International Conference
on
Recent Trends in Materials Science & Devices 2023
(ICRTMD-2023)

22 - 23 July, 2023

Online Conference
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(Affiliated to M.D. University, Rohtak, Haryana, India)

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About Conference

Aims:-

- To provide a platform for presenting research to an international and interdisciplinary audience.
- To help in establishing business or research relations and find global partners for future collaboration.
- The scientific programme will highlight the latest advances in materials research.
- To acquire deep theoretical and experimental knowledge from young researchers and experts.

Outcomes:-

- Exposure to International Research & Development.
- Opportunity to collaborate leading researchers around the globe.
- Full-length research papers will be published in Google Scholar Indexed Open Access Journals of Research Plateau Publishers and SCOPUS Indexed Journal – Materials Protection (Publisher: Engineers Society of Corrosion, Belgrade).
- Proceedings of all abstracts will be published online.

Themes of Conference (but not limited to)

- Materials Science & Engineering
- Ceramics, Glasses & Composite Materials
- Advanced Nanomaterials
- Surfaces, Coatings & Films
- Emerging Areas of Materials Science
- Nanoengineering & its Applications
- Carbon Nanostructures including Carbon Nanotubes and Graphenes
- Electrical, Optical & Magnetic Materials
- Corrosion Engineering & Corrosion Protection
- Functional Materials
- Polymers Science & Nano Engineering
- Nanorobotics & Nanomanufacturing
- Nano-biomedicine
- Nanofabrication
- Nano-optics, Nanophotonics
- Nano-optoelectronics
- Spintronics
- Nanoelectronics: Emerging material and device challenges in futuristic system biosensors & Nanoactuatuators
- Nanomaterials
- Nanometrology & Characterization
- Nanodiamond and nanocarbon structures: materials & devices Education in nanotechnology
- Modeling & Simulation
- Nanopackaging
- Nanomagnetics
- Nanoenergy, Environment & Safety
- Nanoscale Communications & Nanonetworks
- Nano-acoustic Devices,
- Processes & Materials
- Quantum, Neuromorphic & Unconventional Computing
- Emerging Plasma Nanotechnologies
- MEMS/NEMS
- DNA Nanotechnology
- Nano-fluidics and integrated bio-chips
- Nanotechnology Ethics

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Chief Guest's Message

It is a matter of great pride and honor that Research Plateau Publishers and G.A.V. Degree College, Patauda (Jhajjar) Haryana, India are jointly organizing the "International Conference on Recent Trends in Materials Science & Devices 2023 (ICRTMD 2023)" from July 22 to 23, 2023 in online mode.

The conference aims at providing a stimulating forum for eminent scholars from different branches of basic sciences: Physics, Chemistry, Statistics and Mathematics, and advancing the outcome of R&D in these areas from laboratory to practical devices, providing opportunity for the participants to interact with eminent researchers and to develop potential collaborative partnership. The conference also provides a forum for young aspirants to grow with their own start-ups for the overall development of research world.

Further, I am pleased to note that faculty and researchers from various reputed Universities, Colleges and Research Organizations across the globe are presenting their research papers on varied interdisciplinary topics of Materials Science & Engineering. I am sure that this International Conference would pave way for scientists, researchers, faculty members and young professionals which will unfold further opportunities and leads to new research developments.

I would like to commend the efforts put in by team ICRTMD 2023 and appreciate the invaluable contribution of all the lead speakers participating from India and abroad from scientific organizations and academia.

In the end, I wish ICRTMD 2023 a grand success.

DSHooda

D.S. Hooda

Mr. Ashok Sharma

Founder

G.A.V. Degree College,

Jhajjar, Haryana, India

Patron's Message

I greatly appreciate the untiring efforts from Research Plateau Publishers and G.A.V. Degree College, Pataudа (Jhajjar) Haryana, India for jointly organizing the "International Conference on Recent Trends in Materials Science & Devices 2023 (ICRTMD 2023)" from July 22 to 23, 2023 in online mode.
ICRTMD 2023 will provide a unique platform to all stakeholders to have intensive and brainstorming in the area. I extend my hearty welcome to all eminent speakers, distinguished subject experts and wrthy participants from various national and international universities, institutions and research establishments. I am sure that their deliberations on such an important area would pave the way for forging bonds and mutual cooperation, undertaking joint projects and joint publications for achieving long-term goals and establishing significant and long-term contacts for mutual benefits. It will be an enriching experience for brilliant faculty members, scientists, research scholars and students and other participants.
I extend my sincere appreciation to all distinguished members of International/National Advisory Committee for their valuable guidance. I extend a warm welcome to all the participants of ICRTMD 2023 and convey my best wishes for the success of the event.

Mr. Ashok Sharma

Dr. Amrita Hooda

Founder

Research Plateau Publishers,

Jhajjjar (Haryana), India

Organizing Secretary's Message

It is a great honour that Research Plateau Publishers and G.A.V. Degree College, Patauda (Jhajjar) Haryana, India are jointly organizing the "International Conference on Recent Trends in Materials Science & Devices 2023 (ICRTMD 2023)" from July 22 to 23, 2023 in online mode.

The conference aims at providing a common forum for eminent scientists, technologists, entrepreneurs and scholars from various disciplines such as Physics, Chemistry, Material Science and Mathematics to present their work and discuss the latest advances and innovations in this exciting area of research.

When addressing societal challenges, the scientific world must strike the right balance between supporting research in all scientific areas and creating opportunities for both large-scale and small-scale projects that break through disciplinary boundaries. In the modern era, interdisciplinary research is the key to future innovations. From such funders to journal editors, policymakers to think tanks all seem to agree that the future of research lies outside firm disciplinary boundaries.

The "International Conference on Recent Trends in Materials Science & Devices 2023 (ICRTMD 2023)" is being organized to bring together academicians, scientists and industrialists from various fields for the establishment of enduring connections to solve the common global challenges across a number of disciplines. The conference would be a platform to tackle complex problems from a range of perspectives, thereby modeling integrated, solution-focused thinking and partnerships.

I am sure that this conference would be thought provoking and lead to germination of new ideas.

I wish the conference a great success.

Dr. Amrita Hooda

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Keynote Talks

Human Nanomedicine: Real Clinical Trial Results with Nanomaterials

Thomas J. Webster
Interstellar Therapeutics, Mansfield, MA USA; School of Health Sciences and Biomedical Engineering, Hebei University of Technology, Tianjin, China; School of Engineering, Saveetha University, Chennai, India; Program in Materials Sciences, UFPI, Teresina, Brazil

Abstract

Nanomaterials have been widely tested in vitro and in small order animal studies for decades. Results have shown greater tissue growth, decreased bacteria growth, and inhibited inflammation. However, few studies exist examining human tissue response to nanomaterials. This presentation presents a cohort study of nano implants inserted into humans. In particular, one study includes the implantation of nanotextured spinal implants into over 14,000 patients over the past 5 years. Results demonstrated no cases of infections or other implant failures which is significantly better than statistics on conventional spinal implants which can have up to 20% failure rates. This study will further explain that nano implants mimic the natural nano texture of bone itself and possess surface energy that can competitively increase the adsorption of proteins known to promote osteoblast (bone forming cells) functions, decrease bacteria functions, and limit inflammatory cell functions. As such, this presentation will cover the few human clinical studies on nano implants showing improved human health.

Keywords: Nanomaterials; Infection; Clinical Trials.

Molecular Spin Qubits for Quantum Computer and High-Density Memry Devices Based on Molecular Magnets

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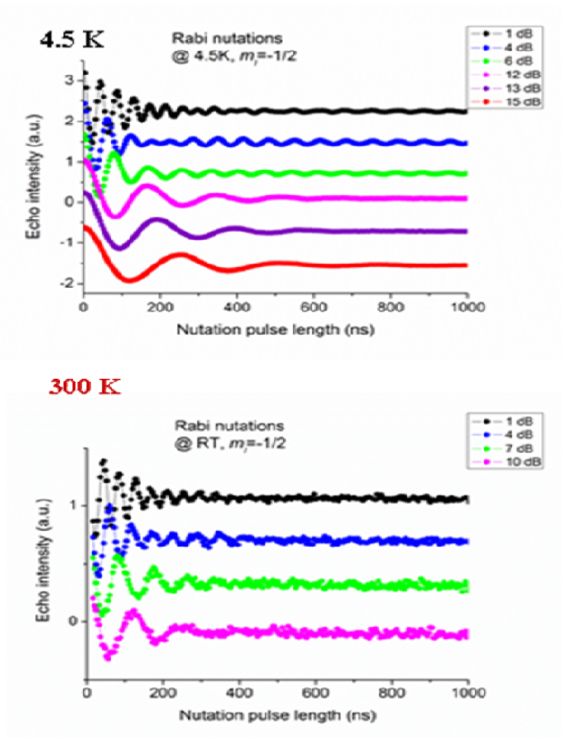
Abstract

Spintronics, based on the freedoms of charge and spin of the electron, is a key technology in the 21st century. Magnetic random access memory (MRAM), which uses giant magnetoresistance (GMR), has several advantages compared with electronics. Although conventional magnets composed of transition metals are normally used, in our study, we use single-molecule magnets (SMMs) to overcome "Moore`s Limitation". SMMs are also available for quantum computer. I will talk about the molecular spin qubits for quantum computer as well as high-density memory devices such as single-molecule memory device, SMMs encapsulated into SWCNT, and metallic conducting SMMs with negative magnetoresistances.



As for molecular spin qubits for quantum computer, we must increase T_1 (spin-lattice relaxation time) and T_2 (spin-spin relaxation time). Therefore, we will focus on the following three strategies:(1) Crystal Engineering Method; To compare 0D [VO(TPP)] and 3D [VO(TCPP-Zn_2-bpy)] (3D-MOF) to investigate the influence of the spin-lattice relaxation (T_1) in 0D and 3D lattices. Due to the rigid lattice of 3D-MOF, the Rabi nutation was observed even at room temperature (Fig.1). (2) g-Tensor Engineering Method; To compare [VO(TPP) and [CrN(TPP)] to investigate the contribution of the anisotropy of their g-values for the spin relaxation. Due to the large anisotropy of g-values, [CrN(TPP)] shows the short life time. (3) Orbital Engineering Method; To compare [Ni(cyclam)X_2]ClO_4 and TBA[Ni$(mnt)_2$] to investigate the relationship between the different occupied orbitals and spin relaxation. [Ni(cyclam)X_2]ClO_4 has the longer life time due to the rigid molecular structure.

As for the single molecule memory, we have used STM and STS for $TbPc_2$ SMM. By using tunnelling magnetoresistance, we have realized the single memory effect of up-spin and down-spin on $TbPc_2$. As for the negative magnetoresistances for high-density memory devices, we have synthesized $(BEDO\text{-}TTF)_3[Co(pmdt)_2]$ (BO3) and $(BEDO\text{-}TTF)_4[Co(pmdt)_2]$ (BO4). BO3 show the metallic behavior around room temperature and M-I transition around 12K. Moreover, BO3 shows the negative magnetoresistance for the first time by the interaction between conducting electron and SMMs. We have succeeded the encapsulation of $DySc_2N@C_{80}$ SMMs into Single-Walled Carbon Nanotubes (SWCNTs). After encapsulation, the coercivity increase by one order by suppression of the quantum tunnelling.

ICRTMD-2023/KT/MS 006

Layered Semiconducting Materials for Energy Applications

Ram K. Gupta
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Abstract

The demand for energy is increasing daily. Many electronic devices and transportation system requires efficient, lightweight, and cost-effective materials for energy production and storage devices. Batteries, supercapacitors, and fuel cells are some of the emerging energy devices to meet the growing demand for energy. Many of these devices use materials that are costly and not efficient. Layered materials such as graphene and chalcogenides are attracting considerable attention for these applications. They can be used for energy production as well as for energy storage applications. Their properties can be tuned to make them more efficient for such applications. This keynote talk will discuss various types of layered materials, their chemistries, and their electrochemical properties. Various approaches to tune their electrochemical and electrocatalytic properties will be discussed. Their main applications as electrocatalysts for water splitting and energy storage devices will be explored.

Engineered Fluorescent Ag-Cu Nanohybrids for Upcoming Biomedicine

S. K. Ghoshal
Physics Department and Laser Center, Faculty of Science, Universiti Teknologi Malaysia

Abstract

Demand of diverse biocompatible nanomaterials with customized physiochemical properties is ever-growing. In contrast to their bulk or macroscale counterparts, various important characteristics of tiny nanoparticles (size less than 100 nm) such as safety, stability, biocompatibility, eco-friendliness, fluorescence, low-cost, chemical inertness, bioactivity, durability, etc. make them advantageous for widespread practical applications. Our studies revealed that strong LSPR of Ag and Cu nanoparticles and unique physicochemical attributes of Ag-Cu nanoshells can be beneficial for the pharmaceutical drug formulation and biomolecular vectorization. The morphology (size and shape) and chemical structures of these organic/inorganic nanoshells can considerably influence their stability, reactivity, biocompatibility, optical and electronic behavior. Accordingly, these emerging attributes may be useful for drugs delivery and cure of various human diseases. However, many drawbacks involving the conventional methods of Ag-Cu nanoshells synthesis with tailored physicochemical features like the requirement of extra chemical precursors (toxic and expensive), prolonged reaction duration, high energy cost and intricate processing conditions must be surmounted. Based on these factors, new types of crystalline and spherical Ag-Cu nanoshells with strong fluorescence and LSPR absorption were produced using PLAL approach. The structure, morphology, and fluorescence properties of these NCs were engineered via the laser fluence tuning. The results displayed that the nanoshells grown at optimum laser fluence has very narrow particle size distribution and high fluorescence quantum yield. In addition, exciton-like energy states (originated from quantum size effects) and unique morphology-induced electronic transitions in the proposed fluorescent nanoshells were demonstrated to be favorable for sundry biomedical uses, especially in the improved fluorescence-based therapy and drug design.

Chiroptical Spectroscopy: Instrumentation and Applications

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Abstract

Chiroptical spectroscopy is exploring the interaction of chiral structureswith polarized light and provides the differential optical responses. Chirality is an intrinsic property of many natural material including the building blocks of life such as DNA/RNAand otherslike sugar, quartz, and cholesteric liquid crystals.

Various chiroptical spectroscopic methods like circular dichroism (CD),optical rotatory dispersion (ORD) and fluorescence detected circular dichroism (FDCD) have so far played an important role in pharmaceutical, chemical, andoptoelectronic industry.Circularly polarized luminescence (CPL) is a promising approach to directly generate circularly polarized light from chiral luminophore. This technique hasmany applications in future displays devices like organic light emitting diodes (OLED) and photonic technologies.

This talk is aims to provide comprehensive coverage of the most important state of the art chiroptical spectroscopy instruments, basic principles,and their applications.

Keywords: Circular dichroism (CD); Fluorescence detected circular dichroism (FDCD); Optical rotatory dispersion (ORD); Circularly polarized luminescence (CPL); Organic light emitting diodes (OLED).

AlGaN/GaN HEMT basedHeavy Metal Ion Sensors for Smart Water Quality Monitoring

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Abstract

The group III nitride semiconductor devices like AlGaN/GaN high electron mobility transistors (HEMT) have become the most emerging candidates in the last two and half decades. The 2DEG forms at the AlGaN/GaN heterointerface without applying an external electric field, which makes AlGaN/GaN HEMTs normally ON devices.There are surface states on the AlGaN/ GaN High Electron Mobility Transistor due to the availability of dangling bonds at the surface. These surface states have a significant impact on the 2DEG. By using this phenomenon, the AlGaN/GaN HEMT are utilized for the detection of toxic heavy metal ions in water.The quick and easy monitoring of heavy metals in drinking water is utmost important due to their harmful effects on human health.

AlGaN/GaN HEMTs with functionalized gate areas were fabricated for sensitive and selective detection of heavy metal ions such lead, and mercury.In order to study the presence of Pb^{2+} metal ions in water, the fabricated GaN HEMT sensor's gate region was functionalized using graphitic carbon nitride (g-C_3N_4) nanosheets. The limit of detection (LoD) of the g-C_3N_4functionalized sensor, obtained a sensitivity of about 0.46µA/ppb and 0.32 ppb as lowest limit which is substantially lower than the permissible limit as set by W.H.O.In another work on Pb^{2+} ion detection, the fabrication of AlGaN/GaN HEMT was carried out for the detection of toxic lead ions in the water by functionalization of the Au-gated region by the 2,5-dimercapto-1,3,4-thiadiazole (DMTD). The sensor reaches the lower detection limit of 0.018 ppb. It exhibits a rapid response time of ~ 4 seconds and high sensitivity of 0.607 µA/ppb. Moreover, a study for the selectivity analysis is performed, and it is found that the sensor is highly selective towards Pb^{2+} ions.In another interesting work, we developed a sensor for highly sensitive, selective, and rapid determination of the trace amount of Hg^{2+} ions using molybdenum disulfide (MoS_2) functionalized AlGaN/ GaN HEMT.The sensor showed an excellent sensitivity of 0.64 µA/ppb and an ultra-low-level detection limit of 0.01152 ppb or 11.52 ppt (parts per trillion) with a rapid response time of 1.8 s. Moreover, the sensor exhibits the linear range of detection from 0.1 ppb to 100 ppb and highly selective behavior towards Hg^{2+} ions. To further enhance the sensitivity, we have successfully demonstrated the detection of Hg^{2+} ions using MoS_2 functionalized AlGaN/GaN HEMT under UV illumination which showed an extremely high sensitivity of 548.07uA/ppb with a lower detection limit of 6.15 ppt. In our another work, we observed that the fabricated sensor after functionalization with Ag-MoS_2 ensured faster electron transfer kinetics and showed out remarkable sensitivity of 1.6 mA/ppb and limit of detection (LoD) of upto 20 ppt. Along with the detection on real time water samples from lake water, a proof of concept by enabling it with IoT interface was also demonstrated. Hence, the development and performance of the AlGaN/GaN HEMT based ion sensors suggest that these sensors have a huge potential for other heavy metal ion sensing applications.

