of 2,6-ANS, a commonly used probe for sensing proteins and other biomolecules, is highly relevant and helps reveal its photoexcitation dynamics.

INTRODUCTION

Probes containing the anilinonaphthalene sulfonate (ANS) fluorophore, which is characterized by the dependence of its absorption, fluorescence (FL), FL quantum yield (QY), and lifetime on its environment, have been used for studying the structures of biological macromolecules for the past several years.[1−4] ANS and the related molecules 1-anilinonaphthalene-8-sulfonate and 2,6-ANS (2-anilinonaphthalene-6-sulfonic acid) are the most widely used molecules featuring this fluorophore. A dramatic change in the FL QY with different solvents, a change in FL intensity with the local environment, and a drastic blue shift of the FL wavelength maximum in low-polarity solvents relative to that in higher polarity solvents such as water have been observed.[1−3] An increase in FL intensity in a hydrophobic environment was also reported in 1954.[4] In biological fields, ANS has been used as a hydrophobicity probe for protein folding and for cell surface studies.[5] The characteristic features of the ANS fluorophore have been used successfully to evaluate the micropolarity of the local environment in proteins and lipid nanotubes.[6,7] These photoinduced electron-transfer-based probes are also sensitive to the pH and the presence of transition-metal ions in the environment.[8] The mechanism of ANS involves the intramolecular rotation of the phenylamino group and the subsequent conversion of its nonplanar (NP) state to the stable charge-transfer (CT) state immediately after photoexcitation. However, different explanations for the massive solvent effects on the excited-state lifetime have been given.[1−11]

Here, we applied nanosecond transient absorption (TA) and time-resolved FL techniques to 2,6-ANS dissolved in degassed methanol and measured the nanosecond TA and FL decays. On the basis of the TA and FL decay curves, along with the steady-state spectra, the S−S (singlet−singlet) and T−T (triplet−triplet) transitions that occur following the photoexcitation

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Probing Charge-Transfer and Short-Lived Triplet States of a Biosensitive Molecule, 2,6-ANS: Transient Absorption and Time-Resolved Spectroscopy

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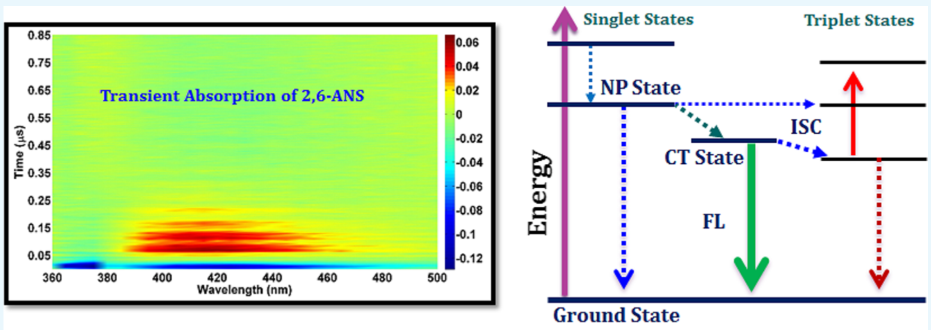
‡State Key Laboratory of Molecular Reaction Dynamics, Dalian Institute of Chemical Physics (DICP), Chinese Academy of Sciences, Dalian 116023, China

Supporting Information



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INTRODUCTION

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Here, we applied nanosecond transient absorption (TA) and time-resolved FL techniques to 2,6-ANS dissolved in degassed methanol and measured the nanosecond TA and FL decays. On the basis of the TA and FL decay curves, along with the steady-state spectra, the S−S (singlet−singlet) and T−T (triplet−triplet) transitions that occur following the photoexcitation

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Protective polyurea coatings for enhanced blast survivability of concrete

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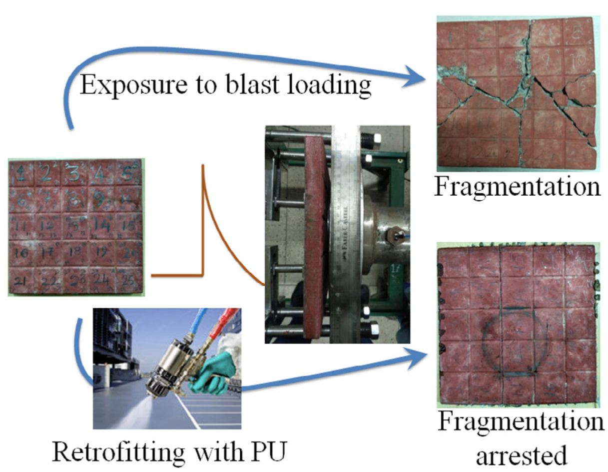
HIGHLIGHTS

- A chain-extended polyurea has been coated on concrete substrate.
- The efficacy of polyurea towards shock loadinghas been demonstrated.
- The effect of coating thicknesstowards blast survivability has been studied.
- Detailed mechanism for explaining the improved blast resistance has been discussed.

GRAPHICAL ABSTRACT



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Keywords:
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Dynamic glass transition
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ABSTRACT

Polyurea is a synthetic high-strength elastomeric coating that can be sprayed over existing structures for protection against weathering effects. In view of the fast kinetics associated with the isocyanate-amine reaction, practical processing of polyurea is performed using spray coating technique. In this paper, we report the effect of varying the type and amount of chain extender on the mechanical properties of spray coated polyurea. An optimal ratio of aromatic: aliphatic chain extender was found to result in optimal H-bonding, which in turn reflected in terms of improved mechanical properties of the coating. In this paper, the efficacy of polyurea towards improving the performance of the substrate towards shock and ballistic loading is demonstrated. Polyurea coated concrete tiles were subjected to controlled blast loadings, and an attempt was made to understand the mechanism responsible for the improved blast survivability. Unreinforced concrete tiles underwent extensive fragmentation at peak pressures <50 psi, while polyurea coated tiles could withstand much higher peak pressures. The extent of mitigation increased with the coating thickness and composites with 6 mm polyurea could withstand substantially higher pressures. Upon further loading, polyurea-concrete debonding was evidenced, however the membrane arrested the fragments formed. Dynamic mechanical studies revealed that polyurea remains as an elastomer under the frequency range associated with the shock tube testing and behaves as a catcher system for the fragments formed due to blast loading.

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Quantitative assessment of mutual relationship of issues experienced in greening supply chain using ISM-fuzzy MICMAC approach

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Abstract: The present research work deals with the identification of the issues, which act as major barriers in greening supply chain. On the basis of literature review and discussion with the field experts, the eleven green supply chain issues were identified and analysed by using interpretive structural modelling (ISM). To visualise the driving and dependency nature of the identified issues, ISM model has been developed. The developed ISM model would help to understand the direct relationship among the considered issues. Further, to establish the direct and indirect relationship of one issue with respect to each other issue, fuzzy MICMAC has been used. The outcomes of this analysis may

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Realization of Resistorless and Electronically Tunable Inverse Filters Using VDTA

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This paper presents resistorless realization of inverse filters using Voltage Differencing Transconductance Amplifier. Firstly, the four topologies are proposed which provide inverse- low pass, high pass, band pass, and band reject responses. Subsequently, a unified inverse filter is also derived by incorporating two switches in the combination of proposed inverse low pass and inverse band pass topology. This topology is capable of providing inverse low pass, inverse high pass, inverse band pass, and inverse band reject responses by appropriate switch settings. The proposed inverse filter structures are electronically tunable and use only grounded capacitors. The behavior of the proposed filters is also investigated for non-idealities. To verify the functionality of the proposed inverse filter circuits, SPICE simulation is carried out using 0.18µm CMOS technology parameters from TSMC. The effect of deviation in active and passive component values on angular frequency is tested through Monte Carlo simulation.

Keywords: Active inverse filter; VDTA based inverse filter; Resistorless inverse filter, Unified filter.

1. Introduction

There are a number of occasions in which a signal is distorted while processing it. Hence there is a need to reconstruct the signal for its effective use. However, the reconstruction technique needs to know a priori, the circuit and system or transfer function which has created a particular distortion. Accordingly, the circuit having inverse of that transfer function may be used to correct the distortion. Some of the distortions may be corrected by utilizing inverse filter, which has the reciprocal frequency response of the circuits that cause distortions. In literature, there are several well-established methods exist for digital inverse filter design in digital signal processing.[1] However, there are a very few methods exist for analog inverse filter design.

Rebuttal to 'Fully-uncoupled independent control of frequency and condition of oscillation: A caution'

Raj Senani[a,]*, Data Ram Bhaskar[b], Shanti Swaroop Gupta[c] and Bhopendra Singh[d]

Abstract: Based upon the experimental results of the two CFOA-based fully-uncoupled sinusoidal oscillators proposed earlier by Bhaskar-Gupta-Senani-Singh, recently Abuelma'atti and Khalifa issued a caution that the classification of this class of oscillators providing independent control of condition of oscillation (CO) and frequency of oscillation (FO) through separate elements, as *fully-uncoupled*, does not appear to be correct. In this communication, we present the results of a recheck of the experimental data of Abuelma'atti and Khalifa and show that their experimental results are *not repeatable* and in *most of the cases*, the oscillations do not even exist and hence, the measurement data as given by them is misleading. Furthermore, it is shown that the measured oscillation frequencies, as shown by Abuelma'atti and Khalifa in four tables, do not tally with those calculated from their own formula as well as the experimental results taken by us. This communication thus, refutes the claims made in the quoted paper of Abuelma'atti and Khalifa published in this journal earlier.

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Indexing terms: Sinusoidal Oscillators, Current feedback op-amps

1. Introduction

Recently, Abuelma'atti and Khalifa [1] issued a *caution* (for another similar caution, see [3]) that the classification of a class of oscillators providing independent control of condition of oscillation (CO) and frequency of oscillation (FO) through separate elements, as *fully-uncoupled*, does not appear to be correct. It may be mentioned that such fully-uncoupled oscillators have been proposed in the past using a variety of active building blocks such as Current Conveyors, Current feedback op-amps (CFOA), operational trans-resistance amplifiers (OTRA) and current differencing buffered amplifiers (CDBA) etc.; see [2]-[13]

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Original Russian Text © F.E. Gostev, I.V. Shelaev, A.V. Aibush, A.N. Kostrov, A.A. Titov, S.Yu. Kochev, Yu.A. Kabachii, M.S. Mekhata, V.A. Nadtochenko, 2018, published in Khimiya Vysokikh Energii, 2018, Vol. 52, No. 4.

PHOTONICS

Relaxation Kinetics of Excitonic States in ZnSe Quantum Dots: A Femtosecond Laser Spectroscopy Study

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Abstract—Relaxation processes in ZnSe quantum dots upon excitation by a 30-fs pulse at a wavelength of 360 nm have been studied by broadband femtosecond absorption spectroscopy. The diameter of ZnSe nanoparticles was 3.7 ± 0.6 nm. A colloidal solution of ZnSe in cyclohexane was used. In the differential spectra, a bleaching band at the edge of the excitonic absorption band of ZnSe, an absorption band of the biexcitonic transition with a peak at about 420 nm, and a broad structureless absorption band in the region from 440 to 750 nm have been revealed. From the analysis of the absorption and luminescence spectra, the shift of the excitonic luminescence band δ_{XX} = 127 meV has been measured. From the femtosecond photolysis data, an estimate of the biexcitonic interaction $\Delta_{XX} \approx$ 75 meV has been obtained. It has been shown that the relaxation kinetics of the differential spectra is described by three-exponential dependences with time constants and corresponding amplitude contributions of 1 ps (42%), 13 ps (22%), and 91 ps (17%). The kinetic component of 1 ps (42%) is presumably due to hole transport to surface traps. The kinetic components of 13 ps (22%) and 91 ps (17%) apparently describe the processes of electron transport to shallow and deep traps.

Keywords: femtosecond spectroscopy, quantum dots, ZnSe nanoparticles

DOI: 10.1134/S0018143918040070

Semiconductor nanocrystals (quantum dots, QDs), whose size is smaller than the Bohr exciton radius characteristic of a given chemical material, are widely used in photonics and electronics [1–5]. Quantum dots are used as luminophores, sensitizers in photocatalysis and photovoltaic devices, in optoelectronic devices, and as fluorescent labels and pigments for visualization of individual biological cells and tissues. General trends in QD research have been presented in recent reviews [1–5]. The dynamics of excited charge carriers in QDs has been studied in less detail. In this direction, quantum dots of cadmium chalcogenides have been studied most fully [5–14]. Fast relaxation processes of excited charge carriers in ZnSe QDs have been studied in less detail. Nonlinear two- and three-photon absorption in ZnSe QDs [15, 16] and the decay kinetics of exciton luminescence as a function of excitation intensity [17, 18] have been studied. The lifetime of excited states in relatively large ZnSe QDs with a diameter from 53 to 82 nm has been determined by femtosecond photolysis at the excitation and probe wavelength of 400 nm [19]. Using femtosecond spectroscopy of differential absorption, the reaction of interphase electron transfer to the external electron acceptor methyl viologen from a photoexcited ZnSe nanoparticle has been demonstrated [20].

The aim of this work was to study relaxation processes in ZnSe QDs using broadband femtosecond laser spectroscopy. In this work, the time evolution of differential spectra of ZnSe QDs after excitation with a 30-fs pulse at a wavelength of 360 nm (3.444 eV) is reported, and the data on the characteristic time constants of relaxation transitions are given.