Memristors and Spintronics for Future Computing Era

Piyush Dua
University of Technology and Applied Sciences, Suhar, Oman

Abstract

Memristor is fourth passive component as resistor, capacitor and inductor. It has been well established fact that memristance does present in all the devices but due to the relatively large dimensions of the active area of the device the magnitude of memristance would be negligible. But when we enter in the era of nano-devices the magnitude of the memristor becomes significant and can no longer be ignored in comparison to other counterpart quantities such as resistance. At the moment, memristors are being explored for various applications such as low power memory devices, neural networks &neuromorphic systems, crossbar latches as transistor replacement, nano-electronics devices for classical, hardware security and quantum computing.

In Computational Materials Science, the problems of the getting the optimized structure in a stipulated time with high level of accuracy may be resolved by using high performance computing with parallel processing. Another way is to use memristors based computing, spintronics based computing, neuromorphic computing and/or quantum computing. The second is a smarter route in such a way which requires less time with high accuracy. On the other hand Moore's law is moving towards saturation, where increasing the transistors would become a challenge. Another way is to increase the performance by altering the materials of the components to reduce the power consumptions using the strength of the materials at quantum level. Because computing resources with separate memory and processing unit is an obstacle. The strength of memristors/memristor materials would be highlighted with real time applications. The work would conscript the future of memristors/memristive devices in addition to the existing applications. The challenges and limitations in regards to properties of materials required to enhance the performance of memristive materials/devices would also be addressed. Use of memristors for technologies such as artificial intelligence and its applications would also be addressed.

Materials Science and Materials Engineering: An Introduction

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Abstract

Now a days, it is useful to subdivide the discipline of materials science and engineering into materials science and materials engineering subdisciplines. Strictly speaking, “materials science” involves investigating the relationships that exist between the structures, properties andapplications of materials. In contrast, “materials engineering” is, on the basis of these structure–property correlations, designing or engineering the structure of a material to produce a predetermined set of properties. From a functional perspective, the role of a materials scientist is to develop or synthesize new materials, whereas a materials engineer is called upon to create new products or systems using existing materials, and/or to develop techniques for processing materials. Most graduates, postgraduates and Doctorate in materials programs are trained to be both materials scientists and materials engineers.

The development of many technologies that make our existence so comfortable has been intimately associated with the accessibility of suitable materials. An advancement in the understanding of a material type is often the forerunner to the stepwise progression of a technology. For example, sophisticated electronic devices rely on components that are made from what are called semiconducting materials.In our contemporary era,humidity sensor gas sensor would not have been possible without the availability of inexpensive hybrid mesoporous nanocomposites or some other comparable substitute. In this investigation Metal oxides has been chosen due to its excellent response in chemical sensing. The structure of mesoporous stayed intact with the incorporation of Metal into the mesoporous framework. This astonishing sensing applications proves the mesoporous hybrid nanocomposites a good candidate for innovative, efficient high performance humidity sensor.

Keywords*:* Metal oxide; Hybrid Nanocomposite; sensor; mesoporous.

Effectiveness of high-energy planetary ball millingon synthesizing alternative cost-effective 2D carbon nanofillers from natural graphite

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National Institute of Technology, Silchar

Abstract

The synthesis of alternative cost-effective 2D carbon nanofillers from natural graphite holds significant potential for various applications, including energy storage, electronics, and composite materials. The study employed natural graphite as the precursor material and systematically varied key milling parameters such as milling time, milling speed, and mainly with and without dispersing agent. The synthesized nanofillers were characterized using various techniques, X-ray diffraction, and Particle size distribution, including FESEM to evaluate their size, structure, and morphology.The results demonstrate that the high-energy planetary ball mill effectively exfoliates the natural graphite and produces 2D carbon nanofillers. By optimizing the milling parameters, the size, thickness, and structural integrity of the nanofillers can be controlled, leading to consistent performance. The influence of different parameters on the nanofiller's characteristics was thoroughly investigated, providing valuable insights for process optimization.Herein a noteworthy size reduction is achieved via wet-balling for the BMG ranging from 227-217 nm.Furthermore, the cost-effectiveness of this synthesis approach is evaluated by considering the scalability and feasibility of the high-energy planetary ball mill. The research explores the economic aspects associated with the production of large quantities of 2D carbon nanofillers from natural graphite and discusses potential strategies for reducing manufacturing costs and time. Overall, this study highlights the significance of the high-energy planetary ball mill as a versatile tool for synthesizing cost-effective 2D carbon nanofillers from natural graphite. The findings offer valuable information and guidance for researchers and industries seeking to develop alternative carbon nanofillers with consistent performance and enhanced affordability for various applications.

Keywords: Ball milling, Milled graphite nanoparticles; Oxidation; Silane functionalization; FESEM.

Inhibition of corrosion of mild steel in simulated concrete pore solution prepared in sea water by an aqueous extract of apple juice"- A Case Study

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Abstract

The inhibition efficiency of an aqueous extract of apple juice in controlling corrosion of mild steel immersed in simulated concrete pore solution (SCPS) prepared in sea water, has been evaluated by weight loss method. Langmuir adsorption isotherm has been investigated. The mechanistic aspect of corrosion inhibition has been investigated by Electrochemical impedance spectra (AC impedance spectra). The protective film has been analysed by Fluorescence spectroscopy, FTIR spectroscopy and AFM. The SCPS system offers 60% inhibition efficiency to mild steel immersed in sea water. In presence of apple juice extract the inhibition efficiency increases as the concentration of the extract increases. When 10 ml of extract is added, 85% inhibition efficiency is obtained. Electrochemical impedance spectra (AC impedance spectra) reveal that a protective film is formed on the metal surface. In the presence of inhibitor system, charge transfer resistance value increases, impedance value increases, phase angle value increases whereas double layer capacitance value decreases as expected. The FTIR spectral study reveals that the protective film consists of complexes consisting of iron-active principles of the apple juice extract. AFM study reveals that when the inhibition efficiency increases the roughness of the surface decreases or in other words the smoothness of the system increases.

Keywords: corrosion inhibition; mild steel I; simulated concrete pore solution; sea water; an aqueous extract of apple juice; electrochemical studies; FTIR; Fluorescence spectroscopy; AFM.

Invited Talks

A novel Nano porous Cermet for the treatment of wastewater

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Abstract

The nano porous activated cermet (NPAC) was obtained by precarbonization and activation of rice bran using phosphoric acid. The activated cermet was characterized with the help of N_2-adsorption/desorption, FT-IR and scanning electron microscope and Transmission Electron Microscopy to determine surface area, functional groups, surface morphology and lattice plane arrangements respectively. The electrical conductivity of NPAC, measured by two-probe method was 2.02×10^{-3} Scm^{-1}. The energy gap value of the NPAC was 0.052eV. The NPAC was characterized using electron spin resonance and X-ray diffraction for quantitative evaluation of free electrons and crystallites to support the mechanism of electrical conduction in NPAC. The NPAC sample was tested for its capacity to generate hydroxyl radicals on integration with molecular oxygen abstracted from air. NPAC sample was tested for its efficiency to treat municipal wastewater and industrial wastewater discharged from leather, Textile, Chemical and Pharmaceutical industries without sludge production.

Keywords: Rice bran; Nano porous activated cermet; Hydroxyl radical; Oxygen; Municiapl and Industrial wastewater.

Green synthesis of a novel porous gold-curcumin nanocomposite for super-efficient alcohol oxidation

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Abstract

Gold nanoparticles (AuNPs) possess tunable size- and shape-dependent properties that are ideal for catalytic properties for many applications. However, the challenge lies in the synthesis of highly stable and ultra-small NPs. We report an energy-efficient galvanostatic route to engineer gold-curcumin (Au-CM) nanocomposites constituting small-sized (~2 nm) AuNPs enveloped by a porous network of curcumin. During electrolytic deposition, the in situ formed Au-CM complexes are the key for the low current involved in our electrosynthesis, which ultimately deposits as CM-enveloped AuNPs at the cathode (Au-CM/GCE). The DFT study also presented high binding energy (18.76 eV) of Au-CM complex in the solvent phase. The Au-CM/GCE nanocomposite exhibited excellent stability (~200 cycles), facile electron transfer ability, catalytic activity, and low Arrhenius energy of 42 and 45 kJ mol−1, respectively, towards electrooxidation of EtOH and MeOH in alkaline medium. The oxidation kinetics are comparable to those of the best gold-polymer composites. This study points the way for one-pot green synthesis of other engineered electrocatalysts for different applications.

Keywords: Electrosynthesis; Curcumin; Gold nanoparticles; Ethanol/methanol oxidation.

Hot carrier effects on threshold and amplification characteristics of Brillouin scattered Stokes mode in semiconductor magneto-plasmas

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Abstract

Brillouin amplification is a nonlinear optical phenomenon where a low frequency (acoustical vibrational) mode induces an inelastic scattering of a higher frequency pump wave in an optical medium in the nonlinear regime. As a result of this, another signal is produced, with the surplus energy resonantly passed to the vibrational states of the medium. This process, as with other stimulated emission processes, allows all-optical amplification. Brillouin amplification is well known for its important applications in modern optics. We develop a theoretical formulation followed by numerical analysis to study the HCEs on the threshold condition for the onset of Brillouin amplification and the parameters characterizing Brillouin amplification in semiconductor magneto-plasmas. The nonlinear mechanisms taken are: (i) the scattering of pump wave by the perturbed carrier density, and (ii) the nonlinear induced polarization that is the cause of nonlinear coupling between pump wave and acoustical vibrational mode. The threshold condition for the onset of Brillouin amplification and the parameters characterizing Brillouin amplification (viz. Brillouin amplification coefficient, transmitted intensity of Brillouin scattered Stokes mode, and Brillouin cell efficiency) of the Brillouin cell are estimated. Numerical analysis is made for three different Brillouin cells (consisting of n-InSb, n-GaAs and n-CdS) at illuminated by a pulsed CO_2 laser. HCEs of intense pump beam modifies the momentum transfer collision frequency of carriers and consequently the nonlinearity of the Brillouin medium, which in turn (i) lowers the threshold intensity, (ii) enhances the parameters characterizing Brillouin amplification, (iii) shifts the enhanced Brillouin gain spectrum towards smaller values of magnetic field, and (iv) widens the range of magnetic field at which peak of Brillouin gain spectrum (around resonance) occurs. The incorporation of HCEs in the analysis lead to better understanding of laser-plasma interactions and validate the selection of appropriate Brillouin medium for the fabrication of efficient Brillouin amplifiers.

Keywords: Hot carrier effects; Stimulated Brillouin scattering; Semiconductor plasmas.

Development of magnetically recyclable visible light photocatalysts for H_2O_2 production

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Abstract

The development of recyclable H_2O_2-producing photocatalysts with in-situ Fenton-like organic pollutant degradation is currently a topical area of research. This presentation is about recent investigations by our group on the visible light photocatalytic formation of H_2O_2 on Ag/$CuWO_4$/$NiFe_2O_4$and Ag/s-(Co_3O_4/$NiFe_2O_4$) composites. Components for photocatalyst construction were chosen using band positions and oxygen adsorption properties. Large-scale molecular dynamics simulations were used to investigate the affinity of a component surface towards oxygen adsorption in an aqueous medium. Appropriate scavenger experiments and molecular dynamics results point to a Z-scheme mechanism. Substantial H_2O_2 formation occurred on continuous oxygen-passing through the aqueous reaction medium under visible light irradiation in pure water. The generated H_2O_2 successfully degraded tetracycline by an in-situ (heterogeneous) Fenton-like reaction. H_2O_2 production on this photocatalyst was tested under various control conditions. The presence of an electron donor further enhanced both H2O2 production and tetracycline degradation rates.

Keywords: H_2O_2 production; magnetically recyclable; composite photocatalyst; molecular dynamics.

Study of life cycle of stars

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Abstract

This research paper explores the life cycle of stars, beginning with their formation and ending with their final stages. The paper describes the various stages of a star's life, including the pre-main sequence, main sequence, red giant, planetary nebula, and white dwarf phases. The paper explains how the Hertzsprung-Russell (HR) Diagram is used to classify stars based on their luminosity and temperature. The paper also describes various mathematical models of star formation, including the Jeans instability model and the turbulence model. The paper explains how these models provide insights into the physical processes that lead to the formation of stars, such as gravitational collapse and fragmentation. Finally, the paper discusses future prospects for the study of star formation and evolution. The paper highlights the importance of ongoing research efforts in understanding the formation and evolution of stars, and how this research can provide insights into fundamental questions in astrophysics. Overall, this research paper provides a comprehensive overview of the life cycle of stars and the mathematical models that are used to study their formation and evolution.

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Modification of optical properties of ferrites: A comparative study of rare earth doping versus swift heavy ion irradiation

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Abstract

Ferrites are magnetic materials with spinel structure. They are significant due to their diverse properties which make them applicable in many fields such as medical diagnosis, electronic industry, automobile, military applications, etc. The properties of ferrites depend upon the synthesis method, temperature, cation distribution, doping with various metal ions etc. Alternatively, Swift Heavy Ion Irradiation is also a unique tool to modify the properties of material. The current research work is focused on the study of doping effect of rare earth ions (Ce and Gd) and 100 MeV oxygen ion irradiation on the structural and optical properties of nickel ferrite thin films. The samples used are thin films prepared by pulsed laser deposition technique. Structural and optical properties were investigated using XRD and UV-Vis Spectroscopy. The cubic spinel structure of pristine and irradiated samples was confirmed by XRD. After irradiation at lower fluence , pure and Ce doped nickel ferrite thin films exhibit some impurity which vanishes at higher fluence whereas Gd doped films remain in pure phase. The direct band gap calculated from reflectance spectra was found to increases with rare earth ion doping. The band gap in nickel ferrite thin films increased with fluence of irradiation, however there was no significant change in band gap in rare earth doped nickel ferrite thin films. Both structural and optical studies indicate that Gd doping has enhanced the resistivity of nickel ferrite thin films towards irradiation induced changes in comparison to Ce doping. Swift heavy ion irradiation was found to be an effective tool for modifying optical properties of ferrites in comparison to rare earth ion doping.

Keywords: Ferrite, Swift Heavy Ion Irradiation, UV-Vis Spectroscopy, XRD.

Ferrite and garnet nanomaterials for magnetic and spintronics applications

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Abstract

In recent years, magnetic materials have gained much attention because of their use in spintronics, biomedical, industrial, and other technological fields. Magnetic nanoparticles have gained a lot of interest in the last two decades due to their interesting properties. In this paper, we report the size-dependent structural and magnetic properties ofspinel ferrite and garnet nanoparticles synthesized by the citrate combustion method. $ZnFe_2O_4$ and its mixed ferrite confirm the spinel cubic phase in samples treated at 600℃ and 1200℃. The Curie temperature was higher for nanomaterials as compared to their bulk counterpart. Structural and magnetic properties of a series of powders of $Y_3Fe_{5-x}Ni_xO_{12}$ (x = 0, 0.05, 0.10, and 0.2) are presented in this paper. The nanopowders were synthesized by using the citrate combustion method and calcined at 800°C and 1000°C for 3 hours. Grain sizes were found to be in the nanometre range, confirmed by the scanning electron micrographs (SEM). Magnetic results exhibit the soft magnetic nature of these particles confirmed by the M-H curves. Saturation magnetization was decreased on Ni substitution whereas there was no remarkable change in coercivity. Curie temperature (T_c) was around 560 K and decreases slightly with Ni substitution due to the changes in magnetic exchange interactions among different sites. These properties have different magnetic applications.

Keywords: Magnetic nanoparticles, spinel ferrite, garnets, magnetic transition temperature.

Synthesis and characterization of electroplated CoFe-Cu multilayer nanowires embedded into the pores of alumina template

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Abstract

Ferromagnetic multilayer nanowires are of considerable interest due to the change of resistance caused by the spin dependent scattering phenomena resulting from the relative orientation of the magnetization in successive ferromagnetic layers. Such multilayer nanowires have potential application in magnetic storage devices such as in hard disks, read heads, data storage and magnetic sensors due to their reduced size, low weight, less power consumption, and low cost in the current technologies. CoFe-Cu multilayered are fabricated by pulse electroplating into the pores of ~ 100 nm diameter anodized aluminum oxide (AAO) templates by varying the magnetic layer thickness using the pulse time t_{CoFe} 10 s, 13 s and 16 s, while keeping the non-magnetic layer thickness constant (t_{Cu}= 30 s). The uniformity, continuity and density of the nanowires is confirmed by scanning electron microscopy and transmission electron microscopy. It is observed in TEM that multilayer stacking is formed by increasing the deposition time of CoFe. The composition of the nanowires measured by EDX line scan along the axis of single nanowire indicates the presence of 10-15% Co, 0-5% Fe and 75-80% Cu, respectively. Magnetic measurements revealed a variation of coercivity with the change of temperature. The increase in coercivity of the nanowires at low temperature is associated with the freezing of thermal fluctuations.

Keywords: Ferromagnetic, nanowires, electroplating, alumina template, coercivity.

Enhancement in the ferromagnetic τ-phase of the MnAl thin films by ion beam irradiation

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Abstract

The τ-phase MnAlalloy has a wide range of applications from generators, electric motors to high-density magneticstorage devices due to its high Curie transition temperature, large saturation magnetization, and large magneticanisotropy.The structural and magnetic properties of alloy thin films can be tailored by the ion beam irradiation technique. In the present study, we report the effects of two different kinds of irradiations (400 keV Xe, and 100 MeVAg ions)on the structural and magnetic properties of Mn/Al bilayer thin films.Mn/Al bilayer thin films were deposited on silicon substrates by the evaporation technique for a thickness of ~97 nm. These as-deposited films were divided into two sets. The first set of bilayer thin films was irradiated by 400keV Xe ions. While the second set of bilayer thin films was irradiated by 100 MeV Ag ions.The structural, microstructural, and magnetic properties of these irradiated Mn/Al bilayer thin films were investigated. The ferromagnetic τ-phase was enhanced in both types of irradiated thin films confirmed by synchrotron X-ray diffraction patterns, MFM images, and magnetic hysteresis curves.This study suggests that the ferromagnetic propertiesof MnAl thin films can be modified by selecting the properirradiation conditions tomake them useful for applications in spintronics and magnetic memory devices.

Keywords: MnAl thin films; τ-phase; Perpendicular magnetic anisotropy; Ferromagnetism; Ion beam irradiation.