EXPERIMENTAL

Materials

1-Octadecene (ODE, 90%, technical grade, Acros Organics), zinc stearate (12.5–14% ZnO, Alfa Aesar), octadecylamine (technical grade, 90%, Aldrich), selenium (99.99%, Aldrich), cyclohexane (99+%, for spectroscopy, Acros Organics), tributylphosphine (≥93.5% Aldrich), *n*-heptane (chemically pure grade), and acetone (chemically pure grade) were used without further purification.

Format: Abstract

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Role of BRCA Mutations in the Modulation of Response to Platinum Therapy.

Mylavarapu S[1,2], Das A[2], Roy M[1].

Author information

Abstract

Recent years have seen cancer emerge as one of the leading cause of mortality worldwide with breast cancer being the second most common cause of death among women. Individuals harboring BRCA mutations are at a higher risk of developing breast and/or ovarian cancers. This risk is much greater in the presence of germline mutations. BRCA1 and BRCA2 play crucial role in the DNA damage response and repair pathway, a function that is critical in preserving the integrity of the genome. Mutations that interfere with normal cellular function of BRCA not only lead to onset and progression of cancer but also modulate therapy outcome of treatment with platinum drugs. In this review, we discuss the structural and functional impact of some of the prevalent BRCA mutations in breast and ovarian cancers and their role in platinum therapy response. Understanding the response of platinum drugs in the context of BRCA mutations may contribute toward developing better therapeutics that can improve survival and quality of life of patients.

KEYWORDS: BRCA1/2 mutations; breast cancer; ovarian cancer; platinum drugs; resistance; response

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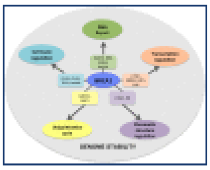
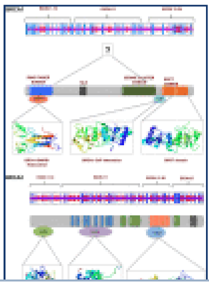
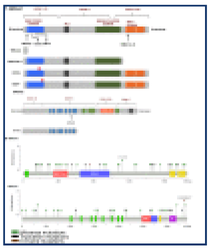
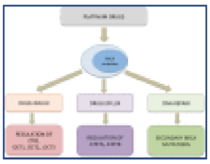

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Role of Magnetic Exchange Interaction due to Magnetic Anisotropy on Inverse Spin Hall Voltage at $FeSi_{3\%}$/Pt Thin Film Bilayer Interface

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Abstract

In our recent studies inverse spin Hall voltage (ISHE) was investigated by ferromagnetic resonance (FMR) using bilayer $FeSi_{3\%}$/Pt thin film prepared by pulsed laser deposition (PLD) technique. In ISHE measurement microwave signal was applied on $FeSi_{3\%}$ film along with DC magnetic field. Higher magnetization value along the film-plane was measured by magnetic hysteresis (M-H) loop. Presence of magnetic anisotropy has been obtained by M-H loop which showed easy direction of magnetization when applied magnetic field is parallel to the film plane. The main result of this study is that FMR induced inverse spin Hall voltage 12.6 μV at 1.0 GHz was obtained across Pt layer. Magnetic exchange field at bilayer interface responsible for field torque was measured $6 \times 10^{14}\ \Omega^{-1}m^{-2}$ by spin Hall magnetoresistance. The damping torque and spin Hall angle have been evaluated as 0.084 and 0.071 respectively. Presence of Si atom in $FeSi_{3\%}$ inhomogenize the magnetic exchange field among accumulated spins at bilayer interface and feebly influenced by spin torque of $FeSi_{3\%}$ layer. Weak field torque suppresses the spin pumping to Pt layer thus low value of inverse spin Hall voltage is obtained. This study provides an excellent opportunity to investigate spin transfer torque effect, thus motivating a more intensive experimental effort for its utilization at maximum potential. The improvement in spin transfer torque may be useful in spin valve, spin battery and spin transistor application.

Keywords: “Inverse Spin-Hall Effect”, “ Ferromagnetic resonance”, “Magnetization”, “damping torque”, Spin Hall angle”, “Spin Hall Magnetoresistance”.

Introduction

Spintronics deals with manipulation and transport of spin current in single or multilayer paramagnetic / ferromagnetic thin films. Spin current can be generated by spin Hall Effect and detected by the inverse spin Hall Effect (ISHE). In bilayer thin film spin current flows towards the interfaces, where it can be absorbed as a spin-transfer torque (STT) on the ferromagnet. This STT affects the magnetization damping or even switches the magnetization [1]. Spin current when crosses the bilayer interface, Fermi energy splitting of spin up and spin down takes place due to difference in chemical potential [2]. Diffusion of spins across interface undergoes absorption and reflection which is controlled by the magnetization direction of ferromagnetic film [3]. Consequently, change in resistance has been observed by sweeping magnetic field direction known as magnetoresistance [4-5]. The spin current transmission across the bilayer interface is controlled by spin mixing conductance $G_{\uparrow\downarrow}$, which is quantified as $G_{\uparrow\downarrow}=G_r+iG_i$ where G_r is a real part, signifies torque at interface, and G_i is known as exchange magnetic field by which accumulated spin precess around the magnetization of ferromagnetic film [6]. Conversion of spin current into charge current is enhanced by adding ferromagnetic layer in which spin wave is generated by ferromagnetic resonance (FMR) excitation [7] and get induced in to Pt layer by spin pumping at interface. The magnitude of spin pumping at interface depends mainly on magnetic homogeneity at interface, bilayer resistance, magnetic anisotropy, spin-orbit scattering. Generated spin current also varies with orientation of charge current and magnetic anisotropy. The magnetization dynamics in ferromagnetic layer is described by a generalized Landau-Lifshitz-Gilbert Eq. (1).

$$\frac{\partial M}{\partial t} = -\gamma M \times H_{eff} + \alpha \left[M \times \frac{\partial n}{\partial t}\right] \qquad (1)$$

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Room temperature response and enhanced hydrogen sensing in size selected Pd-C core-shell nanoparticles: Role of carbon shell and Pd-C interface

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ABSTRACT

In the present work, the effect of carbon shell around size selected palladium (Pd) nanoparticles on hydrogen (H_2) sensing has been studied by investigating the sensing response of Pd-C core-shell nanoparticles having a fixed core size and different shell thickness. The H_2 sensing response of sensors based on Pd and Pd-C nanoparticles deposited on SiO_2 and graphene substrate has been measured over a temperature range of 25 °C–150 °C. It is observed that Pd-C nanoparticle sensor shows higher sensitivity with increase in shell thickness and faster response/recovery in comparison to that of Pd nanoparticle samples. Pd-C nanoparticles show room temperature H_2 sensitivity in contrast to Pd nanoparticles which respond only at higher temperatures. Role of carbon shell is also understood by investigating H_2 sensing properties of Pd and Pd-C nanoparticles on graphene substrates. These results show that higher catalytic activity and electronic interaction at Pd-C interface, a complete coverage and protection of Pd surface by carbon and presence of structural defects in nanoparticle core are important for room temperature and higher sensing response.

Introduction

Hydrogen (H_2) gas is flammable above 4 vol% in air, therefore its safe production, storage, and usages is always a serious concern [1]. There is significant research interest towards the development of H_2 gas sensors operating at low temperature for applications in space and industry [1–3]. Room temperature device requires lower power consumption and hence reduces the operational cost and simplifies the fabrication steps [2].

Palladium (Pd) is one of the most suitable materials for detecting H_2 because of its high H_2 solubility at room temperature (RT), high sticking and diffusion coefficients, and selective response towards H_2 [4,5]. Pd in the forms of wires [6,7], films [8,9], alloys [10,11] and composites [12–17] has been extensively studied for H_2 sensing. The response/recovery time of about 50 s/100 s has been reported for the Pd thin film sensors [8]. Nanostructured materials, due to high surface to volume ratio, are widely used to fabricate room temperature sensing device [2]. Gas sensors based on nanostuctured

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Selection of Traceable Technology in Food Supply Chain

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Abstract Traceability is an essential tool to provide the product information throughout the Food Supply Chain (FSC), this help protecting the consumer welfare and in developing global competencies. Several technologies are available to implement the traceability system in FSC; these are barcoding, QR code, edible label, DNA- barcoding and paper-based systems. In this paper, we have tried to identify the significant factors towards the selection of the traceable technology within FSC through the literature review and supported by the expert opinion. These factor and sub-factors are prioritised using Analytic Hierarchy Process (AHP). The findings of this work suggest that product-related factors have the highest weight, and needs attention while selecting the traceable technology in FSC. This work may assist the practitioners in the selection of traceable technology for their FSC in an efficient manner.

Keywords: Analytic Hierarchy Process (AHP); Factors; Food supply chain (FSC); Traceability; Traceable technology

1. Introduction

Consumer concerns have increased towards the food safety, hygiene, and environment which has made the role of traceability important. Traceability is implemented not only to assure the consumer expectation but also to provide the effective management of product flow, increase the speed throughout the FSC [1]. Traceability systems are considered as the prerequisite for the food industry to explore the global market [2] as well as protecting the public health.

Olsen and Borit [3] define the traceability in a generic way as “The ability to access any or all information relating to that which is under consideration, throughout its entire lifecycle, using recorded identifications". In the context of food "all information" refer to the information related to ingredient origin, processing, logistics and retailing of the food products. The recoded information is stored and carried with the help of the “traceability information carriers” such as a barcode, RFID, edible label, DNA barcode and other advanced technologies. The term "tracing" and "tracking" is widely used in the literature of traceability. Tracing is a backward process where the origin is identified by history or records in the supply chain, and tracking is the forward process where consumers and supply chain partners are identified by location in the supply chain [4]. The traceability is the combination of the "tracing" and "tracking" of the product information in a backward and forward direction in the supply chain.

The implementation of traceability in the FSC gets strengthened with the adoption of technologies having the ability to track the product related information. Effective monitoring is the focus of the food industries which want low cost and easily applicable traceability technology. Thus, the selection of these traceable technologies is based on the several factors to provide product-related information to consumers. In this paper, the selection criteria of traceable technology are identified and ranked through the Multi-Criteria Decision Making (MCDM) techniques.

1.1 Need for the Study

The selection of the traceable technology is a difficult and complex task because of the several factors are involved. In the context of the food industry, it becomes more complicated because of the huge variation in the perception of the food consumers. Thus, in such situation, the selection of the traceable

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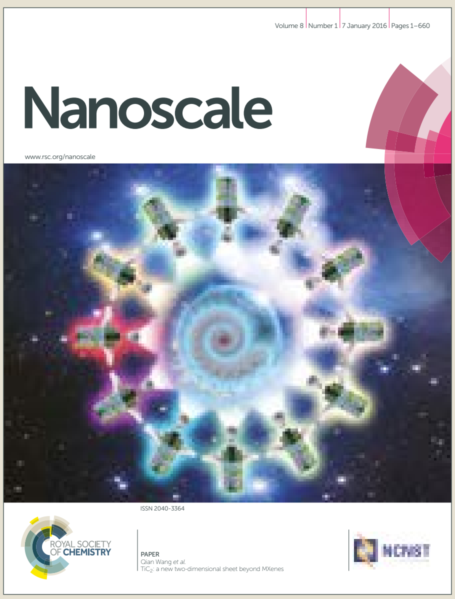

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Significant enhancement in thermoelectric performance of nanostructured higher manganese silicide synthesized employing melt spinning technique

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Abstract

The limited thermoelectric performance of p-type Higher Manganese Silicides (HMS) in terms of their low figure-of-merit (ZT), which is far below unity, is the main bottle-neck for realising an efficient HMS based thermoelectric generator, which has been recognized as the most promising material for harnessing waste-heat in the mid-temperature range, owing to its thermal stability, and earth-abundant and environmentally-friendly nature of its constituent elements. We report a significant enhancement in the thermoelectric performance of nanostructured HMS synthesized using rapid solidification by optimizing the cooling rates during melt-spinning followed by spark plasma sintering of the resulting melt-spun ribbons. Employing this experimental strategy, an unprecedented ZT ~ 0.82 at 800 K was realized in spark plasma sintered 5 at% Al-doped $MnSi_{1.73}$ HMS, melt spun at an optimized high cooling rate of ~ 2×10^7 K/s. This enhancement in ZT represents a ~ 25% increase over the best reported thus far for HMS and primarily originates from an nano-crystalline microstructure consisting of HMS matrix (20-40 nm) with excess Si (3-9 nm) uniformly distributed in the HMS matrix. This nanostructure, resulting from the high cooling rates employed during melt-spinning of HMS introduces a high density of nano-crystallite boundaries in a wide spectrum of nano-scale dimensions, which scatter the low-to-mid wavelength heat-carrying phonons. This abundant phonon scattering results in a significantly reduced thermal conductivity ~ 1.5 W/mK at 800 K, which primarily contributes to the enhancement in ZT.

Keywords: Thermoelectric materials, Higher manganese silicide, Rapid solidification, Melt spinning, Thermoelectric figure-of-merit

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1. Introduction

The applications of thermoelectric power generators (TEGs) are gaining momentum, owing to their green-energy technology and increasing conversion efficiencies over the years. However, in contrast to other renewable sources of energy, these thermoelectric devices have a limitation that the choice of thermoelectric material couple depends on the temperature of the waste-heat to be harnessed. Although TEGs are presently being widely used for both, low (< 300°C) and high temperature (> 600°C) applications, no such commercial devices commercially exists for harnessing waste-heat into electrical energy in the mid-temperature range, despite about four decades of research. Despite several n & p-type thermoelectric materials with high ZT available in this temperature regime (e.g. Silicides,[1-28] Half-Heulers,[29] Selenides [30-31]) the development of efficient TEG for mid-temperature applications still remains a challenge. The main reason for this is the non-availability of n & p type thermoelectric materials, which are cost-effective, non-toxic, thermoelectrically compatible and chemically stable at these temperatures.