Novel Al-layered double hydroxide (Al-LDH) loaded polyurethane (PU) foam polymer nanocomposite for efficient photocatalytic degradation of textile dyes

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Abstract

Organic dyes present in the textile effluents causes major threat to the aquatic life due to its toxicity, non-biodegradability and carcinogenic nature. Hence it is very important to remove these dyes from the effluent using some advanced materials. In this work, we have proposed a novel nanomaterial (Al-LDH) blended with polyurethane (PU) foam for the removal of various dyes such as methyl violet, erichrome black T and methyl orange from synthetic textile effluent. Al-LDH loaded PU foam polymer nanocomposite was successfully synthesized by adding Al-LDH nanosheets at varying concentrations (0.2 g, 0.6 g, and 1.2 g) in the foaming blend. The synthesized polymer nanocomposite was characterized using FTIR, FESEM, EDAX, XRD bulk density and sol fraction. Degradation of the dyes from an aqueous synthetic textile effluent was carried out using Al-LDH loaded PU foams under UV irradiation and measured using UV-Vis spectrophotometer. Pure Al-LDH nanoparticles and Al-LDH-loaded PU foam were successfully used to degrade dyes under UV irradiation by simultaneous degradation (due to Al-LDH nanoparticles) and adsorption (due to PU foam). Almost 99.9 % degradation of dyes was observed in a span of 3 hours.

Keywords: Al-LDH nanosheets; polyurethane foams; degradation; dye; photocatalysis.

Co-catalyst coupled engineered TiO_2 nanostructure photoanode for solar energy

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Abstract

Photoelectrochemical (PEC) water splitting is a promising environment friendly and economic approach to harvest solar energy and to produce solar fuel. Although, TiO_2 has gained significant attention as the active functional oxide semiconductor photoanode, still poor light absorption and severe surface charge recombination are the key challenges with TiO_2 nanostructures based electrodes for PEC water splitting. On this backdrop, our study attempts to design efficient and durable co-catalyst coupled one dimensional (1D) TiO_2 photoelectrode. This work demonstrates the synthesis of Sb-doped TiO_2 NRs coupled with plasmonic Au nanoparticles and an earth abundant CoLa(OH)x catalyst for enhanced photocurrent and applied bias photoconversion efficiency. Integration of a suitable amount of the $LaCo(OH)_x$ OEC with Au/Sb-TiO_2 NRs significantly improves photocarrier separation, photogenerated charge transportation, and the surface photo-electrocatalytic reaction and reduces the charge transfer resistance, delivering above 10 mA/cm^2 photocurrent density at 2.06 V vs RHE and resulting in the enhanced photoelectrochemical (PEC) activity and photostability for water oxidation.

Keywords: Photoanode; solar fuel; co-catalyst; photoelectrochemical; water splitting.

A detailed analyses on factors affecting sensitivity of nanofluids

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Abstract

Nanofluids are among the best alternative working liquids in various heat transfer applications due to their unique features such as improved cooling performance and increased convection heat transfer. The present work investigates the onset of convective instabilities in a nanofluid layer under a small temperature difference. A set of partial differential equations based on conservation laws of mass, momentum, energy and nanoparticles for a horizontal nanofluid layer is considered. The system is disturbed slightly from its initial state and disturbances are assumed to vary as a trigonometric function of horizontal axis and exponentially with time. Numerical treatment on obtained analytical expression leads to some interesting and significant results. A substantial decrease in the thermal sensitivity of liquids is established due to the presence of nanoparticles.Viscosity of the liquid decreases stability of the system and interestingly it affects more through Brownian diffusion coefficient instead of thermophoretic property of particles. Size of particles enters in the result through Brownian diffusion only and contributes in increasing the instability of the system. The coefficient of thermal expansion participates largely in making the liquids more stable. Conductivity and density play contradictory roles in deciding the thermal sensitivity of the system.

Keywords: Nanofluid; natural instability; Rayleigh number; differential equations; physical properties.

Electron-phonon interaction and Chirality effect on some thermoelectric properties in graphene

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Abstract

Graphene has recently attracted much interest due to its excellent properties and potential use in nanoelectronic devices. Since the experimental realization of graphene, it has been one of the most favorite subjects, theoretically and experimentally, for the research community worldwide. Its uniqueness arises from the linear energy dispersion relation with zero effective mass of carriers, regarded as Dirac Fermions. The earlier reported results for thermoelectric properties such as phonon drag thermopower, and the energy loss rate have used the exact approximations for the conventional two-dimensional electron gas systems and neglected the chirality of graphene system, an essential property of charge carriers. Keeping this in mind, we have investigated the energy-dependent phonon drag thermopower and energy loss rate in graphene in the Bloch Gruneisen regime through coupling to acoustic phonons via the deformation potential in the Boltzmann transport equation approach. It is observed that the inclusion of chirality affects the temperature and carrier dependencies and drastically changes the order of the magnitude of the quantities involved. Furthermore, our investigations indicate a new temperature limit below which the obtained analytical results are valid and after which a reduction in phonon drag thermopower and the energy loss rate is observed, exhibiting a behavior different from the one shown by the conventional two-dimensional electron gas systems. The nonmonotonic temperature and carrier dependencies observation in graphene conforms to the experimental investigation.

Keywords: Graphene, chirality, electron-phonon interaction, thermoelectric properties, matrix element, Boltzmann transport approach.

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Decision making on optimal selection of nanomaterials

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Abstract

The nano world is dominating every spheres of product designing and manufacturing. The robust properties and nature of these nano materials make it an integrable part of every product. As the research on escavating nanomaterials from nature and production of nanomaterials are equally gearing up, the nanomaterials are growing in large numbers with varied properties. The production sectors are constrained with the challenges of making optimal decisions on selection of nano materials. To make the selection process more optimal, the mathematical based decision making methods are very essential. The field of decision science comprises several methods to make decisions on selecting nanomaterials. This research work will discourse and sketch the modalities of applying the decision making methods in making optimal selection of nanomaterials.

Keywords: Nanomaterials, decision making, optimality.

Tuning low frequency dielectric properties of flexible ternary polymer blend film by reinforcing Bio Ionic Liquid for application in field of green electronics

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Abstract

Biofriendly conducting polymeric blends and composites exhibiting high dielectric constant and dielectric loss are promising for applications as sensors,actuators, microwave absorbing materials, fuel cells and biomedical applications.A great deal of work is reported on using fillers such as conductive nanomaterials, bio ceramics, carbon nanotubes, graphene etc in blends of PVC,PVP, PMMA, PVA with conducting polymer(PPy, PANI) for enhancing conductivities, tailoring dielectric and electrical, thermal and surface properties of such polymeric materials. However, appropriate dispersion of such fillers in polymeric matrices remains technically challenging. In this regard Bio Ionic liquids (ILs) have emerged as a novel class of materials for the development of advanced multifunctional materials with astounding potential in applications in several areas due to their unique properties and functionalities. The combination of bio ILs with specific polymer blends opens the possibility to develop smart novel materials with different morphologies such as films, gels, membranes, fibers, with tailored functionality. Present work aims to explore the low and high frequency dielectric properties exhibited by free standing, flexible, biofriendly/biodegradable ternary polymer blend film of PVC-PVP-PPy reinforced with Choline acetate. The detailed analysis of low and high frequency dielectric properties authenticates that addition of choline acetate result in modifying the dielectric properties of ternary polymer blend film. The results show that one can tune the dielectric constant, loss factor and ac conductivity of flexible biofriendly ternary polymer blend film by reinforcing appropriate amount of bio ionic liquid Choline acetate and The harmlessness of these films was confirmed from disk diffusion test which shows that the pristine ternary polymer blend film exhibited almost negligible development of inhibition ring whereas the blend film reinforced with Choline acetate showed no ring of inhibition indicating their benign nature towards Gram-negative bacteria (*Escherichia coli*) (CFT073) and gram positive bacteria (*Bacillus subtilis*). Therefore the developed filmscan potentially be used for various scale multifunctional dielectric and electrical applications working in close contact with living matter, green electronics and various health monitoring systems in biomedical field.

Keywords: Bio ionic liquid; choline acetate; dielectric; polyvinylchloride; polyvinylpyrrolidone, polypyrrole.

Analysis of X-ray diffraction spectra, electrical and luminescence properties of undoped and Fe doped CdTe nanoparticles

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Abstract

This article elaborates the analysis of Powder X-ray diffraction (P-XRD) spectra and electrical properties of undoped and Fe doped CdTe nanoparticles synthesized by Hydrothermal method. The P-XRD analysis is done to calculate the size and other structural properties like crystallite size, lattice constant and dislocation density of the undoped and Fe doped nanoaprticles. The EDAX spectra is taken to trace the elements present in the synthesized nanoparticles. From the UV visible absorption spectrum the band gap is found to decrease with increase in the Fe concentration. The van der Pauw Hall measurement technique is employed to study the electrical proeprties such as conductivity, carrier concentration, mobility and Hall coefficient of the undoped and Fe doped CdTe nanoparticles.The consistent p-type consuctivity is verified for the undoped CdTe nanoaprticles and with Fe in 30% concentration is found to change the type of conductivity from p-type to n-type. The Photoluminescence (PL) spectra for the undoped and Fe doped CdTe nanoaprticles reveal that the emission frequency can be tuned between the wavelength 450 nm to 500 nm, which is suitable for light emitting diode (LED) applications.

Keywords: CdTe; Fe doped; Hall measurement; PL spectra.

Photocatalytic activity of biosynthesized silver nanoparticle fosters oxidative stress at nanoparticle interface resulting in antimicrobial and cytotoxic activities

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Abstract

Photocatalytic nanoparticles upon interaction with various biomolecules generate oxidative stress resulting in non-specific cell death.Due tolow band gap energy; silver nanoparticles (AgNPs) demonstrate strong photocatalyticactivity. Therefore, this study is intended to investigate the effect of reactive oxygen species (ROS) produced due to the photocatalytic activity of AgNPsfor evaluating their antimicrobialand the cytotoxic properties. In this study, AgNPs were synthesized via green synthesis technique utilizing the peel extract of *Punica granatum L.* The synthesized AgNPs were further characterized using various tools such as UV-Vis spectroscopy, TEM and X-ray diffraction (XRD) etc. The antimicrobial activity of AgNPswas evaluated against a range of bacteria and the obtained results revealed that ROS generated at the AgNP interface induced stress on the bacterial membrane integrity, primarily leading to bacterial cell death. The Alamar Blue assay was used to assess the cytotoxicity of AgNPs. The results showed that the cytotoxic activity increased with increasing AgNP concentrations. In addition, the γH2AX activity assay was used to investigate DNA damaging activities of AgNPs. The findings showed that AgNPs exhibited increased levels of DNA damage upon increasing the AgNPs concentrations. Our results showed that, both the antimicrobial and cytotoxic properties of AgNPs primarily originate from the interfacial ROS generation due to their photocatalytic activity. These ROS-induced effects led to membrane damage in bacteria and also DNA damage in HT1080 cells, ultimately resulting in cell death.

Keywords: Silver nanoparticles; photocatalytic activity; reactive oxygen species; antibacterial activity; cytotoxic activity.

Structural damage detection through artificial intelligence

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Abstract
The research paper describes the application of backpropagation artificial intelligence to assess the quality of structural elements. Whole grain and crushed grain contours were extracted using the log-polartrans formation, correctly normalized, and used as input data for the neural network. A network optimization was performed, and the results were analyzed based on the response values obtained from the output neurons. Evaluation of the obtained results showed that the training set correctly recognized grain quality at a 97% level and the test set at a 94% level. The achieved detection level will enable the proposed method to be used in industrial devices to assess grain quality. The work in an industry where the consumer is king. Researchers constantly strive to improve structural elements to meet changing consumer demands while seeking opportunities to develop niche products for new markets. However, little is known about there lationship between beertaste and its mechanical and chemical analysis. The ability to predict final structural elements based on material properties and composition opens up the possibility of 'tuning' such products to meet consumer expectations. Extensive empirical data from various sources are available to analyze product structural elements. However, there is currently no mechanism to link them. Such relationships are undoubtedly complex and highly non-linear. Modern artificial intelligence techniques, especially neural networks, and genetic algorithms, are synthetic enough to identify such relationships. The former is related to machine learning, and the latter to chemical evolution. The development of the setwofields of his work dates back to the1960s. However, the availability of software packages and the rapid expansion of computing power has only recently moved these technologies from AIlabsto industry.

Keywords: Structural damage detection; Structural elements; modern artificial intelligence techniques; mechanical & chemical analysis; machine learning & deep learning.

Electrochemical supercapacitor studies of mixed ternary transition metal manganites as potential electrodes

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Abstract

Transition metal oxides are promising electrode materials for electrochemical supercapacitors. Various transition metal oxides such as ZnO, NiO, Co_3O_4, Fe_2O_3, RuO_2, and MnO_2 have been investigated as active electrode materials for energy storage. Out of these, Manganese dioxide (MnO_2) has been widely investigated owing to its high theoretical capacitance (1370 Fg^{-1}), low cost, environmental friendliness, and natural abundance.Never-the less, the poor electrical electricity (105–106 Scm^{-1}) and slow ion transport rate of MnO_2 impede the specific capacitance and charge–discharge rate capability. To enhance the performance and achieve complete utilization of the active materials, it is important to design nanostructured MnO_2 nanomaterials with high external surface area and good electricity conductivity. Over the past decade, mixed metal oxides such as Ni/Mn oxide, Mn/Fe oxides as well as Mn/Ni/Co oxide have demonstrated tremendous improvements in electrochemical performance. Spinel manganites, MMn_2O_4, (where M = Mn, Co or Ni) are fascinating due to their impressive magnetic, electrical and optical properties as well as their ability of exhibiting different redox states and electrochemical stability. Nanocrystallites of three mixed ternary transition metal manganites (MTTMM) were prepared by a facile sol–gel method and adopted as electrode material for supercapacitor. The phase development of the samples was determined using Fourier transform infrared (FT-IR). X-ray diffraction (XRD) analysis revealed the formation of a single-phase spinel manganite in $CuCoMn_2O_4$ (CuCoM). The surface characteristics and elemental composition of the nanocomposites have been studied by scanning electron microscopy (FESEM) and energy dispersive spectroscopy (EDS). The electrochemical performance of the nanomaterials was evaluated using a two-electrode configuration by cyclic voltammetry, electrochemical impedance spectroscopy and galvanostatic technique in 1 M KOH electrolyte. The high electrochemical performance of the MTTMM nanocomposites obtained indicates that these materials are promising electrodes for supercapacitor.

Development of high capacity SnO_2anodes for alkali-ion batteries

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Abstract

Lithium-ion batteries (LIBs) have now become inevitable power source for most of theportable electronic applications. However, employing LIB technology for electric vehicles (EV) or micro-grids is still a challenge, as these applications demand high energy density, high power density and safety. In this context, we present here our recent works on SnO_2 based anodes for lithium and sodium –ion batteries. In this work, hydrothermal method has been adopted to synthesize SnO_2 materialsand studied their electrochemical performanceagainst lithiumand sodium-ion batteries. SnO_2 anodes delivers high capacity and rate performance. Post-mortem microstructural studies reveals the formation of inert oxide phases and degradation of electrolyte by-products in both Lithium and Sodium –ion batteries.

Keywords: SnO_2, anode, lithium-ion battery, sodium-ion battery, specific capacity, post-mortem studies.

Low lattice thermal conductivity materials - Design perspective

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Abstract

Thermal energy applications require materials with low lattice thermal conductivity (kL). We investigated the lattice dynamics and phonon transport of 16 iso-structural MX (Mg, Ca, Sr, Ba, and X = O, S, Se, and Te) in the rocksalt (NaCl)-type structure in this work. In contrast to the expected tendency based on their atomic mass, anomalous trends are predicted for kL in MX except for the MgX series. The fundamental reasons for such low kL behaviour in low atomic mass systems, such as BaO, BaS, and MgTe, are widely investigated. We propose the following prominent factors as possible causes of low kL behaviour in these materials: 1) despite low atomic mass, softening of transverse acoustic (TA) phonon modes, 2) low lying optic (LLO) phonon modes fall deep into the acoustic mode area, increasing overlap between longitudinal acoustic (LA) and LLO phonon modes and therefore scattering phase space; 3) short phonon lifetimes and high scattering rates; and 4) significant anharmonicity. This study sheds light on how to develop low kL materials through phonon engineering in basic crystal systems, which is critical for the development of sustainable energy devices for future thermal energy management applications.

Keywords: Lattice thermal conductivity; molecular dynamics, TDEP, phonon transport.

Immuno-enhancing and anticancer potential of the Pectin-Guargum-Zinc oxide nanocomposite: Two pronged strategy

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Abstract

Cancer is reported as the second leading cause of death and every year, more than 11 million people are diagnosed with cancer throughout the world. Current therapies are limited due to considerable side effects. It is, therefore, necessary to search for novel agents to treat cancer patients with less adverse effects. Immunomodulation using biopolymers mediated nanostructures can provide an alternative to conventional chemotherapy for a variety of diseases. In this study, Pectin-guar gum-zinc oxide (PEC-GG-ZnO) nanocomposite was prepared and evaluated for immunomodulatory and anticancer potential. The composite was characterized by using FT-IR, XRD, HRTEM, SAED, EDS, and SEM. TEM images showed the hexagonal shape of nanocomposite with the size range of 50-70 nm. Treatment of human peripheral blood lymphocytes (PBL) with PEC-GG-ZnO proved the immunostimulatory property of the nanocomposite. ELISA confirmed a significant increase in the release of IFN-γ, IL-2 and TNF-α cytokines and flow cytometry analysis revealed enhanced expression of CD3, CD8, and CD56 after treating PBL with PEC-GG-ZnO as compared to PEC and GG treatment. Moreover, we also found that nanocomposite pretreated human PBL displayed enhanced cytotoxicity towards lung (A549) and breast carcinoma (MCF-7) cells as compared to untreated PBL. PEC-GG-ZnO nanocomposite also displayed cytotoxicy against A549, HeLa (cervical) and PC-3 (prostate) cancer cells. Mechanistically, PEC-GG-ZnO induced apoptosis via mitochondrial depolarisation, ROS generation, cleavage of Caspase-3 and PARP1 leading to DNA fragmentation. This research work depicted that PEC-GG-ZnO nanocomposite can manage cancer by two traits: firstly, through its immune-potentiating effect and, secondly via stimulating death pathways in cancer cells. Taken together, the current data corroborates that PEC-GG-ZnO, a novel nanocomposite, can serve as a promising cancer therapeutic agent.

Keywords: Immunotherapy; lymphocytes; reactive oxygen species; biopolymers; ZnO.

Synthesis and microcontact printing of a 2D nanocomposite on a solid support to check microbial adhesion

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Abstract

Health hazards caused by microorganisms (bacteria, fungi, etc) and its prevention is of primary importance because it directly affects the mankind. Fabrication of different anti-adhesion surfaces using direct or indirect methods and a variety of material have come into view as the heartof addressing the issue. However, research works concerning both these remedies are rare. In this presented work we synthesized Zinc oxide_Silver_Graphene oxide (ZnO_Ag_GO) along with Zinc oxide_Graphene Oxide (ZnO_GO) by a one pot hydrothermal method. A detailed knowledge about the size and morphology of the nanocomposites was obtained from TEM analysis which showed flower like structures in ZnO_Ag_GO. Characterization was followed by fabrication of the nanomaterials on glass coverslips using microcontact printing (μCP) which is an indirect method of generating micro and nano-scale structures using soft elastomeric stamps. The patterns formed were characterized by Confocal Microscopy and Atomic Force Microscopy (AFM) to verify the variations in the surface topology corresponding to the nanomaterials. Finally, adhesion assay using *E. coli* and *C.albicans* were performed on these fabricated structures and their adherence were compared to fully coated thin film surfaces. A declining trend of microbial adhesion was observed in the rough surfaces either due to the dual cumulative effect of both chemical and physical modification against the microbial strains or some other alternative mechanisms which are worth exploring in the future.

Keywords: Microcontact printing, nanocomposites, *E. coli*, *C. albicans*, anti-adhesion surfaces.

High performance ZnO-based electrical biosensor towards label-free point of care disease diagnostics

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Abstract

To overcome existing challenges in PoC devices, we develop for the first time a FET biosensor using simple wet chemical processing and cost-effective screen-printing technology. To achieve our objective, a unified design approach has been devised by considering nanorod spacing dependent liquid penetration depth to achieve significant signal to noise ratio enhancement. We have also adapted the control of defect states by tuning the surface roughness which has improved the receptor binding density, sensor response and reliability of the device performance. Additionally, a vertical electrode configuration has been developed which allows enhanced penetration of the electric-field lines through the nanorods.Presentwork has aimed for the development of PoC diagnostic platform incorporating ZnO nanostructure FET biosensor with a view to improve the sensitivity and lower the detection limit of the PoC devices. Inspite of numerous advantages, ZnO being polycrystalline has several defect states at its grain boundaries which control some significant parameters like field-effect mobility, on-off ratio, threshold voltage and transconductance. I have discussed approaches to overcome the issues of device noise, defect states, reliability and specificity of ZnO-based biosensors. In order to achieve ultrasensitive biosensing, fabrication of novel electrode configuration has been incorporated and introduced a unique competitive impedance spectroscopy-based detection method. Finally, approaches have been taken to provide a new insight towards label-free POC devices through electric field mediated electrochemical biosensing. The major contributions are listed below:

- Noise spectroscopy analysis of ZnO thin film FET-based biosensor for rapid detection of virus in serum
- Optimizing defect states in ZnO thin film FET-based biosensor for reliable detection of cancer biomarker
- Geometry optimization of ZnO nanorods for enhanced sensing performance of ZnO nanorod FET biosensors
- Fabrication of vertical electrode configuration for ultrasensitive detection of virus using ZnO nanorod FET biosensor
- Introducing competitive impedance spectroscopy method for ultrasensitive and specific biosensing in physiological analyte
- Electric field mediated electrochemical biosensing based on graphene/ZnO nanorod heterostructure on flexible substrate integrated with smartphone

Keywords: Biosensor; ZnO; nanorods; graphene; biomarker detection.

Magnetoelectric coupling and energy harvesting properties of 3-0 patterned ferroelectric/ferromagnetic composites

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Abstract

The strain-mediated ME coupling in artificial 3-0 type particulate composites is interesting for their emerging industrial applications such as; energy harvesters, MERAMs, ME sensors, etc. The study presents the ME coupling coefficient in non-resonant frequency and resonant frequency modes in (1-x)PMN-PT:xCFO (x = 10, 15, 20, and 30 mol%) composites. The composite with an 80:20 composition ratio shows the ME coefficient in the range of 4.30 mV/cm-Oe, which is one order more than the intrinsic single-phase multiferroics. In resonant mode, 300 times large enhancements in the ME coefficient values are seen. Furthermore, doping a small amount of rare-earth (RE) element to the magnetostrictive phase for (1-x) PMN-PT:xCF(RE)O (x = 10, 15, 20, and 30 mol%)composites have been undertaken. The large enhancement of αME ~3118 mV/cmOe at 288 kHz for 90PMN-PT:10CFLO composite and 2580 mV/cm-Oe at 282 kHz for 90PMN-PT:10CFEO composite has been observed. The 80PMN-PT:20CFLO composites show a large peak-to-peak voltage (Vpp) of about 4.24V at off-resonance mode. The giant coupling in the composites demonstrates the potential applications of composite multiferroicsasan energy harvester.

Keywords: Magnetoelectric coupling; ferroelectric; ferromagnetic; composites; energy harvester.

Audible sonochemistry with supramolecular systems

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Abstract

Although we find abundant applications of audible sound in our day-to-day life, it has not established itself as a useful tool when it comes to controlling chemical reactions in a laboratory. In the case of sonochemistry, reactions generally occur in the presence of high- intensity ultrasound. However, a completely different cavitation mechanism involving the generation of immense temperatures and pressures locally in solution operates in such cases. In comparison, the energy of audible sound is not high enough to influence any common chemical reaction or process. In this talk, we will discuss about ‘Audible Sonochemistry’, where one can use audible sound to control the spatiotemporal dissolution of atmospheric gases like O_2 and thereby regulate out-of-equilibrium chemical reactions to obtain programmable spatiotemporal chemical patterns.[1] Using this strategy one can spatiotemporally control the concentration of monomers and supramolecular aggregates within the same solution. Additionally, one can carry out the segregation of chirally-assorted supramolecular polymers, i.e., chiral aggregates from achiral aggregates, as well as oppositely helical chiral aggregates within the same solution.[2]

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Keywords: Audible sound; sonochemistry; out-of-equilibrium; supramolecular; pattern.

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Curcumin-loaded mesoporous silica nanoparticles for breast cancer therapy

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Abstract

Cancer is one of the leading causes of mortality, accounting for a decrease in global life expectancy. According to worldwide cancer data, the incidence will climb to 28.4 million cases in 2040, a □47% increase from 2020. Breast cancer is the most difficult disease for women worldwide, regardless of treatment technique.The development of multidrug resistance (MDR) in cancer cells is the greatest impediment to chemotherapy failure, which is accompanied by the characteristic of intractable and recurrent malignancies.Curcumin (*Curcuma longa*) is a phytochemical that is widely used in Asian nations as a spice, culinary additive, and herbal medicine. It possessesa myriad of pharmacological actions, such as anticancer, antibacterial, anti-inflammatory, antioxidant, antidiabetic, and so on. However, its therapeutic applicability is curtailed due to its limited solubility, poor absorption, quick metabolism, and excretion. Currently,nanotechnological-based applicationshave been utilized for enhancing theirpharmacological property. Recent attention has been given to mesoporous silica nanoparticles (MSNs) asthey have distinct features that make them ideal nanocarriers for hosting, safeguarding, and carrying medications to their destination.In this regard, we have developed curcumin (Cur) loaded-MSNs and evaluated their efficacy in MDA-MB-231. The Cur-MSNs illustrated better anti-cancer efficacy compared to the native Cur, illustrating the effectiveness of the formulation.In this context, we developed curcumin (Cur) loaded-MSNs and tested their effectiveness in MDA-MB-231 cells. Cur-MSNs had superior anti-cancer activity as compared to native Cur, demonstrating the formulation's usefulness.

Keywords: Mesoporous silica nanoparticles; curcumin; breast cancer; multidrug resistance (MDR); nanotechnology.

Electrical properties of grain size tuned CdSe nanocrystal films for solar cell application

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Abstract

Nanostructured films of transparent semiconductor selenides find extensive applications in solar cells, electroluminescent devices, photodetectors and chemical sensors. In recent years, there has been rapid development in the field of (CdSe, CdS, ZnSe, CdTe) semiconductor thin films owing to their wide range of applications. As an important member in the II–VI group of binary compounds cadmium selenide (CdSe) with a band gap of 1.7 eV is of interest because of its optical and electrical properties for its applications in high efficiency thin film transistors, solar cells, photoconductors, gas sensors, photo electrochemical (PEC) cells, photoconductors, gamma ray detectors, large screen liquid crystal display and schottky diodes. CdSe nanocrystal (NC) thin films of different NC sizes were synthesized using vacuum deposition technique. The films showed blue shift of band gap and the NC sizes calculated size using Brus equation were 9.40, 9.68 and 9.82 nm. DC conductivity and photoconductivity of as-deposited and annealed films increased and activation energy for conduction decreased with increase in the NC size. Also, both carrier concentration and mobility of the films increased with increase in the size of the NCs which was attributed to the increased electronic coupling between the NCs. The slow response part of photocurrent response pulse analyzed using power law: $I_{ph} \propto t^{\alpha}$ gave larger values for α for larger NC size indicating stronger electronic coupling between grains in films of larger grain sizes. Charge transport in the CdSe NC films was akin to that of solid films of CdSe quantum dots, of sizes given by Brus equation, connected together by an outer shell of CdSe material where charge carriers had free movement.

Keywords: Nanostructured films; solar cells; Brus equation; DC conductivity; photoconductivity.

Ageing precipitation behavior on mechanical and corrosion properties of friction stir processed a new aerospace Al-Li alloy

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Abstract

The Al-Li alloy represents a class of high strength and good corrosion resistances have a wide application in the aerospace and automobile industries. It is notable that adding Li (ρ~0.53 g/cc, and Tm~180.5oC) in aluminium alloy apparently reducing the weight structure by 10-15% and increasing the stiffness to 15-20% compared with conventional aluminium alloys. The two important features of Al-Li alloys are incomparable low density with low melting point and high Young's modulus become more competitive than composite materials. It is well known that δ'(Al3Li), θ'(Al2Cu), β'(Al3Zr) and T1(Al2CuLi) precipitates are responsible for the major strengthening directed to the combination of FSP and ageing treatment (T6) can boost the mechanical and corrosion properties of Al-Li alloys. The corrosion test was measured that Icorr and Ecorr values effectively shown as 9.96E-08 to 1.78E-07 mA/cm2 and -0.7403 to -0.7606 mV respectively, as well as corrosion rate had found 0.62489 milli-inches per year (mpy). The FSP is a known solid state surface modification technique thereby effectively achieving the microstructure refinement, breaking the intermetallic phases and formation of the texture also contributes to the improvement of the strength. The alloy is also sensitive to highly electrochemical activity and released hydrogen act as a driving force for corrosion occurrence. The both strengthening phases δ' and θ' have high corrosion potential as well as enhancing strength after FSP. The FSP parameters had optimized such as rotation speed of 800 rpm, traverse speed of 50 mm/min, axial force of 15 kN and optimized tool design efficiently contributed to better YS of 178.50 MPa, UTS of 192.50 MPa, ductility of 3.35%, and RA of 4.96%, respectively. In this task, several experimental tests were conducted on SZ such as optical microscopy (OM), Vicker's hardness measurements after ageing treatments, corrosion rate measurements (mpy), SEM with EDAX analysis, tensile test and tensile fractography by SEM analysis.

Keywords: low density; corrosion potential; FSP; SEM with EDAX analysis; tensile test and fractography analysis.

Silicon nanoparticle-pulsing ameliorates fluoride stress in rice by fine tuning the ionomic and metabolomic balance and improving agronomic traits

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Abstract

Rising level of fluoride in groundwater is one of the major causes of persistent environmental pollution, owing to its high biomagnifying potential. Investigations have been undertaken to establish the roles of silicon nanoparticles (SiNPs) in ameliorating fluoride toxicity in a fluoride-susceptible rice cultivar, IR-64. Fluoride toxicity reduced overall growth and yield by suppressing grain development. Fluoride stress alarmingly increased the accumulation of cobalt, which together with fluoride triggered electrolyte leakage, malondialdehyde, methylglyoxal and hydrogen peroxide accumulation and NADPH oxidase activity. The overall photosynthesis was compromised due to chlorosis and inhibited Hill activity. Nano-Si-priming efficiently ameliorated molecular injuries and restored yield by reducing fluoride bioaccumulation particularly in the grains. The level of nonenzymatic antioxidants like anthocyanins, flavonoids, phenolics and glutathione was stimulated upon SiNP-priming. Nano-Si-pulsing removed fluoride-mediated inhibition of glutathione synthesis by activating glutathione reductase. Glutathione was utilized to activate glyoxalases and associated enzymes like glutathione-S-transferase and glutathione peroxidase. Uptake of nutrients like silicon, potassium, zinc, copper, iron, nickel, manganese, selenium and vanadium improved seedling health even during prolonged fluoride stress. Nano-Si-pulsing produced a nanozymatic effect, since high level of crucial cofactors like copper, zinc and iron stimulated the activity of superoxide dismutase, catalase, ascorbate peroxidase and guaiacol peroxidase, which synergistically with other enzymatic and non-enzymatic antioxidants scavenged reactive oxygen species and promoted fluoride tolerance. Overall, the study established the potential of SiNP to promote safe rice cultivation and precision farming even in fluoride-infested environments.

Efficient synthesis of alkyl and aryl boronate esters enabled by reusable nano catalysts

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Abstract
Organoboronates are important in medicinal chemistry in and of themselves, as well as being often used as synthetic intermediates for transition-metal catalyzed cross-coupling, conjugate addition and many other reactions.[1] The transition-metal-catalysed borylation is considered as one of the most efficient methods for the synthesis of organoboron derivatives.[2] Taking into consideration of chemical and pharmaceutical process, the major drawbacks of homogeneous catalysis are metal contamination into products and inability to recover the catalyst for reuse, limit its application in industrial interest, biomolecules, and materials science. The use of nanoparticles as heterogeneous catalysts is a current topic of research to overcome these limitations.[3] We have developed a series of easy-to-prepare, air-stable and recyclable nano catalyst systems for alkyl and aryl halides borylation, and the hydroboration of carbonyl, alkenes and alkynes.[4-9] Prominent advantages of these methods include the avoidance of any ligand, a wide substrate scope and high yield. Reactions show excellent recyclability. The key results will be described.

Keywords: Alkyl halides; Aryl halides, Boron, Copper; Hydroboration; Iron; Nanoparticles.

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Effect of citrullus colocynthis on hair growth in albino rats

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Abstract

Ayurveda, the conventional Indian medical system, usually praises Citrullus colocynthis Schrad (Cucurbitaceae) as a hair tonic. Therefore, research was done to determine how C. colocynthis extracts in petroleum ether and ethanol affected albino rat hair development. On the shaved, denuded skin of albino rats, the extracts mixed with the oleaginous ointment base were applied topically. The length of time needed for the beginning and end of the hair growth cycle was noted. The standard was a topically administered 2% minoxidil solution. When petroleum ether extracts were used as a treatment, the time it took for hair to start growing was dramatically shortened—by half—when compared to untreated control animals. Additionally, the amount of time needed for full hair growth was greatly decreased. More hair follicles (>70%) were successfully brought into the anagenic phase by the treatment than by regular minoxidil (67%). Treatment with petroleum ether extracts at 2 and 5% produced results that were comparable to those of regular minoxidil.

Keywords: Alopecia; bitter apple; Citrullus colocynthis; hair growth.

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Polaron induced optical parametric interaction in magnetoactive semiconductor plasmas

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Abstract

In nonlinear optics, the parametric interaction phenomena play a special role. One of the most significant devices and processes that has its roots in parametric interactions in a nonlinear medium is the formation of squeezed states. Other key devices and processes include parametric oscillators, optical phase conjugation, pulse narrowing, and parametric amplifiers. A weak signal is produced to interact with a powerful, higher frequency pump in optical parametric amplification, and both the resultant difference frequency (also known as the idler) and the original signal are amplified. The parametric amplification caused by the polaron mode in the magnetised III-V semiconductor n-InSb has been analytically examined within the context of the hydrodynamic model of semiconductor plasma. The effective second-order optical susceptibility that results from the medium's induced nonlinear current density is what gives rise to the phenomena. The parametric gain coefficient and the threshold amplitudes of the external electric field at which the parametric instability can arise are expressed using the coupled-mode theory. Analysis is done on the gain coefficient and threshold amplitude of the pump electric field as a function of the wave vector and the strength of the external magnetic field. According to the reported results, choosing the right magnetic field can efficiently increase gain while simultaneously lowering the threshold pump field needed to initiate parametric excitation at the right pump electric field.

Keywords: Parametric interaction; polaron mode; III-V semiconductors; coupled mode theory; hydrodynamic model.

Operating features of parametric amplification in magnetoactive $A^{III}B^{V}$ semiconductor crystals

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Abstract

Using a hydrodynamic model of semiconductors, it has been determined how doping concentrations and a transverse external magnetostatic field affect the operating features of parametric amplification of backward Stokes signals in the far infrared zone. Three attainable resonance situations are proposed by the model: These conditions have been used, on the one hand, to significantly lower the value of threshold intensity for onset of the parametric amplification and, on the other hand, for switching of parametric large positive and negative gain coefficient (i.e. amplification and absorption). These conditions include (i) lattice frequency and plasma frequency; (ii) Stokes frequency and electron-cyclotron frequency; and (iii) Stokes frequency and hybrid (plasma and electron-cyclotron) frequency. For instance, a strong 10.0 T transverse magnetostatic field with a 1.5×10^{19} m^{-3} free carrier concentration increases gain by a factor of 10^{3} compared to when it is absent. The findings also point to a possible host for a parametric amplifier/frequency converter: a weakly piezoelectric III-V semiconductor that has been properly illuminated by slightly off-resonant, not-too-high power pulsed lasers with pulse duration sufficiently bigger than the acoustic phonon lifespan.