Higher Manganese Silicides (HMS) are a unique family of intermetallic compounds that are regarded as potential p-type thermoelectric material in the intermediate temperature range, owing to their earth-abundant and environmentally-friendly nature of its constituent elements coupled with high oxidation resistance. The added advantage of HMS is that they are the most promising p-type compatible counterpart to the existing n-type Mg_2Si-based thermoelectric material thereby leading to an efficient TEG, which consists of earth-abundant and non-toxic elements.[1-3, 7,12-17] However, the main impediment in this direction is the low ZT of HMS, which is far below unity although much higher ZT has been reported for Mg_2Si-based compounds.

Several strategies have been reported to enhance the thermoelectric performance of HMS, which include, controlled elemental doping[4,6,7,22,25] or substitution[5,13,14,20,26,27] and the use of different material processing techniques.[4-11,16-20,22-28] Despite intense research during the last

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couple of years, the ZT of HMS is still limited to ~ 0.65.[7,25] One of the main reason for this is the large difference in the melting points of its constituent elements coupled with the fact that the four different Nowotny Chimney Ladder phases of HMS ($MnSi_{1.72}$, $MnSi_{1.73}$, $MnSi_{1.74}$, $MnSi_{1.75}$) are very close in stoichiometry to one another and thus a small variation in composition during processing, can result in a several similar HMS phases.[12-14] The synthesis of single-phase HMS is further compounded by the fact that that it is not a eutectic composition and can exist with either an excess of Si or cubic-MnSi, as is apparent from its phase diagram.[7] However, cubic-MnSi, although a stable phase, but it exhibits metallic properties, which are detrimental for the overall thermoelectric performance,[19,20,28] although, nano-sized inclusion of MnSi in HMS matrix have shown to improve its electrical properties.[13] On the other hand, although Si is a desirable phase due to its favorable thermoelectric properties, it is very difficult to stabilize excess Si-HMS, employing conventional materials processing techniques.[23,28] Thus the compositional control in HMS, to a large extent, dictates its thermoelectric properties, which perhaps accounts for the large scatter in their reported ZT values in the range of 0.28 to 0.65,[4-11,16-20, 22-28] with most of the reported lower ZT values corresponding to HMS containing excess cubic-MnSi rather than Si. [19,20,28]

The HMS have been synthesized mainly employing mechanical alloying,[9,18-20,28] liquid metallurgy,[26,27] and melt-spinning based techniques.[17,24,25] It is well established that HMS, synthesized employing mechanical alloying lead to a variation in their stoichiometry and the formation of undesirable cubic-MnSi phase due to large hours of ball milling.[9,19,20,28] On the other hand, liquid metallurgy techniques have also led to low values of ZT in HMS, primarily due to the low vapour pressure of Mn, large difference in the melting points of its constituent elements coupled with the fact that HMS is not the eutectic composition in the Mn-Si phase diagram.[7] Although HMS [17,24,25] and other thermoelectric materials [32-36] have also been earlier synthesized using melt-spinning, which have led to higher ZT values and for HMS they are in

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the range of 0.4-0.65 (due to the absence of cubic-MnSi phase), however, the cooling rates, mainly responsible for the nano-scale microstructure, have not been optimized.

In order to circumvent these problems, HMS was synthesized in the present study using rapid solidification by optimizing the high cooling rates during melt-spinning, which not only result in the desired compositional control (devoid of cubic-MnSi Phase) but additionally introduce nanostructural features in the synthesized HMS melt-spun ribbons, both of which are favorable for reducing the thermal conductivity and thus enhancing the thermoelectric performance. This strategy resulted in an unprecedented ZT ~ 0.82 at 800 K in 5 at.% Al-doped $MnSi_{1.73}$ HMS, employing melt-spinning at cooling rate ~ 2×10^7 K/s, followed by spark plasma sintering of the resulting nanostructured ribbons. The characterization of the melt-spun and spark plasma sintered HMS samples, employing XRD and HRTEM, indicated a nanocrystalline microstructure that was although rich in Si but devoid of the cubic-MnSi phase, which is known to be detrimental for its thermoelectric properties. Further, the nanoscale features in the synthesized HMS samples lead to a very low value of thermal conductivity ~ 1.5 W/mK at 873 K, which is the lowest reported thus far for HMS, thus resulting in an enhanced ZT.

2. Experiment details

Mn (99.95%), Si (99.99%) and Al (99.5%) were repeatedly arc-melted (Edmund Buhler, Germany) under vacuum to obtain an ingot of doped HMS with uniform composition, which was then melt-spun (Edmund Buhler, Germany) at an optimized temperature of 1300 K, at different wheel speeds 15-30 m/s under a vacuum of ~ 10^{-6} mbar. The melt was ejected at an argon pneumatic pressure of 0.05 MPa through a fine rectangular nozzle (0.2 mm x 10 mm) on a rotating water-cooler Cu-wheel (dia. 250 mm and 60 mm width) at a nozzle-to-wheel distance of 0.4 mm. The average cooling rates were estimated using the equation[37,38] $dT/dt = (h \times \Delta T)/(t \times \rho \times C_p)$, where h is heat transfer coefficient, ΔT is the temperature difference between the melt and water-cooled copper substrate, ρ is the density, Cp is the specific heat of the material and t is the thickness of the melt-spun ribbons.

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The melt spun ribbons were then pulverized and spark plasma sintered under vacuum (Dr. Sinter, SPS-725, Japan) at 1173 K for 10 min at a heating rate of 100°C/min at a compressive loading of 60 MPa, using a 12.7 mm high-density graphite die/punch assembly. The density, as measured by the Archimedes principle, was found to be ~ 98.8% of the theoretical density, for all the samples. The phase analysis was carried out using a monochromatic Cu-Kα radiation employing X-ray diffractometer (XRD, Rigaku, Japan). The surface morphology of melt-spun and sintered samples was studied using a Field Emission Scanning Electron Microscopy (FESEM, Zeiss, Supra V40) and the structural analysis was performed employing a high-resolution transmission electron microscopy (HRTEM: model, Tecnai G2F30 STWIN operated at the electron accelerating voltage of 300 kV). The compositional analysis was determined using Oxford SDD X-max detector by EDS and elemental mapping.

Rectangular specimens were cut from 12.7 mm diameter sintered samples for the evaluation of Seebeck coefficient and electrical conductivity, which were measured by four-probe DC method in helium atmosphere (Ulvac-ZEM 3, Japan). A circular disc sample of 12.7 mm diameter was used for thermal diffusivity measurement employing laser flash analyser (Linesis, LFA 1000, Germany). The specific heat capacity was measured by differential scanning calorimeter (Netzsch DSC 404 F1). Finally, thermal conductivity (κ) was calculated from the relation, diffusivity × specific heat × density. The accuracies in thermoelectric property measurements are: ± 6% for thermal diffusivity, ± 10% for electrical conductivity, ± 6% for the Seebeck coefficient, ± 8% for specific heat and ± 0.2% for density. The Hall effect measurements were performed by using HEMS system (Nanomagnetics Instruments, U.K) with a magnetic field strength of ± 1 T.

3. Results & Discussions

In the present study, the advantages of rapid solidification were exploited to synthesize the Si-rich $MnSi_{1.73}$ HMS-phase by optimizing the high cooling rates, which were controlled by the speed of the water-cooled Cu-wheel during melt-spinning. The cooling rates at the wheel

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speeds of 15, 23, 30 m/s, estimated from the thickness of the as-melt spun ribbons (10-35 μm), were found to be ~ 10^5-10^7 K/s as shown in Table 1. High wheel speeds (>30 m/s) although resulted in higher cooling rates but led to the dominance of undesired amorphous phase in the melt-spun HMS ribbons. On the other hand, lower wheel speeds (<15 m/s) resulted in very low cooling rates of the HMS melt, which led to the formation of cubic-MnSi phase and relatively high grain size in the melt-spun ribbons, both of which are not favourable for achieving high ZT. Thus, the samples synthesized by melt spinning at wheel speeds in the range of 15-30 m/s are only discussed for analysing the results.

3.1. Microstructural characterization

Fig. 1(a), which shows the XRD patterns of the melt-spun Al-doped HMS ribbons synthesized at different cooling rates (corresponding to different wheel speed ~ 15, 23 and 30 m/s), suggests that for all the wheel speeds, the HMS was found to be the major phase with the presence of excess Si-phase in trace amounts. This figure more importantly suggests that the synthesized HMS is devoid of the cubic-MnSi phase, which generally is an inevitable by-product in the synthesis of HMS and is known to deteriorate its thermoelectric performance.[19,20,23] It may be noted that owing to the fact that HMS phase is not the eutectic composition in the Mn-Si phase diagram it can either exist with excess cubic-MnSi or Si. In the present study, the formation of cubic-MnSi which is metallic in nature, has been supressed owing to high cooling rates employed for the synthesis of HMS during melt spinning. The average crystallite sizes of as-melt spun HMS ribbons, estimated using the XRD data employing Williamson-Hall method, were found to be ~ 36, 34, 25 nm corresponding to the wheel speeds of 15, 23 and 30 m/s, respectively (Table 1). Fig. 1(b) shows the XRD patterns of the melt spun + spark plasma sintered HMS samples, which clearly suggests that the nanoscale features of HMS and Si phases, introduced during melt-spinning (Fig. 1) are retained post sintering, indicating a minimal grain growth (Table 1). It is well recognized that spark

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plasma leads to near-theoretical density in the sintered product while retaining the nanoscale features of the starting nanopowders.[30]

Figure 2 (a-c) show the microstructure of the melt-spun Al-doped HMS ribbons at different wheel speeds, employing FESEM. These figures exhibit equiaxed grained microstructure, for all the wheel speeds, with the grain size decreasing with increasing wheel speed, due to higher rate of cooling induced on the melt. The rapid heat of solidification from the water-cooled copper wheel interface at higher wheel speed generates ultra-fine grained structures with equiaxed grains. Fig. 3 shows the surface morphology (Fig 3a), EDS (inset) and the elemental mapping of the constituent elements (Fig 3b-d) of the sintered Al-doped HMS sample, melt-spun at a wheel speed of 30 m/s. These results clearly suggest a uniform distribution of the constituent elements in the spark plasma sintered HMS sample.

In order to elucidate the ultra-fine features in the melt-spun (30 m/s ~ 2×10^7 K/s) and sintered HMS samples, HRTEM was carried out both in real and reciprocal space and these micrographs are shown in Fig.4. Fig. 4(a) suggests that a fine-grained microstructure of the melt-spun ribbons was delineated throughout the specimen with the size of the individual grains ranging ~ 15 to 40 nm, which is quite close to those estimated from XRD analysis (Fig. 1). A selected area electron diffraction pattern (SAEDP) exhibited several Debye rings in reciprocal space (inset A in Fig. 4a), which corresponds to the HMS-phase ($Mn_{15}Si_{26}$, crystal structure: tetragonal, space group: $I\bar{4}2d$, JCPDS file no.: 00-020-0724). The inset in this figure clearly elucidates a set of important planes in the SAEDP marked as 1, 2 and 3, corresponding to hkl: 2 1 15, 1 1 30, 3 0 15 with the inter-planar spacings of 0.22, 0.19, 0.17 nm, respectively. Fig. 4(b) shows an enlarged view encompassing few grains and typical Moiré patterns (marked by white dotted lines), evolved during rapid solidification of the melt. One such region in a grain (Fig. 4b) at high magnification shows the presence grain boundary with the atomic planes on both the sides with inter-atomic separation ~ 0.22 nm (inset B in Fig.

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4b). However, the rest of the grain (marked with an arrow), shows distinct atomic scale image which corresponds to a set of planes with inter-atomic spacing of 0.22 nm (inset C in Fig. 4b). Figs. 4 (c & d) exhibit the TEM images of the spark plasma sintered HMS sample, which suggests a complex microstructure that is observed at a nanoscale throughout the specimen (Fig. 4c). An enlarged view of region G in Fig. 4(c) shows a grain boundary with a thickness ~ 1 nm, with the (inset D in Fig. 4c) presence of two sets of planes on either side with inter-atomic spacings of 0.22 and 0.19 nm corresponding to the HMS phase. Further, due to an overlap of several tiny crystals in the microstructure (region G in Fig. 4c), a dense networking of Moiré patterns has been evolved and a set of atomic planes with an inter-planar spacings of 0.17 nm can also be observed underneath the Moiré patterns (inset E of Fig. 4c). An encircled region marked as H in Fig. 4(c), resolved at an atomic scale, suggests that this region (Fig.4d) is constituted of atomic planes, hkl: 2 1 15 and 3 0 15 with the inter-planar spacings of 0.22 and 0.17 nm, respectively corresponding to the HMS phase. At high magnifications using the angular dark field imaging it was possible to delineate the presence of excess Si phase in the microstructure with a size about 3 to 9 nm. As an illustrative example, an atomic scale image of such a Si nanoparticle in the HMS matrix (Fig.4e) has been displayed in Fig.4(f), which suggests a set of atomic planes stacked along hkl:111 of Si with an inter-planar spacing of 0.32 nm (marked in Fig. 4f). Overall the TEM studies suggest that the microstructure of the sintered HMS sample consists of the HMS grains (15-40 nm) with fine Si nanoparticles uniformly dispersed in the HMS nanoscale matrix.