Keywords: Parametric gain; piezoelectricity; magnetostatic field; doped III-V semiconductor.

Nonlinear refractive index and absorption coefficient of scattered Stokes mode in n-type doped gallium arsenide

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Abstract

Many scientists have become interested in the experimental and theoretical studies concerning the measurement of nonlinear optical susceptibilities in various media due to their potential applications in the development of more modern coherent laser sources over a wide frequency range, including parametric amplifiers and oscillators, optical switches, phase conjugate mirrors, and above all, parametric amplifiers and oscillators. Semiconductors have been the obvious choice as host media for the study of nonlinear optical phenomena, as opposed to materials like gases and liquids, because of the accessibility of sophisticated fabrication technology and the experimental observations of giant optical nonlinearities in the band-gap resonant transitions. Gallium arsenide (n-GaAs), which has a many-valley band structure, has an advantage over other semiconductor materials in the field of device construction due to its NDR feature. I have looked into the nonlinear propagation of a high frequency pump radiation in an n-GaAs sample in the region of negative differential resistivity using a hydrodynamic model of plasma in this research. In order to help the pump wave move electrons from the lower conduction valley to the upper satellite valleys in n-GaAs and therefore increase the effective mass of electrons, a d.c. electric bias is introduced. The effective mass's energy dependence and the sample's piezoelectric properties lead to the nonlinearity. It is discovered that the induction of fourth-order nonlinearity in the sample is caused by the energy dependence of the mass in the region of negative differential resistivity. It is discovered that the nonlinear optical properties of the sample are significantly influenced by the negative differential resistivity area in n n-GaAs.

Keywords: Nonlunear refractive index; nonlinear absorption coefficient; gallium arsenide.

Role of lattice displacement in parametric amplification of nondegenerative semiconductor magneto-plasmas

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Abstract

Nonlinear optics places a significant emphasis on the phenomenon of parametric interaction of coupled waves. In both magnetised piezoelectric and non-piezoelectric semiconductors, it is analytically explored how the lattice displacement plays a significant role in the parametric amplification using the straightforward coupled mode theory. The second order optical susceptibility χ^2, which results from nonlinearly induced current density and polarisation through lattice displacement, is thought to be the source of nonlinear interaction. The lattice displacement (u), effective non-linear polarisation (P_{EN}), and crystal cell efficiency (β_0) are determined for various situations of practical interest. Large lattice displacements (on the order of 10^{-14} m) can be easily accomplished in piezoelectric coupling or both coupling and deformation potential coupling at scattering angles of around 34° and 146°, 36° and 148°, respectively. It is possible to construct highly efficient nonlinear processes by using this typical scattering angle resonance condition. Additionally, it is discovered that wave number effectively increases the lattice displacement. New techniques for building crystal cells and diagnosing semiconductor devices are presented in this work.

Keywords: Parametric interaction; lattice displacement; semiconductor plasma.

Optical phase conjugation via stimulated Brillouin scattering in acousto-optic diffusion driven semiconductors

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Abstract

Stimulated Brillouin scattering (SBS) has been extensively investigated due to its important property of optical phase conjugation (OPC), which can be exploited to recover the phase front of a beam. In this paper, analytical investigation has been made for OPC via SBS in acousto-optic diffusive semiconductor plasma crystal. Our analysis is based on hydrodynamic model and coupled mode approach of interacting waves. The numerical estimations are made for n-type InSb semiconductor plasma crystal duly irradiated by CO_2 laser. The magnitude of the third-order nonlinear optical susceptibility for III-V semiconductor obtained from our analysis is found to agree well with the experimental values. Maximum OPC reflectivity is obtained when cyclotron frequency is in resonance with applied pump frequency.

Keywords: Optical phase conjugation; Stimulated Brillouin scattering; acousto-optic semiconductors.

Insights of nano safe technology: Plant health management and future perspectives

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Abstract

Nanotechnology, as we know it in its modern and post-modern forms, is a very young branch of knowledge but mankind has empirically used nanoparticles since thousands of years. The nanoparticles are potentially used for pollution degradation, transformation and immobilization of contaminants on one hand and it reaches the inaccessible sites with improved biotic degradation on the other. Nano-safety is crucial in light of the dangers posed by synthetic nanomaterials, whose effects may outweigh their benefits for environmental applications. Nanoremediation is experiencing a setback because of the risks associated with the safety of nanomaterials for humans and the environment, despite the fact that nanotechnology shows incremental and clearly beneficial effects for public health and Earth's natural ecosystems. On combining phytoremediation technology with nanoremediation technology, showed better solution for toxic heavy metal decontamination from the environment. Nanotechnology offers a plenty of options for researchers engaged in the timely and rapid detection, identification and monitoring of crop health.Such rapid detection technologies with high precision, sensitivity and selectivity for detecting both abiotic and biotic stresses are indispensable to avert disease spread and diminish losses to get optimal productivity and food security.For example, NPs can be utilized for biotic and abiotic stress management in wheat and barley crop.In addition, innovations in the development of nanosensor seem quite useful for designing of precise and sensitive diagnosis tool, which ultimatly pave way for timely stress management under field conditions as well in grain storage facilities.To successfully apply nano-phytoremediation at local, national, and international scales, new research in green nanotechnology, nano-bioremediation, electro-nanoremediation, risk assessment of NMs, and outreach efforts are required.

Keywords: Nanotechnology; nanoremediation; nanosafety; nano-phytoremediation; crop health.

Parametric interaction of acoustic waves in magnetoactive semiconductors – A numerical approach

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Abstract

In nonlinear acoustics, the phenomenon of parametric interaction of coupled waves plays a significant role. When a laser beam interacts nonlinearly with a low frequency transverse acoustic wave in the presence of a transverse magnetostatic field in a heavily doped n-type piezoelectric semiconductor, it may cause instability and parametric amplification of the acoustic wave. The amplification of acoustic waves when a magnetostatic field is applied perpendicular to the direction of the pump wave propagation has been investigated using a hydrodynamic model of a homogeneous plasma. We employ the Newton-Raphson approach to look for the possibility of fictitious roots that are not genuine while simulating numerically. It has been noted that the root's imaginary portion turns positive. As a result, the acoustic wave becomes unstable and is amplified in the current circumstance. In this article, the InSb crystal's values for physical properties are utilised. The study can be expanded to include a variety of instances and materials.

Keywords: Newton-Raphson method; parametric amplification; magnetostatic plasma medium; nondegenerate semiconductor.

Silver coated 1D random photonic crystals for biosensing

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Abstract

Nanophotonic crystals have garnered significant attention in recent years due to their unique optical properties and potential applications. Photonic crystals are periodic structures that exhibit a photonic bandgap, a range of frequencies in which the propagation of electromagnetic waves is forbidden. Researchers have focused on developing methods to tune the properties of one-dimensional nanophotonic crystals due to their simpler structure, ease of fabrication, and low cost. The concept of one-dimensional random photonic crystals (1D RPCs) has gained attention in recent years due to their outstanding optical properties and potential applications. By introducing disorder into the periodicity of the crystal structure, random scattering of light occurs, leading to multiple scattering events and the formation of random lasing modes. The random nature of the photonic crystal structure can enhance the interaction between light and analytes, resulting in increased sensitivity and detection capabilities. Recent research has explored using one-dimensional RPCs as platforms for ultrasensitive sensors for gas detection, chemical sensing, and biosensing. In this paper, we have developed cancer cell sensor using the silver coated one dimensional random phtonic crystal. Here, we achieved randomness through either a random layer layout or by randomly varying the thickness of the layers. Random photonic crystals were created using the dielectric materials silicon (Si) and silicon dioxide (SiO_2). To detect cancer cells, we use a random configuration of the aforementioned dielectric materials. Analytes are deposited in a random sequence in the sensing layer (SL), which is coated with silver (Ag) and sandwiched between the Si/SiO_2 layers. The unit cell of the photonic crystal as ratio of 1: 1 proportion of Si and SiO_2. For the construction, we employed 10 layers of Si, 10 layers of SiO_2, and a sensing medium. Only the Si and SiO_2 layers were randomly stacked, and the sensing medium was added after 5-unit cells. As a result, the structure is $[(Si/\ SiO_2)^5/Ag/SL/Ag/(Si/\ SiO_2)^5]$. Si, SiO_2 and Ag have refractive indices of 3.477, 1.44, and 0.0515 respectively. The refractive index of Normal Cells, Jurkat, HeLa, PC12, MDA-MB-231 and MCF-7 are 1.350, 1.390, 1.392, 1.395, 1.399, and 1.401 respectively. The thicknesses of the Si, SiO_2, Ag and sensing layers are 86.206 nm, 208.33nm, 5.825µm and 9µm, respectively. The intuitive approach is used to optimize the thickness and random designs. Using the aforesaid technique, the best structure is chosen from 1000 random constructions, and the structure is shown in figure. A transfer matrix approach determines the transmission and sensing properties of constructed random photonic crystals. For the normal incident of light, the simulation results reveal that the developed sensor has an excellent ability to identify cancer cells, with a sensitivity of 1627.45 nm/RIU. As it shows magnitude variations as well as wavelength shift for every distinct type of cancer cells. The results obtained can be very helpful in identifying the early stages of cancer utilizing basic blood tests.

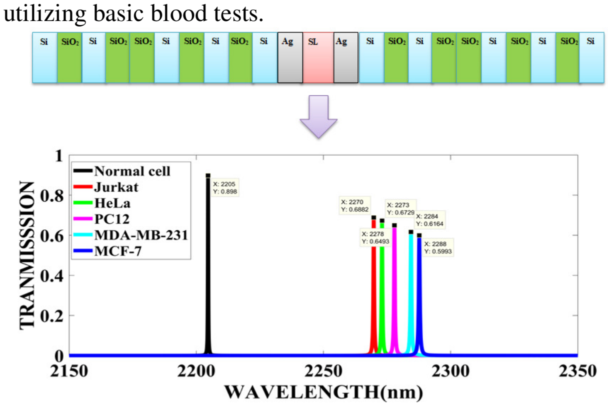

Figure: Schematic and transmission spectra of Ag coated 1DRPC based biosensor

Keywords: Biosensor; cancer cells; random photonic crystal; structure-property relationship; sensitivity.

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Optical thermometry using rare earth activated compound

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Abstract

Luminescence based temperature sensing is one such kind of applications with modern light based application apart from direct display applications such as phosphors, scintillators, photocatalysis and others. Luminescence based thermometry has an enormous potential not only in in vitro and in vivo bio-imaging and medical treatment but also in the fields of temperature distribution and maintenance in vast surface areas such as electronics, aviation, space research etc. Several methods of optical temperature sensing were established in the recent years and vast research has been done on each of them. It has been proved that a single material could be used for thermal sensing through various methods. The requirements of optimized luminescent thermometers are their thermal sensitivity in the range of temperatures to be examined besides their accuracy, repeatability, and stability of the material in the ambiance of measurement. Depending on the measurement conditions the range of operating temperatures are defined. Hence, few phosphors with good sensitivities are not enough for the entire ranges and applications. Wide range of phosphors with varied physical, chemical, and even mechanical properties with excellent sensitivities in defined range of temperatures are very much needed. The presentation describes different approaches in sensing temperature via non-contact approach using diverse optical thermal sensing behaviour of RE3+ co/tri-doped thermally stable inorganic compounds. The dependence of the integral intensity of luminescent ions as a function of temperature was monitored in cryogenic temperature range. Three methods of thermal sensing, namely fluorescence intensity ratio (FIR) based on thermally coupled levels (TCL) and thermally non-coupled levels (NTCL) in the visible upconversion were discussed by comparing the sensitivities of each of the method based on theoretical interpretation of the results. Various temperature sensing techniques were implemented, and corresponding absolute (SA) and relative sensitivities (SR) were estimated to compare.

Keywords: Optical thermal sensing; cryogenic temperature sensors; thermally/non-thermally coupled levels; fluroscence intensity ratio.

Synthesis of SnO_2 nanocomposites by sol-gel method and their characterization

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Abstract

The straightforward sol-gel method was successfully used to create nanocrystalline SnO_2 powder. The SnO_2 nano-powder was made from the obtained sol-gel after it had been cleaned and heated to 400°C. X-ray diffraction (XRD) technique was used to examine the structural characteristics of (SnO_2) nanocrystalline powder. By capturing the absorbance and transmittance spectra, Uv-Vis Spectroscopy was used to investigate the optical properties. The XRD pattern of the initially generated sample showed that SnO_2 nanocrystallites had formed a rutile structure. The SEM examination revealed a uniform distribution of relatively tiny grains throughout the scanned area. The Uv-Vis absorbance spectra also revealed a distinguishing peak of absorbance for SnO2 at $\lambda = 312$ nm. From the graph of variation of $(\alpha h\nu)^2$ with $h\nu$, the energy band gap measurement for nanocrystalline SnO_2 thin film was performed. 3.78 eV is the calculated optical bandgap energy for SnO_2 thin films. According to the findings, the synthetic SnO2 film transmits light at a rate of 78% between 350 and 800 nanometers.

Keywords: Bandgap; metal oxide; tin oxide; nanocrystallites, sol-gel.

Plasmonic in Metal Nanoparticlesfor sensor and SERS application

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Abstract

Plasmonics makes use of the interaction between light and matter at a distance smaller than the wavelength of light. Metal-based plasmonic materials can be a dependable tool for achieving desired plasmonic near- and far-field features and have shown their potential in various applications like sensor, SERS, solar cell. Surface plasmon resonance (SPR) and localized surface plasmon resonance (LSPR) are the most common and efficient label-free refractive index-based biosensing methods today.Out of these two,LSPR sensor performance is highly dependent on the size, shape and nature of the nanomaterial used.By adjusting these parameters, LSPR sensors with tunable wavelength ranges between the deep ultraviolet (DUV) to near infrared (NIR) can be created.This paper gives a thorough discussion of the fundamental scientific concepts underlying such systems and recent developments in the creation of a number of LSPR-based biosensors using metallic nanoparticles. It includes a comparison between metallic nanoparticles (Au, Ag, Al, Cu) based on different nanostructure. In addition to sensing, SERS is another area where metallic nanoparticles have contributed. The use of these substances in SERS shall be accomplished by an overview of their functionalization and effects on the assembly of nanomaterials. We discuss the field enhancement and hot spot spatial location of metallic nanoparticles in various plasmonic nanostructures (dimers, multilayers) as a function of particle number and polarization of the incident electromagnetic field. The paper concludes with a view to future research and development in this area, taking into account key developments concerning SERS and sensing nanostructure characteristics.

Keywords: Metallic nanoparticle; sensor; SERS; field enhancement; finite difference time domain method.

Biopolymer nanocomposite materials for food packaging applications

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Abstract

The development of bio-polymeric materials is exceedingly gaining importance as a potential material for the replacement of petroleum-based material. Polysaccharide based biopolymers are the emerging material to replace petroleum-based material. They have an excellent film-forming property and are extensively used for the formation of polymeric films. However, biopolymers are highly sensitive to moisture, restricting their industrial application. Various strategies such as composite formation, blending, cross-linking, hydrogel formation etc., have been employed to overcome such drawbacks. Packaging is necessary for conserving and protecting food from deteriorating agents such as physical, chemical, microbiological, or other risks that could compromise its quality or safety. Biopolymers are potential materials that are non-toxic, biodegradable, low-cost, and environmentally friendly material for use as packaging material. Therefore, with the rapid advancement and development of technology, the focus has shifted towards the fabrication of smart and active packaging materials to detect and report food quality in a real-time fashion. Such smart and active packaging systems respond to signals while interacting with the food-packaging environment. So, in this talk I discuss our work on fabrication of crosslinked guar gum-chitosan composite film without using any plasticizer fabricated via the solution casting method. The fabricated biopolymer composite film demonstrated superior properties like high stability in water, good mechanical properties etc. The crosslinked guar gum-chitosan composite film also shows a high contact angle and low water vapour permeability when compared with the film of chitosan. We also fabricated guar gum- sodium alginate blending with glucose-glycerol carbon dots nanocomposite film can be used to detect relative humidity. The fabricated nanocomposite film was an excellent smart sensor based on the fluorescence ‘on-off’ mechanisms against humidity. The practical feasibility of the biocomposite developed film was tested in real conditions by placing a piece of bread with high humidity conditions wrapped with the developed nanocomposite film. It was observed that under such conditions, marked quenching of fluorescence was observed and hence detection of humidity was possible. Such biopolymer films can be used as smart packaging material.

Keywords: Biopolymer; nanocomposite; chitosan; packaging application; guar gum.

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ICRTMD-2023/IT/MS 084

Evaluation of photocatalytic dye degradation using ZnO nanoparticles from *Catharanthus Roseus* Leaf Extracts

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Abstract

Green synthesized nanoparticles have raised great importance in the optical, electrical, and biological filed. Here,*Catharanthus Roseus* leaf extract-mediated ZnO nanoparticles were synthesized and their efficacy in dye degradation, corrosion inhibition, and apoptosis induction in the MCF-7 cell line was reported. The synthesized nanoparticles were characterized by UV-Visible, FT-IR, SEM-EDAX, XRD, TEM, Zeta potential, and particle size analyser to confirm their structural and morphological identification.Photodegradatio studies was performed under UV light and sunlight,the photodecoloration rate of green synthesized ZnO nanoparticles (CR ZnO) (95.42 %) is higher than pure MG (3 %). The reason is due to the increased surface area and the doping of zinc oxide creates more number of active sites which enhances the photodecolaration efficiency.

Keywords: Catharanthus Roseus; ZnO nanoparticles; dye degradation; methelene blue.

MS 086

An overview of bionanocomposite films and its application

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Abstract

In the current scenario ‘ready to eat’ means packaged food is the preferred choice for all. To make packaging material more safe and stable, biopolymer materials are in hot demand. But biopolymers have comparatively less compatible than synthetic polymers due to poor mechanical, thermal, physical and chemical properties. Innate permeability to gases and vapour of biopolymers are another greyer side. It adversely affects the quality of food. Nanotechnologies have potential to demonstrate the possibility for using metal nanoparticles to enhance the properties of biopolymeric packaging and edible coatings. Proposed review summarizes the synthesis and characterization of bio-nano composite film and its application in food industry to examine functional properties and antimicrobial movement. The development of antibacterial nanocomposite polymeric films for use in food packaging has been presented as a unique technology. Physicochemical properties of the film - thickness, collapsing continuance, quantitative water absorption barrier properties (oxygen and water permeability), mechanical properties (tensile strength and elongation), thermal behaviors (thermo gravimetric analysis) and water vapour transmission rate (WVTR) were discussed. The prepared films were characterized by Fourier transform infrared spectroscopy (FTIR) , X-ray diffraction (XRD) analysis, Transmission electron microscopy (TEM) and Scanning electron microscopy (SEM), Field emission scanning electron microscope (FE-SEM) and Atomic force microscopy (AFM) analysis, Total soluble matter (TSM) and Thermo-gravimetric analysis (TGA) were discussed and compared.

Keywords: Bio-nanocomposite film; food packaging; metal nanoparticle; antimicrobial.

Understanding the dynamics of wave propagation in diverse media through equations of motion and wave equations

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Abstract

Wave propagation involves the transfer of energy through a medium or in a specific direction. It is described by two distinct mathematical formulations: the wave equation and the equation of motion, each capturing different aspects of wave propagation in a medium. A comprehensive exploration of various media and their associated mathematical equations provides the fundamental basis for studying wave propagation. This study delves into ten different types of media, examining how waves behave within them using the equation of motion and the wave equation. Both the differences and similarities in these media are discussed. Variances are observed in composition, mechanical properties, and applications, while commonalities exist in terms of anisotropy, non-linearity, constitutive models, and engineering design. The three perspectives analyzed for each medium are linear isotropic, linear anisotropic, and non-linear anisotropic mediums. The study focuses on three-dimensional wave propagation analysis in understanding wave behavior in materials and structures. This approach provides a more realistic representation of wave dynamics, enables comprehensive analysis of complex material properties, and facilitates precise imaging and non-destructive testing. To study wave dynamics, required governing equations are enlisted, including equilibrium equations, constitutive equations, compatibility equations, pre-stress equations, coupling equations, smart equations, and electro-mechanical coupling equations. The specific equations employed depend on the material's structure and characteristics. In essence, the primary objective of this study is to provide researchers with guidance regarding the range of materials available and the corresponding wave dynamics equations that align with their specific research objectives. By comprehending the behavior of waves in various media, scholars can make informed choices for their investigations.

Keywords: Wave propagation; equation of motion; wave equation; constitutive equations; equilibrium equations.

Scalable Fabrication of Diamond-Shaped Gold Nanoparticles for Catalysis Reaction MoniteredUnder In-situ Raman Spectroscopy

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Abstract

This paper reports scalable synthesis of diamond-shaped Au nanoparticles (NPs) buried inside individual inverted pyramidal pits in Si substrate using simple, quick, and cost-effective solid-state de-wetting techniques.A series of thermal deposition of different initial Au thicknesses and variations in the de-wetting temperatures enables the achievement of the desired structure. In-depth structural and morphological analysis bring up a unique growth model for diamond-shaped Au NPs. Importantly, intact optical properties of such peculiar structure are tested using UV-Visible spectroscopy for analysing plasmonic behaviour and verified using finite difference time domain (FDTD) simulation. More importantly, excellent hydrophilicity along with luminescence in a wide range from UV to Visible are confirmed for optimized diamond-shaped Au NPs using contact angle and cathodoluminescence (CL)measurement, respectively.This simple method delivers noteworthy prospects for plasmonic-based engineering to achieve a probable scope in efficient catalysis activity owing to its excellent electromagnetic confinement effect which has been observed under an in-situ Raman spectroscopy experimentation.

Keywords: Au NPs; De-wetting; CL; Contact angle; Plasmonic; Absorbance; In-situ Raman; Catalysis.

Analysis of Distinct Fractional Order Derivatives on Axi-Symmetric Problem in Photothermoelastic with Diffusion under Hyperbolic Two Temperature

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Abstract

In this paper, a unified model of fractional order photothermoelastic with diffusion based on hyperbolic two temperature (HTT) is developed. Fractional order derivatives, namely Riemann-Liouville (RL), Caputo-Fabrizio (CF), Atangana-Baleanu (AB) and Tempered-Caputo (TC) are used to propose this model. Two dimensional axisymmetric problem is explored in the assumed model by employing Laplace and Henkel transforms. Integral transform technique reduces the system of equations into ordinary differential equation. The arbitrary constants in the solution are determined by considering the loading environment on the surface. Three different categories of the sources are taken to explore the application of the problem as (i) normal force (ii) thermal shock (iii) harmonic chemical potential source. In the new domain, the closed form expressions of physical quantities like displacement, normal stress, conductive temperature field, chemical potential and carrier density distribution are derived. The numerical inversion method is employed to recover the results in a physical domain. The solutions are presented graphically to know the impact of various fractional order derivatives in case of hyperbolic two-temperature (HTT), two-temperature (2T) and one-temperature (1T) for different fractional derivatives (RL, CF, AB and TC) on physical field quantities w.r.t. radial distance. Unique cases are also explored. The results provide are helpful for understanding the photothermoelastic interactions due to various sources and open up wide applications of using new fractional derivatives.

Keywords: Photothermoelastic; hyperbolic two temperature; diffusion; Riemann-Liouville; Caputo-Fabrizio; Atangana-Baleanu; Tempered-Caputo.

One route aqueous synthesis of 3D cubic mesoporous Gd_2O_3/KIT-6 nanocomposite with incorporating hydrothermal methodology

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Abstract

Gd_2O_3 doped KIT-6, a mesoporous hybrid nanocomposite was synthesized using facile hydrothermal method with enhanced specific surface area analysis. The ordered mesoporous framework of hybrid nanocomposite with large surface area and substantial pore volume is analysed using N_2adsorption-desorption curves. The structural insights for 3D-cubic mesoporous arrangement of KIT-6 having Ia3d symmetry is determined through analysis of powder X-ray diffraction curves, transmission electron microscopy (TEM) visuals, field emission scanning electron microscopy (FESEM) imageries and energy dispersive X-ray analysis (EDXA) . It was observed that the synthesized 1,5 and 10wt% Gd_2O_3loaded in KIT-6 nanocomposite synthesized by hydrothermal channel exhibits ordered mesostructured porous arrangement. This work presents the production of mesoporous hybrid nanocomposite having ordered pore framework with significant potential to act as sensing material by implementimg hydrothermal aqueous route.

Keywords: Nanocomposite; KIT–6; Cubic Mesoporous; Hydrothermal; Hybrid.

An Insight to Drug Delivery Devices for Non-Conventional Routes of Drug Administration

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Abstract

The way in which a drug enters the human body is often termed as drug administration route. Of the many ways, oral and intravenous (IV) administration are the most common despite of their disadvantages like first pass metabolism, non-uniform drug distribution, limited availability of biocompatible polymers, etc. The field of other routes, generally termed non-conventional routes are yet to be explored to their potential which include numerous advantages like no first pass metabolism, better patient compliance and uniform drug concentration in blood plasma, minimum invasiveness and so on. Ocular drug delivery which involves the usage of drug loaded contact lenses is a best choice for instant and effective drug delivery. In the present article, the advatntages, erfficacy and the potential of reusable therapeutic contact lenses (TCL) synthesized by molecular imprinting technique would be discussed. The potential of transdermal devices have already been explored and is being widely used for a variety of applications like chemotherapy, pain killers, anti-inflammation purposes, etc. By the use of biodegradable polysaccharide based materials, efficacy could be manifold. The ways in which these materials were characterized, efficiency parameters and biological studies that were performed would be thrown light upon. Thus, the potential applications of novel materials for the effective delivery of drugs *via* non-conventional administration routes would be deliberated.

Keywords: Drug delivery; non-conventional routes; polysaccharides; stimuli responsive.

Anaerobic co-digestion of bagasse and filter cake for biogas production

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Abstract

Sugar industry waste such as bagasse and filter cake has large potential to get conberted into clean and green energy through anaerobic digestion. However, the lignocellulosic nature poses recalcitrance to their sustainable utilization thorugh anaerobic digestion. Chemical pretreament of lignocellulosic biomass helps to enhance their biodegrartion through anaerobic digestion. Therefore, NaOH pretrament of bagasse and filter cake was carried out in this study. The NaOH pretreament of bagasse resulted into enhanced biogas production as compared to filter cake.

Keywords: Anaerobic digestion; biomass; pretreatment; biogas.

Synthesis and Characterization of L-ascorbic acid capped Cr doped ZnS Nanoparticles

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Abstract

We report synthesis of L-ascorbic acid capped pure, 1, 3 and 5% Cr doped ZnS nanoparticles by soft chemical route. The XRD analysis confirms crystal structure of grown nanoparticles with average particle size of 4 nm. Peak broadening mechanism can be witnessed certifying the nanoparticles formation. Ultraviolet–visible absorption spectra show absorption peaks in the range of 290 to 320 nm indicating huge blue shift as compared to the bulk ZnS (340 nm, E_g = 3.6 eV) due to the quantum confinement effect. FT-IR spectrum shows the rotational-vibrational signatures of ZnS and capping agent L-ascorbic acid. Both UV-vis and XRD data confirms that the particle size of ZnS NPs increases with increase in the concentration of Cr. Keywords: ZnS NPs, Cr-doping, L-ascorbic acid, XRD, etc

Synthesis of Nanoparticles in Ionic Liquid and Photocatalytic Study Using Spectroscopic & DFT Techniques

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Abstract

Ionic liquids (ILs) have received great attention during the past two decades due to their versatile applications in various fields and are considered to be new materials and have been the subject of comprehensive experimental and theoretical studies due to their unique solvent properties and used in a wide range of applications in substitution of conventional organic solvents. Due to the non-toxic, non-volatile, and non-flammable nature of IL, it is used in different kinds of synthesis, electrochemistry, catalysis, separation techniques, and many more applications. As a result of the unique electronic, optical, magnetic, mechanical, physical, chemical, and catalytic properties of nanoparticles (NPs), there is a wide variety of potential applications. The properties of bulk materials change when they are considered in the nanoparticle form.The properties of NPs are determined by their size, shape, composition, stability, crystallinity, structure, etc. The synthesis and photocatalytic activities of 1-butyl-3-methylimidazolium tetrafluoroborate IL functionalized Ag and Cu_2O nanoparticles will be discussed in detail during the talk.The effect of IL on Ag and Cu_2O nanoparticles will be explained using DFT calculations. [1]The Ag nanoparticles (AgNPs) are functionalized by ILs prepared in the range of 40-140 nm range and are spherical. [2] Photocatalytic properties of these nanocomposites were studied for PNP reduction to AP and Methyl Orange degradation.

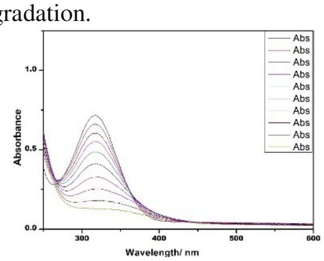

Figure: UV visible spectra of hydrogenation of PNP in presence of Ag NP

Keywords: Nanoparticle; Ionic Liquids; Photocatalytic activity; MO degradation.

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Synthesis and characterization of dibenzo[a, g]coronene and their thin film transistor properties

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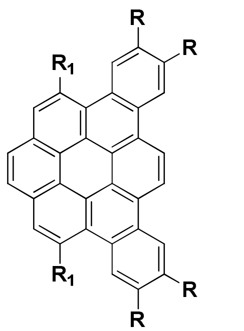
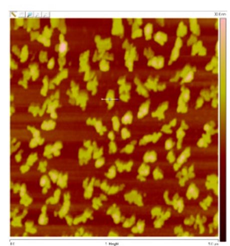
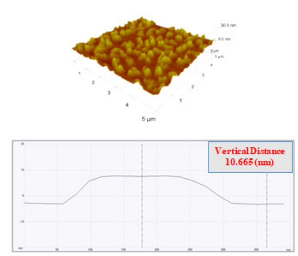
Abstract

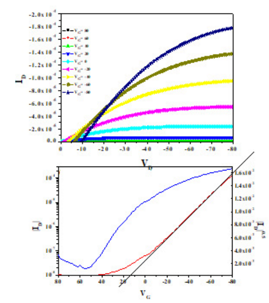
Synthesis of polycyclic aromatic hydrocarbons (PAHs) and elucidate their solidstate structures in crystals. Thesynthesis fully here is simple and provides easy access to this important class of materials. One of the most frequently used methodologies forthis purpose is the aromatic framework of PAHs to improve their physicochemicalproperties and enhance the carrier transport of the systemfor applications as organic field-effect transistors. We have designed and synthesized a new family of PAHs containing a triphenylene core which can be synthesized from aldehydes using a two – stepsequence of Mcmurry coupling, scholl reaction oxidative aromatization under mild conditions to give dibenzo[a,g]coronenes.All the fused PAHs used for the fabricated the organic thin-film transistors studies and preliminary results showing average hole mobility 0.62 cm^2/Vs and 0.46 cm^2/Vs and with on/off ratio 10^5 and 10^6 respectively.



R = Ph, Cl, Me, OMe and F







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A Proposal to Design MEMS based IOT Health Care Sensor

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Abstract
In the Present time, healthcare and other medical services can be easily accessed with the help of a smart phone. It has become more convenient to track, regulate, and monitor several medical cycles such as medicine intake, therapy, and treatment. Telehealth holds the promise to significantly impact some of the most challenging problems of our current healthcare system: access to care, cost effective delivery, and distribution of limited providers.
MEMS is the acronym for Micro-Electro-Mechanical Systems. This technology has the potential to revolutionized consumer, industrial and commercial products by fabricating micro-range miniaturized devices which are conjunction of mechanical and electronic components on a single chip. MEMS based sensors integrated into a telemedical system holds the promise to become a key infrastructure element in remotely supervised, home-based patient rehabilitation. It has the potential to provide a better and less expensive alternative for rehabilitation healthcare and may provide benefit to patients, physicians, and society through continuous monitoring in the ambulatory setting, early detection of abnormal conditions, supervised rehabilitation, and potential knowledge discovery through data mining of all gathered information.
Our proposed system's block diagram, and components are shown in Fig. 1 and Fig. 2.

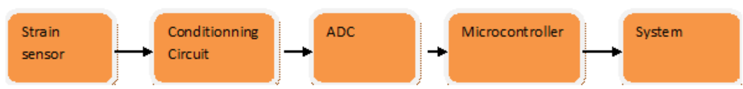


Figure 1: Basic Block Diagram of proposed proposal

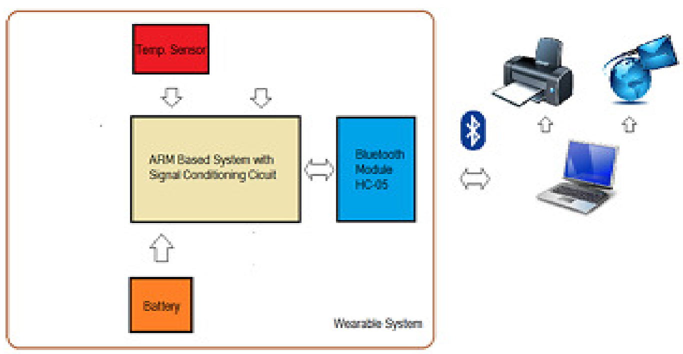
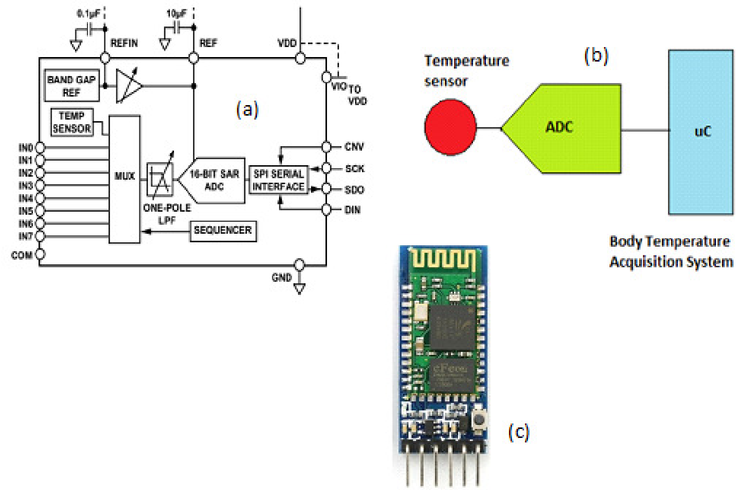


Figure 2: Basic components of proposed work

Our system consists of two parts:
(1) Wearable system, which includes sensors, signal conditioning circuits, a microcontroller and (2) a personal computer (PC) for collecting and elaborating data. The wearable system mainly consists of strain sensor, temperature sensor, bluetoothmodule , the custom electronics forconditioning and transmitting the sensor signals, and a battery. Here we use Bluetooth UART module based on HC-05 as it is easy to use and designed for transparent wireless serial connection setup. A temperature sensor which has following properties:calibrated directly in centrigrade,linear +10mv/degC scale factor,swuitable for remote application ,low self-heating,and low cost.Multiple such kind of sensors can be used simultaneously. Finally a CPU which plays the pivotal role of the whole process system. It is the heart of the whole processing system which is programmed. Circuit diagram of different parts are shown in next figure (3-4).