3.2 Thermoelectric properties

Fig. 5(a–c), which shows the temperature dependence of the electrical and thermal transport properties of the synthesized Al-doped HMS sample, suggests that the behaviour of the electrical conductivity (σ), Seebeck coefficient (α) and thermal conductivity (κ) is similar to the other reported studies,[5-10,19-24] albeit with different magnitudes. Fig. 5(a) suggests that the σ exhibits an expected monotonous decrease and finally a slight increase at higher

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temperatures, which may be attributed to the bipolar conduction. This figure also suggests that σ increases with increasing wheel speed (cooling rate), which indicates an inverse dependence of *σ* on the crystallite size (Table 1). This increase in σ with the decrease in the crystallite size can be attributed to the enhancement in the carrier concentration (Table 1). It has earlier been reported that nano-precipitates with σ greater than the semiconductor matrix can increase the carrier concentration leading to an enhancement of σ, depending on the size and spacing of the nano-precipitates in the matrix.[39,40] In the present context, the presence of Si nanoparticles in the HMS matrix (Fig. 4) similarly could lead to lattice-size and local compositional fluctuations in the microstructure thus affecting the Fermi level and the carrier concentration (Table 1). Fig. 5(a) shows that the temperature dependence of α for the spark plasma sintered HMS, which suggests that α initially increases with increasing temperature and after reaching a peak value it finally shows a decreasing trend at higher temperatures, which may be attributed to the thermal excitation of charge carriers across the band gap.[15,21] Further, the magnitude of α is found to be nearly independent of the wheel speed (cooling rate). The increase in the wheel speed although increases the carrier concentration in the HMS sample but this increase is compensated by a concurrent increase in the effective mass. The positive value of α, over the entire measured temperature range, confirms the p-type conduction in the synthesized HMS samples and a highest value of α ~ 252 μV/K is realized for the sintered HMS sample melt-spun at a wheel speed of 30 m/s (2×10^7 K/s).

Fig. 5 (b), which exhibits the temperature dependence of κ in sintered HMS samples, shows a decrease with increasing temperature followed by a slight increase at higher temperatures (> 800 K) at all wheel speeds and is this behaviour is similar to that reported earlier in HMS.[10,11,19] The lowest thermal conductivity ~ 1.5 W/mK at 800 K was realized at the wheel speed of 30 m/s (~ 2×10^7 K/s). This low value κ owes its origin to the nanoscale microstructure resulting from rapid solidification during melt-spinning. The high wheel speed

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results in an enhanced cooling rate of the melt (Table 1) leading to a significant amount of undercooling of the melt, which results in a substantial grain refinement of the microstructure. The microstructure of the sintered HMS sample (Fig.4(c&d)) consists of nano-crystalline HMS (20-40 nm) with uniformly distributed excess Si (3-9 nm), which introduces a high density of nano-crystallite boundaries in a wide nano-scale dimensional range, leading to abundant nano-grain boundaries participating in phonon scattering process. It has been earlier reported that in most thermoelectric semiconductors the majority of heat is transported by low-to-mid wavelength phonons.[41,42] In the present study, the nanocrystallite boundaries in our sintered HMS sample, cover a broad dimensional range which scatter low-to-mid wavelength heat-carrying phonons leading to a very low value of κ. The temperature dependence of the lattice thermal conductivity (κ_L) (obtained by subtracting the electronic contribution (κ_e), calculated from σ using the Wiedemann–Franz law with Lorenz number 2.45×10^{-8} $W\Omega K^{-2}$, [7,21] from the total κ), shown in Fig. 5(b) clearly suggests that the total κ has a significant contribution from its lattice counterpart. Thus, the reduction in κ in our sintered HMS samples can primarily be attributed to abundant scattering of heat carrying phonons by the HMS (20-40 nm) and Si (3-9 nm) nano-crystallites, which introduce a high density of grain boundaries in the broad low-to-mid dimensional nano-scale range.[41, 42]

It may also be noted from Fig 5(b) that the κ of the synthesized HMS samples exhibits a non-monotonic dependence on the wheel speed during melt-spinning. Although the κ initially exhibits a decrease with increasing wheel speed, however, this trend is reversed at the highest wheel speed of 30 m/s. This may be attributed to the presence of nanosized inclusions in the HMS samples synthesized at a high wheel speed of 30 m/s (Si nano-inclusions (3-9 nm)) leading to electron-phonon scattering.

Fig. 5(c) shows the temperature dependence of the calculated power factor ($\alpha^2\sigma$) for spark plasma sintered HMS samples at different wheel speeds, which suggests that the highest power factor is realized in sintered samples melt-spun at the wheel speed of 30 m/s (~ 2×10^7 K/s).

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The temperature dependence of the ZT for 5% Al-doped HMS sample, shown in Fig. 5(c), suggests that an unprecedented $(ZT)_{max}$ ~ 0.82 at 800 K was realized in Al-doped $MnSi_{1.73}$ HMS spark plasma sintered sample, melt spun at a wheel speed 30 m/s, which is ~ 26% higher than the best reported thus far in HMS. This result assumes special significance in view of the fact that despite HMS have been extensively researched for the past couple of years for the enhancement of thermoelectric performance, their ZT is still limited to ~ 0.65.

A high ZT ~ 0.82 in our Al-doped sintered HMS samples originates from an enhanced power factor and a greatly reduced κ resulting from an nano-crystalline microstructure, consisting of the HMS phase (20-30 nm) with uniformly distributed Si nanoparticles (3-9 nm), owing to rapid solidification employing melt spinning at optimized high cooling rates (2×10^7 K/s). The resulting nanostructured features in spark plasma sintered HMS samples, which are maintained post sintering, introduce a high density of nano-scale nanocrystallite boundaries at different length scales, which scatter the heat-carrying phonons in a wide spectrum of low-to-mid wavelengths leading to a very low value of κ ~ 1.5 W/mK, which primarily contributes to the enhancement of ZT. The high cooling rates not only introduce nanoscale features in the synthesized HMS but additionally result in the desired compositional control (devoid of cubic-MnSi phase), both of which are favorable for enhancing the thermoelectric performance.

4. Conclusions

The advantages of rapid solidification processing employing melt-spinning have been exploited to significantly enhance the thermoelectric performance of Al-doped HMS, which not only greatly refines the microstructure but also enables a better control on the composition and phase of HMS, which are known to dictate its thermoelectric properties. A state-of-the-art ZT ~ 0.82 at 800 K was realized in spark plasma sintered 5 at% Al-doped $MnSi_{1.73}$ HMS, melt-spun at a cooling rate of 2×10^7 K/s. This unprecedented thermoelectric performance in the synthesized Al-doped HMS originates from an nanocrystalline microstructure owing to rapid solidification features, which consists of HMS matrix phase (20-40 nm) with excess Si

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nanoparticles (3-9 nm) uniformly distributed in the HMS matrix. The HMS and Si nanocrystallite boundaries, at different length scales, scatter heat-carrying phonons in a wide spectrum of low-to-medium wavelength thus resulting in a very low thermal conductivity, which primarily contributes to the enhancement of ZT. Thus, the nanostructured microstructure as a result of rapid solidification, the control of chemical composition and absence of the metallic cubic-MnSi phase (due to rapid solidification) lead to a substantial enhancement in thermoelectric performance in the synthesized HMS.

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Table: 1. Average crystallite sizes and electrical transport parameters of spark plasma sintered Al-doped HMS samples synthesized at different wheel speeds

Wheel speed (m/s)	Thickness of melt-spun ribbons (μm)	Cooling rate (K/s)	Average crystallite size (nm)		Carrier concentration (10^{21} cm^{-3})	Mobility (cm^2/VS)	Effective mass
			Melt-spinning	Melt-spinning + spark plasma sintering			
15	35	7×10^5	36	40	0.69	3.52	4.7m_e
23	20	5×10^6	34	38	0.83	3.02	5.2 m_e
30	10	2×10^7	25	29	1.94	1.53	9.2 m_e

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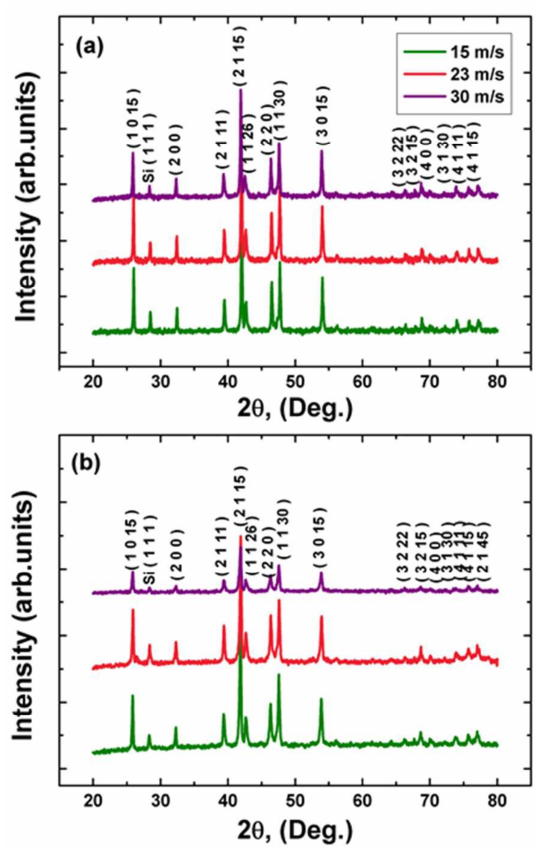

Fig.1. XRD pattern of synthesized Al-doped HMS samples at different wheel speeds (a) melt-spun ribbons (b) melt-spun and spark plasma sintered sample

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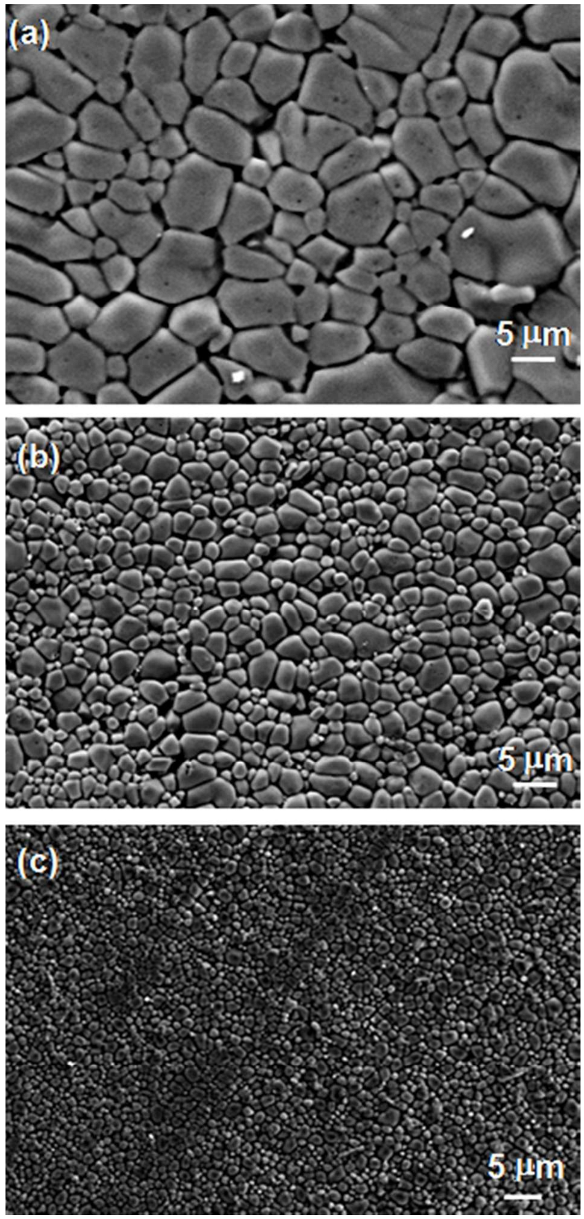

Fig. 2. FESEM microstructures of the melt-spun ribbons of the synthesized Al-doped HMS sample at different wheel speeds (a) 15 m/s, (b) 23 m/s and (c) 30 m/s

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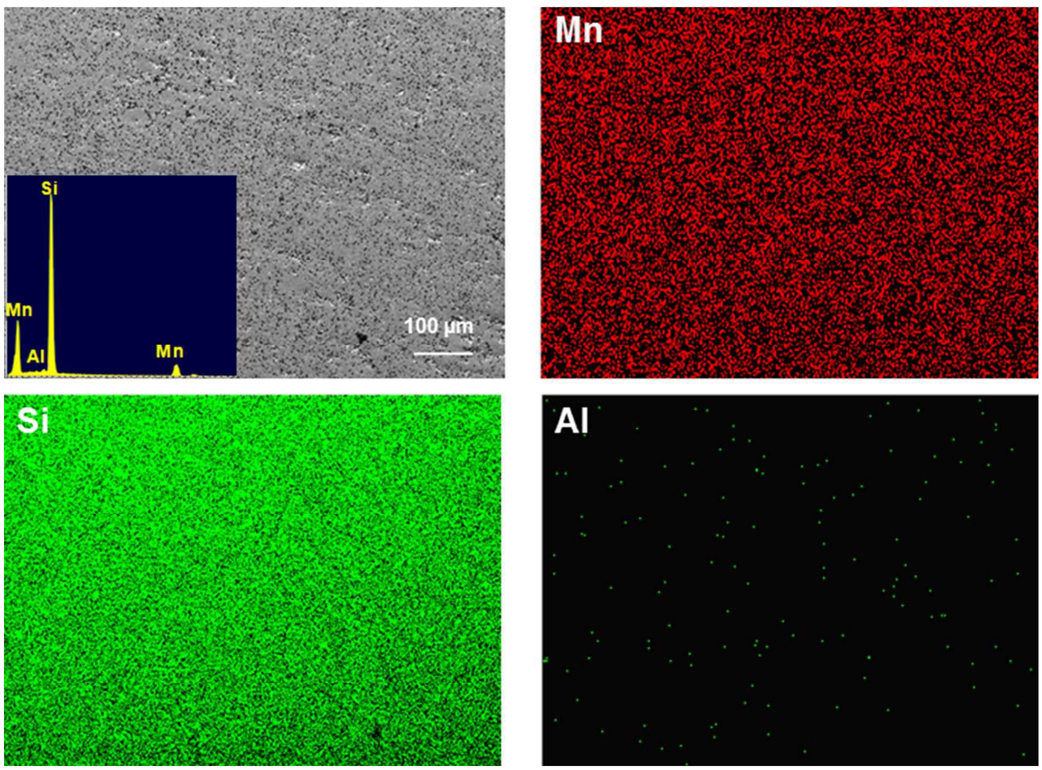

Fig.3. (a) FESEM images of spark plasma sintered Al-doped HMS sample with its EDS spectrum (inset); (b), (c) and (d) Elemental distribution maps of the constituent elements of synthesized HMS

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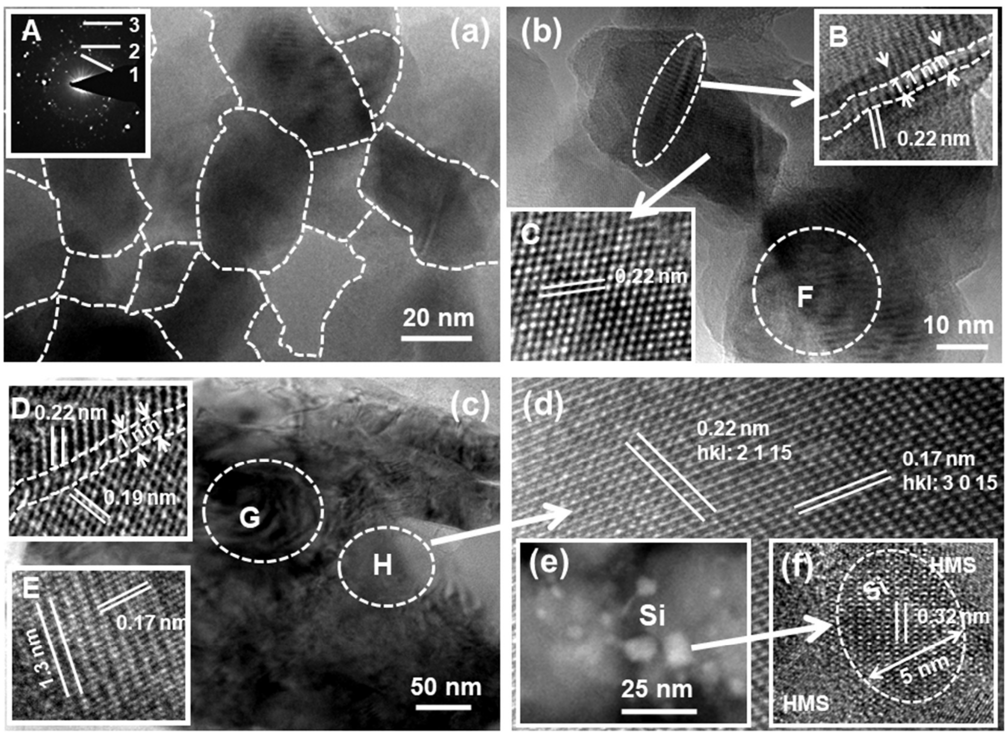

Fig.4. HRTEM images of Al-doped HMS samples (a) ultra-fine distribution of grains in melt-spun HMS sample, (b) enlarged view of the grains observed in (a), (c) a complex intermingled microstructure of melt-spin & spark plasma sintered sample, and (d) atomic scale image of a region of (c) exhibiting crystallographic planes, (e) presence of Si nanoparticles and (f) atomic scale image of a Si nanoparticles in HMS matrix. Insets: (A) SAEDP of ultrafine grains, (B) typical grain boundary, (C) atomic scale image, (D) atomic scale image of a grain boundary, and (E) microstructure composed of Moiré fringes and a set of atomic planes.

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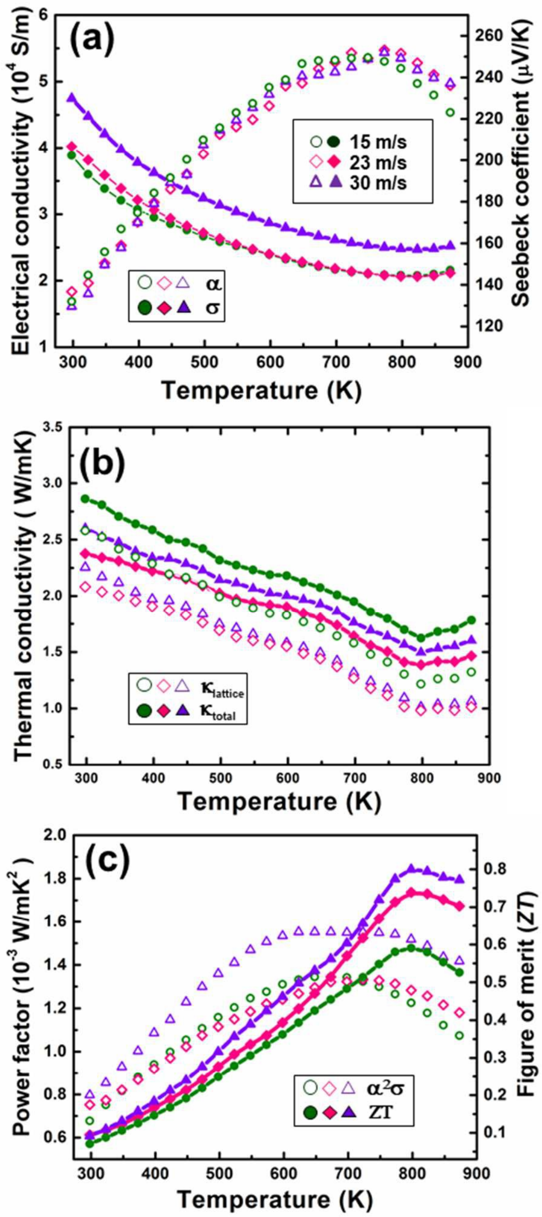

Fig. 5. Temperature dependence of the thermoelectric properties of spark plasma sintered Al-doped HMS sample (a) Seebeck coefficient and electrical conductivity, (b) total and lattice thermal conductivity, (c) power factor and figure-of-merit.

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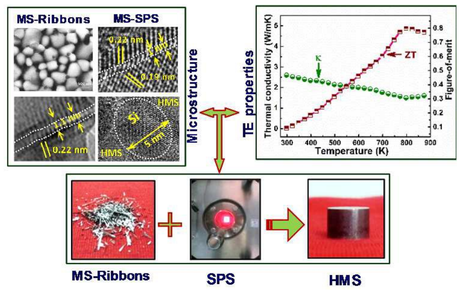
An unprecedented ZT ~ 0.82 realized in spark plasma sintered Al-doped $MnSi_{1.73}$ HMS, melt spun at high cooling rates.



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FULL LENGTH ARTICLE

Sorting of *Glossiphonia complanata* (Linnaeus, 1758) (*Rhynchobdellida*: *Glossiphoniidae*) from three aquatic plants in Tigris River within Baghdad city

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KEYWORDS

Glossiphonia complanata;
Aquatic plants;
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Abstract The present study shows that the reason for isolation of *Glossiphonia complanata* from these aquatic plants was firstly founding of aquatic oligochaeta, snails and chironomidae that settled on aquatic plants as food. Secondly the aquatic plants itself represent favorable environment for growth and reproduction for *G. complanata* and as food for oligochaeta, chironomidae and snails. When the number of *G. complanata* increased the number of worms and snails decreased as observed. The aim of this study was to discover causes of isolation of *G. complanata*.

1. Introduction

Glossiphonia complanata species is one of phylum Annelida, class clitellata, subclass Hirudinea, order Rhynchobdellida, family Glossiphoniidae [7,12].

This species is broad and dorso-ventrally flattened brownish color. Eyes normally are three pairs in two rows parallel with the mid dorsal line, and have small anterior sucker and broad posterior sucker [7].

This species is one of the commonest leeches in fresh water and is usually rare on a muddy substratum and found chiefly on stones and macrophytes [14,16]. Although molluscs consider its chief prey including *Bithynia tentaculata*, *Lymnaea stagnalis*, *Physa fontinalis*, *Physa heterostropha*, *Planorbarius corneus*, *Planorbis vortex* (L.), *Potamopyrgus jenkinsi* (smith), *Pisidium* spp., *Sphaerium* spp., it sucks the body fluids of aquatic oligochaetes and insect larvae, [4,5,8]. The young *G. complanata* gains its first meal by feeding on other leeches including *Erpobdella octoculata*, *Dina lineata*, *Trocheta subviridis*, *Trocheta bykowskii*, *Hirudo medicinalis*, *Haemopis sanguisuga*, *Hemiclepsis marginata*, and *Haementeria costata*, that is considered an unusual feature of feeding. The attacked leech moves violently,

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Spectroscopic investigations of Nd^{3+} doped Lithium Lead Alumino Borate glasses for 1.06 μm laser applications

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Neodymium doped lithium lead alumino borate glasses were synthesized with the molar composition $10Li_2O{-}10PbO{-}(10{-}x)\ Al_2O_3{-}70B_2O_3{-}x\ Nd_2O_3$ (where, x = 0.1, 0.5, 1.0, 1.5, 2.0 and 2.5 mol %) via conventional melt quenching technique to understand their lasing potentialities using the absorption, emission and photoluminescence decay spectral measurements. The oscillator strengths measured from the absorption spectra were used to estimate the Judd-Ofelt intensity parameters using least square fitting procedure. The emission spectra recorded for the as-prepared glasses under investigation exhibit two emission transitions $^4F_{3/2} \rightarrow {}^4I_{11/2}$ (1063 nm) and $^4F_{3/2} \rightarrow {}^4I_{9/2}$ (1350 nm) for which radiative parameters have been evaluated. The emission intensity increases with increase in Nd^{3+} ion concentration up to 1 mol % and beyond concentration quenching took place. The decay profile shows single exponential nature for lower Nd^{3+} ion concentration and non-exponential for higher concentration. To elucidate the nature of energy transfer process, the non-exponential decay curves were well fitted to Inokuti-Hirayama model. The relatively higher values of emission cross-sections, branching ratios and quantum efficiency values obtained for 1.0 mol% of Nd^{3+} ions in LiPbAlB glass suggests it's aptness in generating lasing action at 1063 nm in NIR region.

1. Introduction

With the swift evolution of diode-pumped solid-state laser technology, owing to the optical properties of glasses doped with trivalent Rare Earth (RE) ions, research in the field of newly developed laser materials has acquired significant importance. Further, RE ions doped glassy matrices change the spectral properties by providing a variety of dopant sites due to efficient host-ion interactions and facilitates to realize the applications in second generation telecommunications such as optical fiber amplifier having window at 1.3 μm [1–4]. Quite recently, RE doped inorganic glasses such as borates, phosphates, germinates, tellurites and vanadate families are gaining much interest in the lighting industries and photonic device applications [1–7]. Snitzer first demonstrated lasing action in Nd-doped glasses and since then the scientific interest in glasses containing Nd^{3+} have been increasing gradually [8]. We can estimate the immense progress in this area because today the less tunable but high power terawatt lasers are all Nd-glass lasers only [9]. Quite recently, Nd doped glassy systems have attracted the scientific community because of their demand in ultra-high intensity laser applications such as fusion confinement projects [10]. However, the difficulty with Nd glass ultrafast laser system is the narrow gain spectrum of the commercially available Nd glasses. To overcome this problem a mixed Nd glass approach was proposed with chemical constituents such as phosphates and silicates [9]. But this approach also limited the emission cross-section as well as total gain bandwidth. Therefore, it is essential to have a new glassy system with improved emission cross-section and bandwidth for ultra-high-intensity laser applications. Quite recently, various researchers have studied lasing potentiality of Nd^{3+} doped various glasses [4,5,11–13]. Unfortunately all the reported studies suffers from low emission cross-section. This infact motivated us to develop a borate glasse system having low phonon energies with improved emission cross-sections and quantum efficiency.

Among all inorganic glasses, borates (B_2O_3) possess excellent photonic properties such as good transparency, high density, optimum bandwidths, good infrared transmissions, high mechanical stability and low cost besides having good glass forming ability [14].