(a) Circuit diagram of ADC, (b) temperature sensing system, (c) Bluetooth device
Figure 3: Proposed System Components and connections

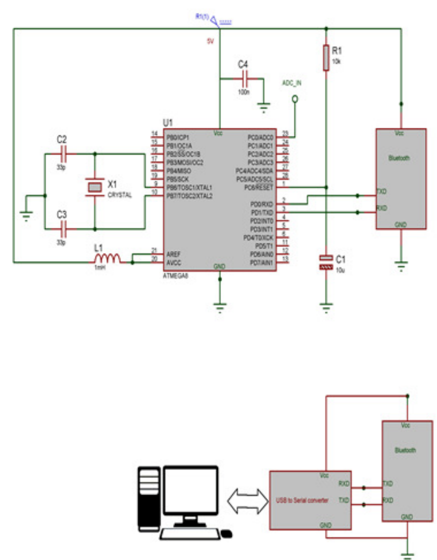


Figure 4: The measurement system including the microcontroller, the transmitting unit and the power supply. The PC collects the data via Bluetooth connection

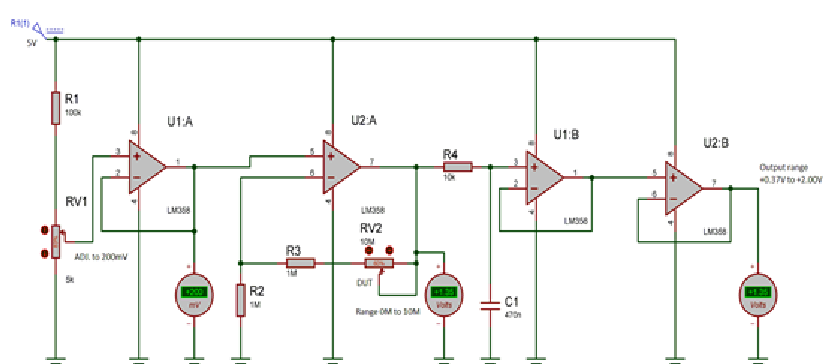


Figure 5: Conditioning circuit

In the above we use OPAMP, low pass filter, buffer etc. All functions are given below:

1. U1: A op amp is acting as constant current source where the current is limit by RV1.
2. U2: A op amp is a non-inverting amplifier and its gain developed by the sample's stressed resistance.
3. A low pass filter is incorporated after that.
4. Then a buffer is placed. And the circuit runs by 5V DC power.
5. The output of the buffer is fed to the ADC_IN pin of microcontroller and it has 10 bit SAR ADC internal which is further fed to the Bluetooth module to transfer data to the PC where real time graph to be plotted.

Keywords: IOT; MEMS; Healthcare; Conditioning Circuit.

Tb^{3+}:$Li_6AlGd(BO_3)_4$ phosphors for lighting applications

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Abstract

Different concentrations of Tb^{3+}ions doped $Li_6AlGd_{(1-x)}Tb_x(BO_3)_4$phosphors were prepared by solid state reaction method and characterized through X-ray diffraction, Fourier Transform infrared, high resolution-scanning electron mcroscopic and photoluminescence studies. The XRD analysis showed that the studied phosphors were crystallized having $Li_6Al_2(BO_3)_4$ and Gd_2O_3 phases. The increased concentration of Tb^{3+}ions leads a slight change in length of various FTIR bonds resulting a small shift in their positions towards longer wavenumber regions. The excitation analysis was carried out controlling the emission wavelength corresponding to Tb^{3+}:$^5D_4 \rightarrow {}^7F_5$(545nm) transition optimizing 378 nm for efficient emission. The emission spectra showed twogroups of emission bands through Tb^{3+}:$^5D_3 \rightarrow {}^7F_J$ and Tb^{3+}:$^5D_4 \rightarrow {}^7F_J$ transitions. The concentration dependent investigations revealed the optimum Tb^{3+}ions concentration as 2.0 mol% for intense luminescence. Upon 378 nm excitation, they produce greenish-yellow luminescence of colour purity 60% with CIE colour coordinates of (0.286, 0.572). These phosphors show their applicabilityas green component in the design of phosphor converted white LEDs.

Keywords: Powder phosphor; Solid state method; Greenish-yellow emission; Lighting devices.

Investigation of optical properties of a copolymer polymer blend

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Abstract

We investigated the optical parameters of doped polymer blends (PVC / PMMA). The energy gap (Eopt), absorption edge, optical permittivity, refractive index, constant B, (n0B)-1, and N/m* are composition-dependent. Increase the dopant concentration. The refractive index (n_0) was calculated in the range of 400 to 1000 nm and its linear or nonlinear behavior was also investigated with increasing Iodine content. The ratio of carrier concentration to the effective mass (N/m*) was evaluated.

Keywords: Optical properties; PVC/PMMA blends; optical constants.

In vitro examination of anticancer effectiveness of chitosan/biogenic silver nanoparticle conjugate on MDA-MB Cell

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Abstract

Cancer nanomedicine is a developing field with a cutting-edge approach to cancer treatment. In this study, in vitro tests on MDA MB (human adenocarcinoma) cells were used to assess the anticancer efficacies of biogenic silver nanoparticles stabilized by chitosan (Ch/Bio- AgNPs). By using the MTT assay, antiproliferative and cell apoptosis assays, ethidium bromide/acridine orange double staining assay, RO analysis, DNA fragmentation studies, caspase 7 and 9 assays, and flow cytometry, the IC 50 for Biogenic silver nanoparticles (BioAgNP) and Ch/Bio-AgNPs was investigated.The real-time PCR gene expression analysis employed the housekeeping gene β-actin. The computed IC 50 values for Bio-AgNP and Ch/Bio-AgNP for MDA MB cell lines were 4.3460.6381 g/ml and 0.98510.0065 g/ml, respectively. The findings demonstrated Ch/Bio-AgNPs' effectiveness as an anticancer agent by demonstrating typical apoptosis and up-regulation of the p53 and p38 genes.

Keywords: Cancer nanomedicine; *in vitro* anticancer studies; MDA -MB; Chitosan/Bio-AgNP conjugate.

Evaluation of hydrocarbon-basednon fluorinated membranes as electrolytes for efficient Microbial Fuel Cell performance

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Abstract

Microbial Fuel Cells (MFC) is a bio-electrochemical method that drives a current via bacteria and mimics bacterial interactions found in nature. Proton exchange membranes(PEM) play a crucial role in membrane-based MFC. Conventionally, Nafion 117 has been the membrane accepted worldwide. However, Nafion has several limitations including a fluorinated backbone, high cost, substrate crossover, oxygen leakage and accumulation. Hence, intensive research is carried out to find a suitable membrane to overcome the problems of oxygen cross over and substrate loss. The alternate membrane should be environment friendly, with increased power density and should be cost-effective in addition to lower oxygen permeability to maintain an anaerobic environment in the anodic chamber of the cell. Our research focuses on non-fluorinated polymer based membranes such as Sulfonated Poly Ether Ether Ketone (SPEEK) with Silver (Ag) and sulphonated forms Titanium Nanotubes (S-TNT), Silicon dioxide(S-SiO_2), Polyhedral Oligomeric Silsesquioxane (S-POSS). The physicochemical properties of the composite membranes such as water uptake, ion–exchange capacity, ionic conductivity, dissolved oxygen crossover, durability and transport of cations were studied for suitability in constructed tubular MFC. The presentation will highlight the performance of such lab-synthesized membranes in MFC terms of power density and microbial community analysis.

S.No	Membrane	Power Density (mWm^{-2})	COD removal (%)	References
2	SPEEK + S-TNT	121 ± 1.8	79.3	(Kugarajah & Dharmalingam (2020)) *Chemical Engineering Journal*
3	SPEEK+ S-SiO_2	154 ± 1.5	80.1	(Kugarajah et al., (2020)) *Enzyme and Microbial Technology*
4	SPEEK + S-POSS	162 ± 1.4	79	(Kugarajah & Dharmalingam, (2020)) *Chemosphere*
5	SPEEK + Ag	156 ± 0.5	79.9	(Kugarajah & Dharmalingam, (2021)) *Chemical Engineering Journal*

Biomedical application of substituted hydroxyapatite-polymer electrospuncomposite

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Abstract

Electrospinning is a technique used to prepare nanofiber scaffold. The scaffold used in bone tissue engineering should meet certain requirements like biocompatibility, mechanical strength, bone bonding ability. Bone itself is a composite of calcium phosphate and collagen. In recent time, many researchers are focussing on scaffold which mimic the extracellular matrix. In the current work, zinc and copper ions were substituted in the calcium site of hydroxyapatite of formula $Ca_5(PO_4)_3OH$ and studied for biomedical applications such as hemocompatibility, antibacterial activity. Silk fibre (SF), methyl cellulose (MC) were added to prepare the composite of substituted hydroxyapatite and polymer. The composites were characterized using various techniques such as powder XRD, FTIR, SEM. The composite was subjected to porosity measurement, hemocompatibility, antibacterial activity against *E.coli, S.aureus*and*C.albicans,*mechanical strength, cell viability and bioactivity using SBF solution for 28 days. All the synthesized composites were found to be hemocompatible with hemolysis ratio of less than 2% ratio. An enhanced zone of inhibition was noted with an increase in the wt % of Zn-HAP into the SF/MC was observed against *E. coli* (34±0.33 to 47±1.15), *S. aureus* (28±0.24 to 38±1.32) and *C. albicans*(24±0.36 to 39±2.36).110.92±0.58 MPa of tensile strength was observed using zinc substituted hydroxyapatite/Silk fibre/Methyl cellulose composite which was higher than copper substituted hydroxyapatite composite. The optimized composite $Zn_{1.0}Ca_{4.0}(PO_4)_3(OH)$/SF/MC) nano-composite exhibited good cell viability against human bone osteosarcoma (MG-63) cells.

Keywords: Polymer composite; substituted hydroxyapatite; mechanical strength; antibacterial activity; bioactivity.

Exploring the Boundless Potential: Surface-engineered Magnetite Nanoparticles in Environmental, Biomedical, and Forensic Sciences

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Abstract

The superparamagnetic behaviour of magnetite nanoparticles has attracted significant attention from researchers due to their potential applications in environmental, biomedical, and forensic sciences. In this study, functional magnetite nanoparticles were developed using amino acids as the functionalizing agent, which showed promise in various applications. In environmental science, Cys@MNPs-GO nanocomposites were developed for adsorption and degradation of basic dyes from waste water. In biomedical science, magnetic nanocarriers were developed for sustained drug delivery for plant based lipophilic compounds to enhance bioavailability. Furthermore, Trp@MNPs were utilized as a smart, multifunctional nanoprobe for latent fingerprint development on porous surfaces such as cotton, polycotton and polyester using non-invasive technique. The presentation will highlight the advancements and potential of surface-engineered magnetite nanoparticles in the aforementioned fields, with an emphasis on surface coating that improves the stability and biocompatibility for versatile applications. Therefore, the scientific community can further explore the boundless potential of surface-engineered magnetite nanoparticles in environmental, biomedical, and forensic sciences.

Keywords: Surface functionalization; Magnetite nanoparticles; waste water treatment; drug delivery systems; fingerprint; forensic science.

Sandwich Composites of Polygon-Shaped CFO Substrate adorned with BiS NPs: Strategy to Manage and perform as Heavy Metal Sensor, Anti-Fungal and Photocatalytic Application

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Abstract

Pollutants, such as heavy metal ions(HMIs), azo dyes, and domestic sludge(DS), are becoming a serious threat to the aquatic environment. To detect HMIs, electrochemical and calorimetric studies have been performed due to their high sensitivity and selectivity. Heterogeneous photocatalysts have been used to degrade and decolorize azo dyes because they are adaptable, cause less secondary pollution, and are cost-effective. In this study, synthesized bismuthsulfide nanoparticles adorned with cobaltferriteoxide(BiSNPs@CFO) substrates by using chemical methods. X-ray diffraction (XRD), UV-Vis-spectrometry, scanning electron microscopy (SEM), and energy-dispersive x-ray spectroscopy was employed to analyze the structural and morphological nature of thehighly stable, multifunctional composite. The XRD pattern demonstrated the formation of the heterojunction material, which was further, confirmed using SEM images. The primary source of Cd^{2+} ions in digested detergent samples was detected and coded as samples A, B, and C. Laundry wastewater was denoted as sample D. Both photoluminescence spectroscopy(PL) and cyclic voltammetry techniques(CV) were employed to detect the presence of HMIs in the selected samples. Pollution assessment risk index values indicated that samples B and C contributed to HMI pollution more compared with sample A. The I_{geo}(geo-accumulation) values were 4.08(sample B), 3(sample C), and 13.5(sample D), which indicated a high pollution level. Then, the methylene blue(MB) dye was periodically degraded at a fixed concentration and pH, and the efficiency reached 83%, with the apparent rate constant of 0.0106/min with a high R^2 value of approximately 0.9015. In this study, the two pathogens were isolated from laundry wastewater, namely *Aspergillus* sp. and *Trichoderma*sp, and their growth and biomass production were examined. The antifungal activity of BiSNPs@CFO composites was studied using the standard fluconazole.The nanocomposites can be used as a probe to detect the presence of Cd^{2+} ions and degrade azo dyes and *Aspergillus* sp. and *Trichoderma* sp. predominantly grown in laundry wastewater.

Biopolymer-based films and coatings in food packaging applications

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Abstract

Food sectors are facing issues as a result of food scarcity, which is exacerbated by the rising population and demand for food. Food is generally wrapped and packaged using petroleum-based plastics such as polyethylene, polyester, polyvinyl chloride, etc. However, excessive use of these polymers has already imposed tremendous environmental issuers and health risks. Recently, research is focusing on the use of bio-based materials for food packaging. Biodegradable polymers that are compatible with food products are used to make edible packaging (film, coating, etc.) materials. These can be ingested with food and provide consumers with additional health benefits. Recent research has shifted its focus to functional coatings and films-based food packaging, which can provide a material with an additional distinct feature, such as protection from unwanted food-borne microbes and prevention of food oxidation. The properties and applications of several bio-based polymers in food packaging is already well-known. The numerous types of edible film and coating production technologies are also been well explored. Furthermore, the use of edible films and coatings in the food packaging industry for active and smart packaging has under examination. It is expected that in future the edible films and coatings might be applied commercially to improve shelf life and preserve the quality of foods.

Keywords: Biopolymers; Biodegradable; Film & coatings; Food shel-life; Food packaging.

Development of Novel Coating Material for Solar-Thermal Conversion

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Abstract

One of the key goals of the Sustainable Development Goals 2030 is to achieve water security and safety for drinking and sanitation, which is considered as one of the major concerns in many developing countries. With the usage of high-grade energy-based sources, conventional water treatment such as RO, MED, and MSF has been found to be energy-intensive and it contribute towards rising greenhouse gas emissions. Therefore, alternative techniques to produce potable water with the use of clean energy resources such as solar desalting or solar still is a perfect answer for water scarcity. It is suitable for dry and semi-arid regions with abundant yearly radiation. Brackish water and sea-water are generally used as feed water for purification in the solar still. However, the major concern of solar still is its lower water generation capacity and thermal efficiency. In this regard, the present work explores the role of nanocoating in improving the rate of evaporation and water yield of solar still. Diffeent conductive material based nanopaint was explored as the thermal enhancer for increasing the rate of evaporation and water yield of the solar still. It exhibited higher thermal conductivity, and long-durability along with superior thermal performance. It is concluded that the nanocoated solar absorber demonstrated superior thermal performance that will pave the way for enhancing the evaporation and water generation potential of solar-thermal desalination units for wastewater, and seawater purification.

Keywords: Solar Energy; Nanoparticle; Coating; Water Desalination; Thermal Energy.

Role of micro/nano-size ceramic fillers in enhancing electrochemical properties of flexible polymer electrolyte membranes for metal/ion batteries

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Abstract

Polymer-based electrolytes have receivedsignificant attention for battery applications in last decade. Different than conventional liquid electrolytes, these electrolytes possess high flexibility and shape versatility, which demonstrate the suitability of these systems for flexible and wearable electronics applications. However, issues like low ion conductivity, poor cation transport number, narrow electrochemical stability window andpoor electrode/electrolyte interfacialproperties of polymer electrolyte are still the main defiesfor commercial development.In order to deal with these issues, various interesting approaches of structural tailoring of polymer matrix have been attempted such as plasticization of polymer network, polymer blending, dispersion of ceramic fillers etc. The dispersion of micro/nano-size ceramic fillers in the polymer electrolyte is one of the most promising approach.

In last couple of years, our research group has studied different micro/nano-size ceramic fillers such as SiO_2, TiO_2, Al_2O_3, $NaAlO_2$, TiO_2, MgO, and ZrO_2 in polymer electrolytes. The filler dispersed polymer electrolytes have been found to display significant ionic conductivity ~ 1 mS/cm with superior electrochemical stability window > 3.5 V and significantly enhanced cation transport number. In the present talk,different methods of preparation of micro/nano-size ceramic fillers dispersed polymer electrolytes will be presented. The effect of the fillers on the structural and electrochemical properties of few important composite polymer electrolytes, prepared by our group, will be discuss. A section of the talk includes the strategies to preparehigh performance composite polymer electrolytes using different types of ceramic fillers including active and passive ones.

Keywords: Ceramic fillers; polymer electrolytes; conductivity; electrochemical properties.

Biogenic synthesis of TiO_2 NPs by extract from Pigeon Pea for elimination of hexavalent chromium from wastewater

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Abstract

Titanium oxide nanoparticles (TiO_2 NPs) are valuable materials with a large number of application in different sectors used. Green synthesis of NPs is gaining interest as they depict environmental friendly properties thus avoiding use of toxic chemicals. In this study, TiO_2 NPs were easily synthesized following green approach using extract of *Cajanus Cajan* (Pigeon Pea) easily found in every household kitchen waste by simple hydrolysis mechanism. Characterization of NPs was carried out to confirm the formation of particle using Fourier Transform Infrared Spectroscopy (FTIR) analysis, X-Ray Diffraction Diffractometer (XRD), Scanning Electron Microscope (SEM). It was concluded that crystalline size of 20-25 nm size of TiO_2 NPs was obtained using Debye Scherrer formula. The performance of syntheiszed particle was studied both in dispersed and undispersed phase against elimation of Cr(VI) removal from wastewater and concluded that the recovery and reusability of undispersed TiO_2 NPs was found excellent compared to dispersed medium. Antimicrobial property of particle against Gram-negative *E. Coli (Escherichia coli)* further depicts particle possess excellent antimicrobial property.

Keywords: Antimicrobial; Dispersed; Extract; Nanoparticle; Wastewater.