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Spectroscopic study of Pr^{3+} ions doped Zinc Lead Tungsten Tellurite glasses for visible photonic device applications

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Optical properties

A B S T R A C T

Zinc Lead Tungsten Tellurite (ZnPbWTe) glasses doped with different Pr^{3+} ion concentrations having the composition $5ZnO + 15PbO + 20WO_3 + (60\text{-}x)TeO_2 + xPr_6O_{11}$ (where $x = 0.5$, 1, 1.5, 2.0 and 2.5 mol%) were prepared by using sudden quenching technique and characterized to understand their visible emission characteristic features using spectroscopic techniques such as absorption, excitation and emission. The Judd-Ofelt (J-O) theory has been applied to the absorption spectral features with an aim to evaluate various radiative properties for the prominent fluorescent levels of Pr^{3+}ions in the as-prepared glasses. The emission spectra recorded for the as-prepared glasses under 468 nm excitation show three prominent emission transitions $^3P_0 \rightarrow {}^3H_6$, $^3P_0 \rightarrow {}^3F_2$ and $^3P_1 \rightarrow {}^3F_4$, of which $^3P_0 \rightarrow {}^3F_2$ observed in visible red region (648 nm), is relatively more intense. The intensity of $^3P_0 \rightarrow {}^3F_2$ emission transition in the titled glasses increases up to 1mol% of Pr^{3+} ions and beyond concentration quenching is observed. Branching ratios (β_R) and emission cross-sections (σ_{se}) were estimated for $^3P_0 \rightarrow {}^3F_2$ transition to understand the luminescence efficiency in visible red region (648 nm). The CIE chromaticity coordinates were also evaluated in order to understand the suitability of these glasses for visible red luminescence devices. From the emission cross-sections, quantum efficiency and CIE coordinates, it was concluded that 1mol% of Pr^{3+} ions in ZnPbWTe glasses are quite suitable for preparing visible reddish orange luminescent devices.

1. Introduction

Recently, Rare Earth (RE) doped crystalline and non-crystalline materials are playing a vital role in the field of science and technology because of their applications in diversified fields [1–4]. Quite recently, studies on non-crystalline materials (glasses) doped with RE ions have attracted great deal of attention by researchers because of their potential applications in designing lasers, fiber communication, color display devices, sensors and hole burning memories, etc. [5,6]. Further, RE doped glassy matrices are considered as luminescence material due to their higher emission efficiencies corresponding to 4f-4f and 4f-5d electronic transitions [7]. The sharp fluorescence pattern observed from 4f-4f electronic transitions in UV to NIR regions owing to shielding effect of 5s, 5p orbital on 4f orbitals. Furthermore, intensity, effective bandwidths of emission transitions and thereby quantum efficiency depends much on the structure of the host matrix. Therefore selecting a good host matrix with relatively higher luminescence efficiency is very much essential for the design and development of a good photonic device [8].

It is reported in literature that, heavy metal oxide glasses are quite suitable for the development of non-linear optical devices, electro-optic modulators, electro-optic switches, solid state laser materials and IR technologies because of their high density, refractive index and low phonon energy [9–12]. In general, the host glass with relatively low phonon energies can give high quantum efficiency and therefore useful for the designing of a good photonic device [13]. Tellurite glasses are one such kind of materials having lowest phonon energy [~800 cm^{-1}] and high refractive index [14,15]. Further, tellurite glasses have recently gained wide

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STRESS INDUCED MAGNETIC FIELD INHOMOGENEITY IN A 1.5 T SUPERCONDUCTING MRI MAGNET

S. R. Thekkethil, S. Kar, M. Kumar, V. Soni, N. K. Suman, R.G. Sharma, V. Rastogi and T. S. Datta

Abstract**—**The heart of the present-day MRI scanners is a **s**uper-conducting magnet producing the required central field. A 1.5 T multi-coil magnet with ±5.5 ppm field homogeneity in 45 cm field of view (FOV) is designed. These coils will operate at an average current density of 130 A/mm^2. The magnet bobbin will be made of 5083 aluminium alloy, while the winding pack of the magnet will be a composite structure which will consist of Nb-Ti, copper, epoxy and insulations. The winding pre-tension, thermal strains; due to cooling and Lorentz forces contributes to the overall stress, which during operation can cause deformation of the magnet. To design a structurally sound and stable magnet system it is critical to evaluate the stresses that are generated in the magnet during winding, cool down and operation. The paper discusses the stresses generated on the magnet and deformations produced due to the forces acting on the coils. The effect of deformation on the field homogeneity and the influence of winding tension on the overall operational stress are also studied. The von-Mises stress during the operation is found to be 40 MPa along the median line. The deformations of the magnet due to operational stresses increased the field homogeneity to ±85 ppm in the FOV.

Index Terms**—Electromagnetic modelling, Numerical simulation, Magnetic resonance imaging, Stress measurement, Superconducting devices**

I. Introduction

The heart of the present-day MRI scanners is a superconducting magnet. The magnet provides the required magnetic field with very high homogeneity in the Field of View (FOV) in the range of 45-50 cm. High homogeneity is needed in the desired FOV for getting quality images [1]. To minimise the amount of superconductor thus the cost, while maintaining the desired size of the clear bore, MRI magnets are built in an axisymmetric multi-coil configuration with 6-12 individual coils instead of a single coil solenoid [1]. The coils are designed and arranged in axially symmetric position in such a way that they produce a high homogeneity at the desired field in the FOV region. The field homogeneity has to be of the order of 10 ppm. This multi-coil configuration, however, leads to higher peak field so the Lorentz forces and thereby large stresses on the coils, both in radial as well as in axial directions [2]. Besides, the winding pre-tension and thermal contraction during its cool-down to 4.2 K also lead to additional mechanical stresses. These stresses will eventually deform the coil structure, and consequently, there will be a degradation of homogeneity in the FOV. This paper discusses the calculation of these stresses and shows how they can degrade the homogeneity of the MRI magnet and how the winding pre-tension can be chosen to neutralise the effect of other stresses.

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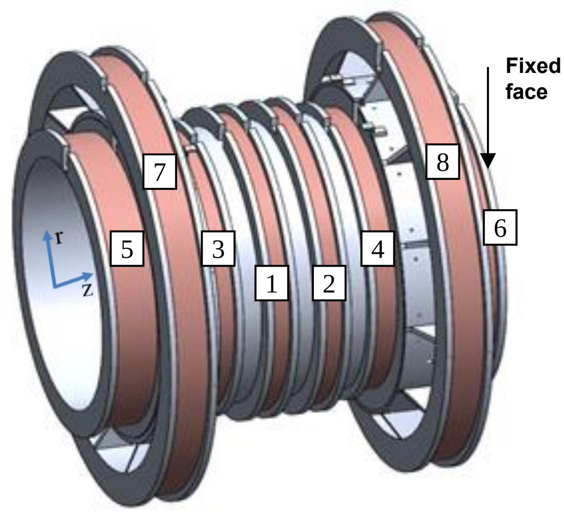

Fig. 1. The six primary coils (1-6) and two shield coils (7, 8) mounted on an aluminium 5083 alloy bobbin.

II. Magnet Parameters

We have designed an MRI magnet which will produce a central field of 1.5 T with a peak-to-peak field homogeneity of 10 ppm in a 45 cm FOV. The magnet has four pairs of coils positioned symmetrically on either side of the mid-plane. The coils will operate at an average current density of 130 A/mm^2. The magnet will have a clear bore of 0.9 m over a length of 1.5 m. The coils are designed to operate at 60% of conductor's critical current. The magnet coils will be wound over an aluminium 5083 alloy bobbin and will be mechanically fixed on to the inner helium vessel to prevent any movement during the operation. The magnet coils along with its bobbin are shown in Fig. 1.

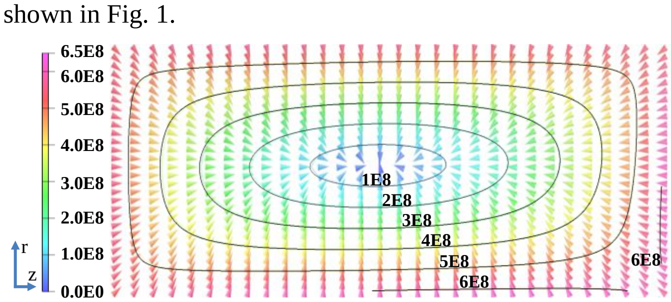

Fig. 2. The Lorentz force vectors and contours inside the coil-6 as calculated from the magnetic field profile. The colour scale is the magnitude, in N/m^3.

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Structural, magnetic and electronic properties of armchair graphene nanoribbons interacting with Co: DFT investigations

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ABSTRACT
Theoretical investigations based on density functional theory (DFT) have been performed to reveal the effect of Co impurities on structural stability, magnetic and electronic properties of armchair graphene nanoribbons (AGNR). It is revealed that Co forms stable chemical bonding with host (C) atoms and settled in magnetic ground state. Calculated magnetic moment per Co atom was found to be 1.02–1.67 μ_B. Moreover, up to ~70% spin polarization is also predicted which is a function of doping site. Present findings are useful to induce width independent metallicity in AGNR making them a potential candidate for contact/interconnect applications in upcoming nano-devices.

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KEYWORDS
Electronic band structure; structural stability; spin polarization; *I-V* characteristics

1. Introduction

The significant progress in the synthesis proficiencies and the exotic chemical, physical and electrical properties of graphene are responsible for making it a favorite material to research [1–2]. Researchers have demonstrated distinct applications of graphene which include capacitors, solar cells, transistors and sensor applications [3–7]. The major drawback with graphene that hinders its path for semiconducting device application is its intrinsic semi-metallicity [8]. Graphene exhibits linear dispersion relation and have been studied with various dopants [9–11]. The quasi 1D strips of graphene, known as graphene nanoribbons (GNR), exhibit finite band gap due to quantum confinement of electronic states. Efforts have been made to alter the electronic properties of GNR through passivation of the edge dangling bonds by various elements/functional groups [12–14]. Particularly B and N have been investigated as dopant or terminating agent in GNR [15–17]. Effect of transition metals (TM) impurities has also been investigated on the electronic and transport properties of graphene [18, 19]. Longo et al., [20] reported that Fe impurities in GNR acquire magnetic character upon relaxation. Similar behavior was also observed for Co impurities in graphene and GNR by Cocchi et al., [21]. Wang et al., [22] experimentally achieved substitutional doping

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Structural, optical absorption and photoluminescence spectral studies of Sm^{3+} ions in Alkaline-Earth Boro Tellurite glasses

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ABSTRACT

Sm^{3+} ions doped Alkaline-Earth Boro Tellurite (AEBT) glasses were prepared by using conventional melt quenching technique and characterized using the spectroscopic techniques such as FT-IR, optical absorption, emission and decay spectral measurements to understand their utility in optoelectronic devices. From absorption spectra, the bonding parameters, nephelauxetic ratios were determined to know the nature of bonding between Sm^{3+} ions and its surrounding ligands. From the measured oscillator strengths, the Judd-Ofelt (J-O) intensity parameters were evaluated and in turn used to estimate various radiative parameters for the fluorescent levels of Sm^{3+} ions in AEBT glasses. The PL spectra of Sm^{3+} ions exhibit three emission bands corresponding to the transitions $^4G_{5/2} \rightarrow {}^6H_{5/2}$, $^6H_{7/2}$ and $^6H_{9/2}$ in the visible region for which the emission cross-sections and branching ratios were evaluated. The decay spectral profiles measured for $^4G_{5/2} \rightarrow {}^6H_{7/2}$ transition showed single exponential for lower concentration and non-exponential for higher concentration of doped rare earth ion in the as prepared glasses. Conversion of decay spectral profiles from single to non-exponential have been analyzed using Inokuti–Hirayama (I–H) model to understand the energy transfer mechanism involved in the decay process. CIE Chromaticity coordinates were measured using emission spectral data to identify the exact region of emission from the as-prepared glasses. From the evaluated radiative parameters, emission cross-sections and quantum efficiencies, it was observed that AEBT glass with 1 mol% of Sm^{3+} ions is more suitable for designing optoelectronic devices.

1. Introduction

Glassy materials are playing a starring role in designing the photonics and optoelectronics devices due to their advantages over crystalline materials. The crystalline materials have huge optical losses resulting from light scattering produced the grain boundaries. Moreover, the compositional/concentration variation facility of glassy materials provides ample scope for researchers to work on various alloys to produce relatively good optoelectronic devices. Glass materials possess short-range order and random network structure; they have stronger ability to provide accommodation for foreign atoms in their interstitial positions. Due to this, glass materials easily accept various dopants like nano particles, transition metal ions and Rare Earth (RE) ions [1]. Especially glassy materials doped with RE ions have the utmost importance because of their advantages such as insensitiveness of the spectral transitions of RE ions to the host glass materials, the stable intense narrow emissions of RE ions which are originated from the 4f-4f and 4f-5d electronic transitions and the long lifetimes of RE's meta stable states [2]. Due to these advantages, glass network incorporated with the RE ions attains the feasibility of employing them in the designing of optoelectronic devices like light converters, sensors, lasers, color displays, optical amplifiers and solid-state lightening devices depending on the emission regions of the RE ions [3,4].

Among the RE ions, samarium (Sm^{3+}) ion has strong emission transitions with $4f^5$ configuration in the orange-red visible region. Especially, the excited level $^4G_{5/2}$ of Sm^{3+} ion has strong luminescence and high quantum efficiency. Due to these reasons, Sm^{3+} ions doped glasses have numerous applications in the development of photonic devices like color displays, high-density optical memory

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Study of ferroelectric phase transition in new lead free $Ba(Ca_{1/3}Nb_{2/3})O_3$ compound

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ABSTRACT
$Ba(Ca_{1/3}Nb_{2/3})O_3$ (BCN) compound was prepared by solid state reaction route. Structural and electrical analyses were done by X-ray diffraction (XRD), Field effect scanning electron microscope (FESEM), temperature and frequency dependent dielectric and impedance study. Final phase compound shows the formation of single phase cubic crystal system. FESEM micrograph shows the development of the grains in various shapes with different sizes. Relative density of sintered compound found to be 97%. Variation of dielectric constant and dielectric loss with temperature show diffuse ferroelectric characteristics. Electrical ac impedance study reveals that behavior of the electrical resistance and poly dispersive nature of the dielectric relaxation.

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KEYWORDS
Sintering; crystal structure; dielectric properties; electrical properties

1. Introduction

The diffuse ferroelectric phase transition in complex perovskite $A(B'_{1/3}B''_{2/3})O_3$ materials as summarized raise several significant questions regarding the experimental difficulties in material processing as well as the theoretical understanding of the polarization mechanism involved. Further, a lot of lead based perovskite compositions have been synthesized and many of them exhibit relaxor properties. They have drawn considerable attention during last few decades due to to their commercial applications such as multilayer ceramic capacitors, actuators and electro-mechanical coupling devices due to their low temperature synthesis, high dielectric constant and comparatively low temperature coefficient of capacitance [1–6].

The concept, which this paper rooted in, is the basic need of replacing the lead contains from the materials using in device fabrication due to toxic nature of lead. Thus the present work is an endeavor to obtain lead free ferroelectric/relaxor material for device application. It is well known from the literature that usual solid-state reaction route does not stabilize perovskite phase easily in these materials [7], because a significant amount of pyrochlore

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Study on the establishment of a diversified National Ambient Noise Monitoring Network in seven major cities of India

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We describe the diversified National Ambient Noise Monitoring Network (NANMN) set up across 7 major cities of India and covering 70 stations for continuous noise monitoring throughout the year. The annual average L_{day} (06–22 h) and L_{night} (22–06 h) values observed in 2015 for these 70 locations are described. Of these, 25 locations are in commercial zones, 12 in industrial, 16 in residential and 17 in silence zones. Each city has 10 noise monitoring stations installed for analysing environmental noise pollution levels round the clock (24 × 365 h). The long-term noise monitoring shows that ambient noise levels are very high compared to the recommended standards for some sites and thus noise abatement measures are essentially required for controlling these levels. The present study is focused on evaluation, analysis and reporting of environmental noise pollution in seven major cities of India and is instrumental in planning for the noise abatement measures for controlling noise pollution in these cities. Such a noise monitoring network established in India is unique and one of the largest noise monitoring networks of its kind across the globe.

Keywords: Day equivalent level, day–night average sound level, National Ambient Noise Monitoring Network, night equivalent level.

NOISE pollution has become a serious concern over the past several years in India. With growing vehicular population and urbanization, it is imperative to monitor the ambient noise levels and devise suitable measures for control to avoid health hazards and annoyance faced by the community. The evidence for effects of environmental noise on health is strongest for annoyance, sleep and cognitive performance in adults and children. The occupational noise exposure also shows some association with high blood pressure[1]. There have been many such studies conducted so far on the noise exposure and correlation with human blood pressure[2–5]. Meta-analyses have been carried out to derive the exposure–response relationships that can be used for quantitative health impact assessments[6]. The meta analysis of 24 cross-sectional studies on the relationship between road traffic noise and prevalence of hypertension reported an odds ratio (OR) of 1.07 (95% confidence interval (CI) = 1.02–1.12, $P < 0.05$) per 10 dB increase of 16 h day-time average road traffic noise level ($L_{Aeq,16\,h}$) in the range of <50 to >75 dB (refs 7, 8). In India, there have been limited studies carried out on correlating the effect of noise on human health. A recent study provides evidence that road traffic noise is a serious cause of concern[9]. The study infers that association between transportation noise exposure and cardiovascular disease is evident, but not at significant level. A similar study suggests epidemiological evidence that exposure to road traffic noise of $L_{den} > 65$ dB(A) may be associated with coronary heart disease (CHD) in adult subjects[10]. Traffic noise is probably the most rigorous and pervasive type of noise pollution[11]. Traffic noise is said to account for over 1 million healthy years of life lost annually to ill health and may lead to a disease burden that is second only in magnitude to that from air pollution[12].

It is thus imperative to continuously monitor the ambient noise levels especially at the noisy sites in the cities to not only ascertain the magnitude of noise levels, but also take preventive actions to control them. The Central Pollution Control Board (CPCB), India has taken this issue seriously and therefore has established a pilot project on National Ambient Noise Monitoring network (NANMN) covering seven major cities of India. This programme was established initially in 2011 with 35 noise monitoring stations covering seven major metropolitan cities: Delhi, Lucknow, Kolkata, Mumbai, Hyderabad, Bengaluru and Chennai[13]. However, the strengthening of this network to 35 more stations in the same 7 metropolitan cities since November 2014 has been indispensable in analysing a wider noise scenario situation in the country and adoption of noise abatement measures for controlling noise pollution in India.

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Swertia chirata: A Comprehensive Review with Recent Advances.

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Author information

Abstract

BACKGROUND: Swertia chirata, an ethnomedicinal plant, is renowned for its diverse medicinal properties. The plant produces large number of therapeutic phytochemicals responsible for remedial effect against various ailments mainly chronic fever, malaria, bronchial asthma, liver disorders, certain type of mental disorder, blood purification and diabetes. Recently reported anticancer effect of S. chirata has amplified its importance in the scientific community.

OBJECTIVE: The aim of this review is to deliver the pharmaceutical importance of S. chirata as diverse therapeutic agent and attract the scientific community working in the field of pharmacology to produce new drug to treat various ailments.

METHODOLOGY: Data compiled and presented here were obtained from E-resources like Science Direct, Pubmed, Google, through books and web of science up to Oct 2017.

RESULT: This review comprises the common aspects of S. chirata like pharmacologically important phytochemicals with in vitro and in vivo studies, toxicology, adulteration with similar species, dosage, conservation via in vitro studies and genetic stability with molecular markers. A bioinformatics approach to explore therapeutic targets that might suppress many diseases is also compiled to make it complete.

CONCLUSION: The medicinal plant S. chirata is continuously being used as a traditional herb. The data indicated its safe and positive effect in the treatment of various diseases. It presents many promising prospects for modern medicine, which may be validated after the process of successful in vivo research, clinical studies, and human trials.

KEYWORDS: Bioinformatics; Swertia chirata; hepatoprotective; hypoglycemic; modern drug; traditional medicine

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Synthesis and effect of Misch metal on mechanical properties of conventional cast Mg–Al–Zn–Sn–Pb alloy system

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Abstract

Magnesium alloys are increasingly accepted in automobile industry owing to their greater strength-to-weight ratio. These qualities lead to less vehicle weight and better fuel economy. Therefore, in the present work an effort has been made to develop a new Mg alloy system that exhibits greater ductility together with greater mechanical strength. Misch metal is added in Mg-based alloys to investigate the changes in mechanical properties. The microstructure of alloys Mg–4Al–3Zn–3Sn–3Pb (H1) and Mg–4Al–3Zn–3Sn–3Pb–0.5MM (H2) are dendritic in nature while for Mg–3Zn–3Sn–3Pb–2Si (H3) the "Chinese script" Mg_2Si intermetallic structure was obtained. The ultimate tensile strength and elongation of Mg–4Al–3Zn–3Sn–3Pb–0.5MM (H2) alloy are about 40% and 100 % higher than that of H3 alloy. The ultimate tensile strength, yield strength, and percentage elongation of H2 alloy are 170 MPa, 44 MPa, and 3.4%, respectively.

Keywords

Mg alloy, Misch metal, mechanical properties, microstructure

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Introduction

Due to growing environmental concerns and severe government regulations on CO_2 emissions, vehicle weight and fuel economy are becoming more and more important in the automobile industry. Therefore, the need of light weight metallic materials has led to significant consideration of materials researchers into Mg alloys because of their low density and high specific strength. The growth of magnesium alloys in the automotive industry is determined primarily used as steering wheel, cylinder head cover, door frames, transmission housing, and structural support materials.[1–3] Many application of Mg alloys such as ZE41 (Mg–4.2% Zn–0.7% Zr–1.3% MM), QE22 (Mg–0.7% Zr–2.5% Nd–2.5% Ag), and particularly WE43 (Mg–4% Y–3.25% Nd–0.5% Zr) are commonly used for aircraft applications due to their improved corrosion and creep resistance.[3–8] EZ33 (Mg–2.7% Zn–0.7% Zr–3.2% MM) sand castings are used in the "Skylark" research rockets because of high specific strength and rigidity coupled with ease of fabrication. Among Mg alloys, Mg–Al and Mg–Al–Zn alloys are the most promising for a light weight industry because of their acceptable mechanical properties, good corrosion resistance, and excellent castability.[7,9] It has been reported that aluminum forms intermetallic phases Mg_2Al_3 and $Mg_{17}Al_{12}$ with Mg, which imparts great tensile strength to the alloy and hence is one of the most universally used element.[10–16] Further to improve the strength of cast Mg alloys, several mechanisms for hardening are put to use. These include solid solution hardening, grain size or Hall Petch hardening, age hardening and dispersion hardening.[7,8] The strength of the Mg alloy depends directly on total wt% of the elements in use. The most frequent hardening elements are Al, Zn, Si, RE elements.[11,17–20] At high temperature, these elements show greater solubility which decreases with increases in temperature. $Mg_{17}Al_{12}$ intermetallic is responsible for room temperature strengthening effect but at temperature greater than 100°C, this intermetallic has a tendency to become coarse because of its low melting point (437°C) and no longer acts as a barrier for dislocations. Therefore, this phase and

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Tb^{3+} and Eu^{3+} Doped Zinc Phosphate Glasses for Solid State Lighting Applications

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Abstract: Tb^{3+} and Eu^{3+} doped zinc phosphate (ZP) glasses were prepared by conventional melt-quenching technique and their photoluminescence properties were investigated in detail. For, Tb^{3+} doped glasses the intense emission was at 545 nm corresponding to ${}^5D_4 \rightarrow {}^7F_5$ transition under 377 nm n-UV excitation. The optimized concentration for Tb^{3+} doped zinc phosphate glass was 3 mol% and above this concentration quenching takes place. The Eu^{3+} doped zinc phosphate glass revealed intense emission at 613 nm attributed to the ${}^5D_0 \rightarrow {}^7F_2$ transition under intense 392 nm n-UV excitation. The concentration quenching phenomenon was not observed in the Eu^{3+} doped ZP glasses. The CIE chromaticity coordinates for 3 mol% Tb^{3+} and 5 mol% Eu^{3+} doped ZP glasses were found to (0.283, 0.615) and (0.652, 0.331) lying in the green and red regions, respectively. The above mentioned results indicate that the prepared glass are suitable for application in the field of lighting and display devices.

INTRODUCTION

In the recent era, white-light emitting diodes (W-LEDs) in solid-state-lighting (SSL) technology are receiving great importance, as it offers higher efficiency, longer lifetime and environment-friendly characteristics in comparison to incandescent and fluorescent lamps. Currently, W-LEDs are fabricated using a phosphor (wavelength converter) in combination with the LED chips. The phosphor can single or multitude in nature which is being excited by UV/n-UV/blue LED chips [1,2]. However, the phosphor is suspended in the form of powder inside an epoxy-resin which is made up of polymer/organic material. This epoxy-resin gets damaged by high power/excitation LED chips, which leads to the yellowing and carbonization of epoxy. Further, this high temperature leads to the reduction in phosphor emission. As a result, there is a decrement in the luminous efficiencies and chromaticity shift takes place, which hampers the optical performance drastically [3,4]. To overcome these shortcomings, a futuristic material with excellent optical properties, simpler manufacturing technique, and high thermal and chemical resistance is required. A luminescent glass is the best alternative as they possess all the characteristics mentioned above, in addition to that they serve both the purpose of wavelength converter and encapsulant. Therefore, luminescent glasses can be considered as the potential alternative candidate for fabrication of w-LEDs. Among different glass formers, phosphates have the low melting temperature, very high transparency in the broad spectral region and offer excellent solubility for the transition and rare earth metals. Phosphates glasses have a broad range of applications in lasers, optical amplifiers, waveguides and solid state lighting. However, the phosphate glasses are hygroscopic in nature and to eliminate Zinc oxide (ZnO) are incorporated in the phosphate glass batch to eliminate the hygroscopic nature. ZnO offers chemical and thermal stability to the phosphate structure. Barium oxide (BaO) incorporation in the phosphate glasses can enhance the mechanical strength. Further, the addition of titanium oxide (TiO_2) to the glass batch can provide stabilization and improves chemical durability [5–8]. Among various rare-earth

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The impact of total productive maintenance on key performance indicators (PQCDSM): a case study of automobile manufacturing sector

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Abstract: Total productive maintenance (TPM) is a maintenance program, which involves a customised approach for maintaining plants and equipment ensuring maximum availability, equipment effectiveness and promotes autonomous maintenance culture. The objective of this paper is to highlight the significant improvements of operational efficiency regarding TPM key performance indicators known as productivity (P), quality (Q), cost (C), delivery (D), safety (S) and morale (M) termed as 'PQCDSM' in selected two wheeler automobile sector. The study has focused on the tangible benefits gained regarding TPM key performance indicators. The results show that there was a significant improvement in production volume, customer complaints, the cost of operations, number of accidents and morale of the employees which the selected automobile plant achieved in the target period of three years. The findings of the research determine a significant contribution due to systematic TPM interventions to 'PQCDSM' indicators and hence motivated the workforce to contribute for improvement activities. An important aspect investigated from this study was the intangible outcomes achieved by implementing TPM.

Keywords: total productive maintenance; TPM; overall equipment effectiveness; OEE; performance indicators; autonomous maintenance; productivity; automobile industry; 5S implementation.

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Thermodynamic analysis of low grade solar heat source powered modified organic Rankine cycle using zeotropic mixture (Butane/R1234yf).

Deepak Tiwari, Ahmad Faizan Sherwani & Akhilesh Arora

Thermodynamic and multi-objective optimization of solar driven organic Rankine cycle using zeotropic mixtures .

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Abstract

This paper communicates the performance of low-grade solar heat source powered Organic Rankine Cycle (ORC).To investigate the system performance, first law and exergetic efficiencies, power output are evaluated and compared for zeotropic mixtures of (iso)butane / (iso)pentane and cyclohexane/R123.The results indicate that there exists an optimal mass fraction for which energy and exergetic efficiencies, and power output are maximum correspondings to a given value of expander inlet temperature compared to pure fluids. However, the specific volume flow ratio of the expander is higher for zeotropic mixtures; which results in lower economy of mixtures than pure fluids. The use of internal heat exchanger in the system improves cycle performance. Moreover, multi-objective genetic algorithm further improves the performance of ORC and exhibits better exergetic efficiency 51-57% and 0-14.09% reduction in lower expander specific volume flow ratio (v6/v5), than thermodynamically optimized organic Rankine cycle.

Keywords: Low grade solar heat source, organic Rankine cycle (ORC), zeotropic mixtures, Internal heat exchanger (IHE), Multi-objective genetic algorithm (MOGA).

Thermo-economic and multiobjective optimization of saturated and superheated organic Rankine cycle using a low-grade solar heat source

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This paper presents detailed energy and exergy analysis and comparison of low-grade solar heat source powered superheated and saturated organic Rankine cycle (ORC) using zeotropic mixture butane/R1234ze. The required expression to evaluate the power output, first law efficiency exergetic efficiency, exergy destruction, and required heat exchangers area are coded in Matlab 2015a interfaced with REFPROP 9.0. Moreover, saturated and superheated ORCs are further optimized by genetic algorithm by selecting exergetic efficiency and product of overall heat transfer coefficient and heat exchanger area. It is observed that superheated ORC exhibits better net power output, first law, and exergetic efficiency, lower exergy destruction, and poorer economy than saturated ORC. Further, the performance of saturated ORC is increased by 34.02% and that of superheated ORC by 17.06% by the multiobjective genetic algorithm. *Published by AIP Publishing*. https://doi.org/10.1063/1.5005551

I. INTRODUCTION

In spite of amelioration in harnessing of renewable and sustainable energy resources, three-quarters of the world's energy demand is furnished by fossil fuels.[1] Fossil fuels are depleting very fast owing to accelerating consumption and result in several grievous environmental impacts such as air pollution, global warming, acid rain, and climate change.[27] Therefore, it is mandatory to focus on some low-grade (60 °C–200 °C)[2] renewable energy resources such as solar,[3,4] geothermal,[5] biomass,[6] ocean thermal,[7] and wind.[8] Solar is the most promising energy source because it is clean and naturally abundant. The energy from solar radiation that reaches Earth (1.7×10^4 W), is about ten thousand times more than the world's current total energy consumption.[9] The conventional vapor power cycle becomes inefficient and expensive when vapor temperature falls below 370 °C.[10] The organic Rankine cycle (ORC) is the best system to successfully convert low-grade heat into useful power.[11,15] The organic Rankine cycle is similar to conventional the vapor power cycle,[12] but in place of water, the organic substance is working fluid, which has relatively lower evaporation and boiling point temperature.[13,14] The bottlenecks in ORC's applications are lower thermal efficiency[15] and major exergy destruction in evaporators due to the bad thermal match between heat source and sink.[16] Some notable research works are as follows. Wang *et al.*[17] did a thermodynamic analysis of low-grade solar heat source powered organic Rankine cycle for generating power using zeotropic mixtures (R245fa/R152a) and reported significant improvements in first and second law efficiency. Wang *et al.*,[18] carried out an experimental study comparing pure fluid (R245fa) and zeotropic mixture (R245fa/R152a) of

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Tuning the properties of segmented polyurea by regulating soft-segment length

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ABSTRACT: Polyurea is being widely advocated as a "retrofit" coating on structures, which mandate protection against blast. The physical properties of polyurea can be tuned by judicious choice of reactants, and the processing methodology employed for its preparation. The purpose of this study is to establish the dependence of material properties on the soft segment length in polyurea. Polyurea formulations were prepared by reaction of commercially available isocyanate prepolymer with polypropyleneoxide based amines of varying molecular weights (230–2000 g/mol). The effect of increasing the soft segment length on the mechanical properties of polyurea under both quasi-static as well as dynamic conditions was determined. Ductility was found to increase proportionally with increasing soft segment length, with a concomitant decrease in the tensile strength. All the compositions exhibited sub-ambient glass transition temperature, which was found to reduce with increasing soft-segment length. Time–temperature superposition principle was used to arrive at master curves for all compositions. The frequency essential to initiate the process of dynamic "rubber to glass" transition was found to be directly proportional to the soft segment length. All the formulations were found to be capable of exhibiting an elastomeric response even under high frequencies typical of blast loadings. © 2018 Wiley Periodicals, Inc. J. Appl. Polym. Sci. **2018**, *135*, 46284.

KEYWORDS: elastomers; glass transition; mechanical properties; thermal properties

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INTRODUCTION

Polyurea is formed by the rapid reaction of diisocyanate($-N=C=O$) with diamine ($-NH_2$) forming hard domains, which remain heterogeneously dispersed within a matrix of flexible chains, commonly referred to as the soft phase.[1–3] Thermodynamic incompatibility between the hard and soft segments result in phase segregation, leading to a two-phase morphology.[4,5] The hard segments are extensively H-bonded and serve both as reversible physical crosslinks as well as reinforcing fillers, thereby bestowing excellent mechanical properties to the polymer.[2,6,7] In view of the same, polyurea is finding use in challenging applications, especially where protection against ballistic and blast loadings is desirable. What renders this particular class of polymer fascinating is that the formulations can be tuned to offer a range of mechanical properties, from soft rubber to hard plastic, by tuning the causal "hard" and "soft" domain structure.

The soft domains in polyurea are formed of long polyether chains, which exhibit a glass transition temperature (T_g) much below ambient temperature.[6,8,9] The material thus exists in the "rubbery" region at room temperatures. It is surprising to note that although poly(propyleneoxide) (PPO) based amines are the "workhorse" of the polyurea industry, systematic studies on the mechanical response of such formulations are unavailable in public domain, which inspired us to take up this study. In addition, both the methodology adopted for preparation of polyurea as well as the operating conditions involved also affect the morphology as well as resulting properties of the polymer.[7,10] Due to the difference in the T_g of the soft and hard segments, polyurea behaves like a crosslinked elastomer reinforced by the nanosized hard domains[11] which serve as focal centers for mechanical constraints. The wide transition zone of polyurea from rubbery state to glassy state renders the viscoelastic properties of polyurea highly sensitive to several parameters especially temperature, pressure, and strain rate.[12]

In all commercial polyurea formulations, chain extenders are included in the "amine component" to increase the hard segment content and the extent of microphase separation, which reflect in terms of its mechanical properties. Wilkomm *et al.*[10] studied the mechanical properties of polyurea in which the hard segment content was increased by introducing diethyltoluene

Additional Supporting Information may be found in the online version of this article.

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CIVIL & ENVIRONMENTAL ENGINEERING | RESEARCH ARTICLE

Use of paper mill waste for brick making

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Abstract: The intent of the present research work is to explore the prospect of replacing natural soil used in brick making by some extent with industrial waste, that is, lime mud, as obtained from paper mill waste. Extensive adoption of this mill waste as a brick making material will deter the environmental effects of this waste disposal. Moreover, its adoption will not only solve the problem of stocked waste piles but also scale down the usage of natural soil as a brick making material. In consideration of the central intend of this study to utilize industrial waste as an alternate raw material, yet another industrial waste—fly ash, has also been blended to the mix to manufacture unburnt bricks, such that, it may produce cementitious compounds with lime mud. So, the materials used for brick making in this study are: lime mud, collected from the dumping site of M/s Hindustan Paper Corporation Limited, Jagiroad, Assam, India; soil, collected from a brick manufacturing unit also near Jagiroad; and fly ash, collected from National Thermal Power Station, Badarpur, Delhi, India. The materials have been characterized with respect to their chemical and geotechnical properties. Then, experiments have been conducted on hand-moulded bricks of aforementioned mix in distinct proportions. In this study, all the bricks have been dried in the natural condition and then tested for compressive strength conforming to International standards. It has been duly noted that none of the treated unburnt bricks satisfies the requirements of standard codes. Nonetheless, in case of burnt bricks, the compressive strength satisfies the requirements of International standard codes wherein lime mud has been added up to a certain percentage (=20%) in soil-lime mud mix.

Subjects: Industrial Hygiene; Waste & Recycling; Environmental Health; Geomechanics

Keywords: lime mud; geotechnical characterization; unburnt brick; burnt brick; scanning electron micrograph

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PUBLIC INTEREST STATEMENT

Due to ever-increasing problem of pollution, there is an immediate need for the communities and industries to come up with radical measures such as strict environmental regulations, and cleaner waste disposal technologies. The intent of the present research work is to explore the prospect of replacing natural soil used in brick making by some extent with industrial waste, that is, lime mud, as obtained from paper mill waste. Extensive adoption of this mill waste as a brick making material will deter the environmental effects of this waste disposal. Moreover, its adoption will not only solve the problem of stocked waste piles but also scale down the usage of natural soil as a brick making material.

IET Intelligent Transport Systems

Research Article

Video-based road traffic monitoring and prediction using dynamic Bayesian networks

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Abstract: The varied road conditions, chaotic and unstructured traffic, lack of lane discipline and wide variety of vehicles in countries like India, Pakistan and so on pose a need for a novel traffic monitoring system. In this study, the authors propose a novel camera-based traffic monitoring and prediction scheme without identifying or tracking vehicles. Spatial interest points (SIPs) and spatio-temporal interest points (STIPs) are extracted from the video stream of road traffic. SIP represents the number of vehicles and STIP represents the number of moving vehicles. The distributions of these features are then classified using Gaussian mixture model. In the proposed method, they learn the road state pattern using dynamic Bayesian network and predict the future road traffic state within a specific time delay. The predicted road state information can be used for traffic planning. The proposed method is computationally light, yet very powerful and efficient. The algorithm is tested for different weather conditions as well. They have validated their algorithm using Synchro Studio simulator and got 95.7% as average accuracy and on real-time video we got an accuracy of 84%.

1 Introduction

Traffic congestion primarily occurs due to unknown factors like bad weather conditions, unexpected vehicular failure or a road accident. Hence, a continuous evaluation of the road traffic needs to be done to determine the congestion free paths as explained in [1, 2]. Unlike the conventional sensors used in road traffic monitoring like Auto scope, loop detectors and so on in [3], cameras provide the best technology to acquire the data in real time due to their higher sensing range. In this paper, we present a distributed camera network-based road traffic monitoring and prediction scheme.

The main aim of the proposed work is to classify and predict the state of the road in a real-time scenario, by using the video feed taken from the fixed cameras $C1$–$C7$ as shown in the sample network given in Fig. 1. This helps to reduce congestion, enhance public safety, improve travel and transit information, with the aim of benefiting the mankind. This method is suited for real-time application as it is computationally light and scalable. A sample road network is shown $R1, R2, \ldots, R7$ are different road links and $C1, C2, \ldots, C7$ are cameras for recording the activities on the road links, respectively. Computational complexity is reduced by classifying the road traffic using SIPs and STIPs. DBN (dynamic Bayesian network)-based learning and prediction scheme is used to accommodate the random nature of the road traffic.

Fig. 1 *Road Links*

Section 2 presents about the state-of-the-art and related work. In Section 2.1, we describe the contributions of the proposed work. In Section 3, the architecture and the feature extraction for the proposed algorithm are explained, which forms the base for learning and prediction techniques discussed in Section 3.3. Section 4 discusses the experimental results related to Synchro Studio traffic simulator and also real-time videos. Finally, paper is concluded in Section 5.

2 Related work

Traffic monitoring has been a research topic for a long time. The first image-based traffic monitoring scheme was introduced by Koller *et al.* [4]. Kalman filter and contour trackers were used for traffic scene analysis and classification. Beymer *et al.* [5] gave a twist by detecting non-recurring incidents on road and connecting it to traffic congestion on highways. In [6] feature-based method for detecting and tracking moving vehicles in real time is proposed. They track features which are less sensitive to partial occlusion. Even though the method worked for both day time and night time, the method was not suitable for real-time operation as it was less accurate, slower and requires larger storage space. In [7], vehicles are detected using background subtraction, binarisation, gradients and so on and classified road condition using rule-based reasoning. The computation involved in detecting vehicles is quite high and time consuming and hence the method is not suitable for real-time operation. Masoud *et al.* [1] proposed a vision-based system for monitoring traffic in weaving road sections. The system consists of three levels: a feature level, blob level and vehicle level detections. They used a simple rectangular patch together with a dynamic behaviour model to characterise a moving vehicle. They tracked vehicles using extended Kalman filter. In [8] the authors applied the snake model to extract the contours of vehicles, and then used these contours as the base for tracking vehicles. However, these features are very sensitive to occlusion, noise and ambient lighting conditions. Cheng *et al.* [9] developed a particle filter-based traffic estimation scheme which utilises hand off data. In order to implement this strategy, a cell phone is required for every vehicle, which sometime becomes impractical. Spatial interest points (SIPs) are simple to detect in road traffic image, Mikolajczyk and Schmid [10] described interest point detector invariant to scale and affine