Crystal Structure, Surface Roughness and Magnetic Properties of FePtCo Ternary Alloys Thin Films

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Abstract

Recently FePt based films attracted the attention of the researchers due to its intriguing features such as magnetic anisotropy, high saturation magnetization, and other tunable properties, leading to their promising application in magnetic storage devices. It was further empahsized that adding a thrird transition metal elements in such materials will enhance its properties. In this work, we have deposited thin films of FePtCo ternary alloys using a DC sputtering technique. The crystal structure, surface roughness, and magnetic properties of these films have been studied in a great details. Moreover, we have looked into the influence of in-situ annealing of the subtrate as well as post-annealing on its magnetic properties. These films were found to be crystallized in the face centeredcubic structure and its was evident that surface roughness varies under different conditions. The in-plane and out-plane magnetizationa versus field measurements indicate that these films exhibit in-plane magnetic anisotropy and the saturation magnetization was of the order of 10^6 A/m. A corelation of the structure, surface roughness and magnetic properties of these films prepared under three different conditions will be discussed.

Keywords: FePtCo Ternary Alloys; Thin Films; Magnetic Properties; Crystal Structure; Surface Roughness.

Uniform and Rapid Film with Precise composition and structure for Device Application: Electrochemistry is the Pathway

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Abstract

With the advent of sophisticated instruments and understanding of thermodynamic principles, electrochemistry an age-old concept, has emerged as an advanced tool to design and synthesize advance materials. Guided by few reaction variables electrochemical techniques has emerged functional and smart materials like conducting polymers (polyaniline, polypyrrole, polythiophene, etc.) and their composites, metal nanoparticles (Au, Pt, Pd, Ag, etc.), nanostructured carbonaceous materials (graphene, graphene oxide, etc.), metal-organic frameworks (MOFs), porous template membranes (porous anodic alumina) etc. based on the reactions driven by the transfer of electron over surface interface (substrate/electrode). Electrodeposition is performed via techniques like cyclic voltammetry, chronoamperometry, double phase deposition, step voltammetry, electrophoretic deposition etc. Precise control over current density, driving force of electron-transfer processes, applied potential and optimised reaction time has guided electrochemistry in achieving size selectivity (synthesis of materials from nano range to bulk) and complex shapes via template/non-template assisted methods. The performance and properties of the deposited materials rely over the choice of electrodes (working, counter and reference), solvents (protic/aprotic, aqeous/non-aqeous), nature of supporting electrolyte, cell design to obtain a wide potential window (range for oxidation/reduction of reactants). Even though, organic solvents can operate over wide potential window they suffer from disadvantages like low vapor pressure, flammability, toxicity, as an alternative during recent times, room temperature ionic solvent, eutectic solvents have emerged as a solution. Temperature of the reaction also plays a key role in oxidation of reactants during electropolymerisation of one-dimensional nano-porous membranes. From the plethora of opportunities available our group has performed electrosynthesis of various advanced functional materials such as few layered reduced graphene oxide (ERGO) synthesis and utilized it for fabrication of triglyceride sensing, electropolymerized polyaniline matrix for development of reusable cholesterol and glucose sensor, MOF template guided rapid electrosynthesis (120sec) of anisotropic gold nanostructures for pesticide sensing, electrochemical synthesis of Metal organic framework. We are sailors in sea of electrochemistry and on a voyage for exploring its novel opportunities.

Keywords: Electrochemistry; template; solvent; electrolyte.

Preparation and Characterization of Eco-friendly Functional Food Packaging Film based on PLA/PCL/Turmeric Essential Oil

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Abstract

In recent times, use of biodegradable polymeric materials has full-fledged in many sectors to replace synthetic fossil source derived polymers. Active packaging of food materials using biodegradable polymers helps in safe preservation of food with no ecological footprints and it also promotes sustainability if the materials are based on green chemistry. In the present work, turmeric essential oil was successfully extracted from matured turmeric leaves (biowaste) by hydrothermal distillation process without using any organic solvents. The extracted oil was mixed with polylactic acid/polycaprolactone (PLA/PCL) blend solution and casted on Teflon molds. The dried films with potential antimicrobial activity was tested for mechanical properties like tensile strength, percent elongation, elastic modulus, tear propagation resistance and heat seal strength. The films were further characterized by Fourier transform infrared spectroscopy (FTIR), Raman spectroscopy, X-ray diffraction (XRD), polarizing microscopy, antioxidant test, water vapor transmission rate (WVTR) test, gas chromatography and mass spectrometry (GCMS) and antimicrobial test. The results showed that 90/10 (wt%) PLA/PCL is better in terms of transparency and mechanical strength. The essential oil was encapsulated at different weight percentages (1, 5, 10 and 15 %) to 90/10 blend system and evaluated for assuring the mechanical strength and antimicrobial activity. The addition of essential oil improved the stiffness of film, which is also evident from increase in crystallinity of the film (from XRD data). The antioxidant activity of films increased with increasing essential oil concentration. The WVTR values of 90/10 blend was found to be around 17.87 g/m^2 day, with the addition of essential oil there was no adverse effect on WVTR, it remained around 16-20 g/m^2 day. The bread packed with essential oil loaded film showed extended shelf life (20 days) than the control film indicating potential antimicrobial activity of the film.

Keywords: Eco-friendly; Food Packaging; Turmeric Essential Oil; antimicrobial activity.

Hall Effect and Chemical reaction of nanoparticle shapes on peristaltic flow through asymmetric channelof Casson fluid in presence of slip effects

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Abstract

In this research paper, we have studied nanoparticles shapes on peristalsis of Casson fluid in achannel flow is completely new concept and Casson fluid behavior and chemical reaction and hall effects on peristaltic flow with different shapes are not yet in the literature review. For the study of such flows is various relevance applications in biomedical engineering and industries.For nanofluid, copper (II) oxide or cupric oxide nanoparticles of needle and plateletshapes of different sizes are considered in the present work and we have considered water as a base fluid. Slip conditions is maintained at the velocity, temperature andconcentration of nanoparticles. The velocity slip effect and concentration slip effect increases the fluidwhile it enhanced the velocity and reduced the nanoparticle concentration.The governing equations are constructed under long wavelength and low Reynolds number assumptions. The present study focusses on copper (II) oxide nanoparticles with two different shape of nanoparticles. Here, we observed that the different shapes are different thermal conductivity, but the plateletshaped nanoparticles have high thermal conductivity as compared to needle shaped nanoparticles. The problem is modelled in terms of partial differential equations with suitable slip boundary conditions and then computed by Homotopy Analysis Method with Mathematicasoftware. The influences of nanoparticles shape on velocity, pressure, temperature and nanoparticle concentration distributions are discussed with the help of graphs.

Keywords: Peristaltic Flow; Chemical reaction; Hall effect; Copper (II) oxide; Casson fluid; Shape factor.

Allicin mediated bio-fabrication of Silver nanoparticles and comparison of its antioxidant, antibacterial and anticancer activity with garlic extract

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Abstract

Allicin is a natural bioactive metabolite in garlic and has immense biological properties and therapeutic value. It is a fascinating compound and its potential in nano-based materials have been rarely explored. In this study, Silver nanoparticles (AgNPs) were bio-fabricated using Allicin and the antioxidant, antibacterial and anticancer properties of AgNPs and aqueous hill garlic extract were compared using in-vitro bioassays. The UV-Visible spectrum revealed a maximum absorbance at 426 nm for AgNPs and 207 nm for garlic extract.The crystalline nature of the AgNPs was confirmed by XRD analysis. Functional groupsof the AgNPs and garlic extract were identified by FTIR spectroscopy. TEM analysis revealed that the AgNPs were predominantly spherical in shape and the average size was the particles was calculated as 20 ± 0.3 nm. Antioxidant activity assays demonstrated that Allicin mediated AgNPs and aqueous garlic extracts showed effective DPPH and H_2O_2 free radicals scavenging activity. AgNPs demonstrated potential bacterial growth inhibiting property when tested against gram positive and negative pathogens when compared to aqueous garlic extract. The minimum inhibitory concentration was established by broth dilution method and the lowest concentration of AgNPs required to inhibit the bacterial pathogens ranged between 11.26-23.25 µg/ml and 120- 462.96 µg/ml for aqueous garlic extract.*E.coli* was identified as the most susceptible organism and *V. cholerae* was the least inhibited species. The cytotoxicity results of the AgNPs tested on Human cervical cancer cell lines (HeLa) revealed that the synthesized nanoparticles can potentially affect the viability of these cancer cells (IC_{50}=24.09 µg/ml) and caused depolarization of the mitochondrial membrane resulting in apoptosis of the cancer cells. An $IC_{50}$of 125.07 µg/ml of garlic extract was required to inhibit the growth of the cancer cells. Thus, the study revealed that when compared to aqueous garlic extract, AgNPs synthesized using Allicin are promising therapeutic candidates and they can be further investigated for their potential roles in-vivo.

Keywords: Bio-fabrication; Allicin; AgNPs; Antioxidant; Antibacterial; Anticancer.

Activated Carbon: The Black Diamond

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Abstract

Activated carbon is a porous carbonaceous material containing carbon as major constituent along with the traces of other elements oxygen, hydrogen, nitrogen and sulphur. It is derived from any carbonaceous raw materials such as bamboo, coir, wood, peat, coal, lignite, coconut shell etc. Their preparation involves two main steps: the carbonization of the raw material at temperatures below 800^0 C in an inert atmosphere and the activation of the carbonized product. It has very high surface area, extensively developed porous structure, high pore volume and high degree of surface reactivity. Activated carbon is potent adsorbent which has have been widely for removal of noxious pollutants from air and water since decades. However, due to its unique physiochemical properties, it finds utility in many other applications too such as catalysis, solvent recovery, energy & gas storage, personal care products, food & beverage industry, pharmaceutical and metallurgy. The adsorptive, catalytic, electrical, chemical and other useful properties of AC are significantly influenced by its porous as well as chemical structure. The porous structure consists of pores of different sizes and shapes while chemical structure is due to presence of surface functional groups which can be classified as acidic, basic and neutral. Further, its physical and chemical structures can be tuned by choice of raw material, activation method and surface functionalisation. In addition, activated carbons are available in various forms, including powders, cylindrical extrudates, spherical beads, granules and fibers. Different types of activated carbons are suited for different applications. In this review, all the important aspects of activated carbons such as their preparation, structure & properties and modification methods will be discussed. The review also highlights the environmental as well as non-environmental applications of activated carbons.

Keywords: Activated carbons; structure; physicochemical properties; environmental and non-environmental applications.

Photo-thermal actuators based on polyaniline incorporated liquid crystal Elastomers

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Abstract

Liquid crystal elastomers (LCE) are soft actuators which exhibits a spontaneous reversible deformation in response to heat. However, multi-stimuli responsive LCEs (for example sensitive to light, electric and magnetic field) having better performances can be obtained through incorporation of other materials such as nanoparticles, inorganic conductive thermal fillers, conjugated polymers etc. Conjugated polymers are efficient infrared (IR) light absorbers and exhibit excellent photothermal conversion efficiency. Thus, upon used as dopant in LCEs, IR actuating LCE composites can be obtained. In this regard, we have prepared LCE-polyaniline composite films and their response to IR radiation is investigated. The elastomers and composite films were prepared following thiol-ene Michael addition click chemistry method. Polyaniline was prepared through chemical method. Different wt% of polyaniline was incorporated in LCE during the preparation to obtain the composite films. The films were characterized using FTIR, UV-DRS, SEM, and Tensile test techniques. The thermal and IR actuation of the films are studied and the results are presented. The polyaniline incorporated LCE films showed reversible longitudinal contraction and lateral expansion on irradiation of IR light. More interestingly, the films displayed excellent weight lifting capability.

Keywords: Liquid crystal elastomer; Polyaniline; Photothermal Actuation; Mechanical property; Weight lifting.

Aqueous extract of CycleaPeltata leaves adsorption behavior towards aluminium corrosion in alkaline media

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Abstract

Plant extracts have been successfully used to develop efficient and environmentally friendly corrosion inhibitors for metals in alkaline mediums, and research into the topic is constantly growing.In the present study aqueous extract of CycleaPeltata(CP) leaves extract was used as corrosion inhibitor for Aluminium coupon in alkaline medium. The effectiveness of the inhibitor in corrosive medium was assessed using several methods. The SEM method was used to assess the plates' microscopic properties. Potentiodynamic polarization measurements were used to assess the plates' electrochemical properties. According to results from the potentiodynamic polarisation curve, CP leaves extract is a mixed-type corrosion inhibitor since it may concurrently inhibit anodic and cathodic reactions in aluminium metal. Gravimetric measurements were made in order to examine the effectiveness of the inhibition and the rate of corrosion. CycleaPeltata extract is a potent inhibitor owing to the presence of organic components such as sugars, tannins, steroids, saponins, and flavonoids, which have been found through phytochemical analysis. The extract components are adsorbed on the aluminium surface resulting in an inhibitory action. The spontaneous adsorption process follows the Langmuir adsorption isotherm.

Keywords: Bio inspired Corrosion inhibitor; Potentiodynamic Polarization Study; Gravimetric Analysis; Weightloss Measurement; Adsorption Study.

Carbon nanostructures based flexible strain sensors

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Abstract

Flexible polymer nanocomposite-based strain sensors shows un-precedent merits in stretchability, sensitivity, and mechanical strength compared to conventional metal or semiconductor-based strain sensors. The traditional metal, ceramic, and semiconductor materials cannot satisfy the current requirements for emerging flexible strain sensors due to low sensitivity, ease of fabrication, and limited stretchability. Piezoresistive strain sensors with good sensitivity, reproducibility, stretchability and processability are essential for the applications such as human health monitoring, structural health monitoring, and robotics. Advance carbon nanostructure reinforced polymer nanocomposites can provide good mechanical properties, excellent piezoresistive properties, and excellent stretchability in the application of strain sensors, which show great potential in structural health monitoring for aerospace industries and human health monitoring. Herein, we present the recent development in the research of flexible carbon nanostructures reinforced polymer nanocomposites strain sensors. The future challenges are also highlighted during the presentation. The high value of gauge factor nanocomposite materials, their tunable sensitivity in small and large strain regimes, enhanced strength, and ease of fabrication make them attractive for high-performance strain sensing devices.

Keywords: Strain sensors; Carbon nanotubes; Graphene; Polymer nanocomposites.

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Optimizing Sustainable Nanomaterials for Photocatalytic Conversion of Solar Energy to Green Hydrogen

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Abstract

One of the alarming problems of modern civilization is global warming due to the inevitable rise of CO_2 in the environment, mainly because of the excessive use of traditional fossil fuels. The gradual depletion of fossil fuels is another challenge regarding the future energy demand; therefore, alternative renewable energy research is necessary. One of the alternative approaches is the solar fuel generation by means of photocatalytic water splitting and more specifically, hydrogen evolution from water through the reductive half-reaction. Hydrogen is the cleanest fuel and does not produce any greenhouse gas upon direct combustion, or even while acting as a chemical feedstock for other transportable fuel generation. Therefore, it is desirable to produce efficient photocatalysts for solar water splitting. Till date several advancements have been made with metal-based inorganic semiconductor photo-catalysts. However, their practical applicability is still under debate considering the environmental sustainability, stability and economical expenses. As a result, it is essential to develop alternate photocatalysts that are environmentally sustainable, cost-effective, stable and highly efficient. The metal-free approach is one of the most promising approaches in contrast to the traditional metal based photocatalysts. In this regard, our major focus is to optimize carbon-based materials and their hybrids as alternative metal free photocatalysts for solar H_2 production. It includes the rectification of exciton generation, charge separation and interfacial photochemical processes for photocatalysis, followed by possible optimization pathways of these typical all carbon-based materials.

Keywords: Sustainable nanomaterials; Photocatalysis; Solar energy to Green Hydrogen.

Nano-based materials in medical applications

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Abstract

Nano-based materials have turned out to be very promising in generating newer medical applications. Carbon nanotubes (CNTs) exhibit outstanding intrinsic physical and chemical properties that have been intensively explored for versatile applications in the past few years. Nanotubes are classified as single-walled and multiwalled nanotubes. There are various methods of production of CNTs such as arc discharge, laser ablation, chemical vapor deposition, flame synthesis method, and silane solution method. Parameters such as surface charge, size distribution, structure, surface area, surface chemistry, and agglomeration state, as well as purity of the samples, have a considerable role in the reactivity of CNTs. CNTs hold good for desired drug delivery systems for gene transfer, treatment of cancer, transdermal, and DNA applications. CNTs have found their use in artificial implantation due to their size, which easily gets attached to the other amino acids where body oftenly shows rejection to the implants. Their application has also been seen in tissue regeneration where superior mechanical strength of CNTs plays a role. Carbon nanotubes have a promising application in the interesting field of drug delivery because of its unique physic-chemical properties along with ease of modification. The success of these applications largely depends on the toxicity of CNTs to human beings as well as the environment. With the increasing utilization of CNTs, research is needed to know their toxicity.

Keywords: Carbon nanotubes (CNTs); Drug delivery system; functionalization; properties.

Biomedical applications of nano-based Photoacoustic technique

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Abstract

Recently, Photoacoustic (PA) technique has emerged as a potential diagnostic tool for different disease diagnosis, thanks to its unique features e.g., non-invasive, non-ionizing, high contrast, and good sub-centimeter penetration depth. PA is a pump and probe technique that utilizes nanosecond laser irradiation for sample excitation and probe acoustic signals produced owing to the thermoelastic expansion of the sample. These acoustic signals are referred to as PA signal which is used for PA image reconstruction as well as PA signal analysis that is employed for different disease diagnosis. Unlike conventional techniques (X-ray, Ultrasound), PA is a hybrid technique that fuses the intrinsic advantages of conventional optical (high resolution) and ultrasonic (sub-centimeter penetration depth in biological tissue) techniques. Further different nanoparticles (e.g. gold, melanin, copper sulphide, polymer nanoparticles) are employed for enhancing the contrast of the PA image by amplifying the PA signal amplitude for deep tissue imaging. Therefore, PA has been explored for a spectrum of biomedical applications. In this work, the basic physics of PA would be discussed followed by the different types of PA techniques e.g. PA imaging and PA frequency spectral analysis, and the role of different nanoparticles in PA techniques are delineated. Later, some of the major biomedical application areas of the PA technique would be discussed.

Keywords: Laser; ultrasound; photoacoustics; signal analysis; frequency spectrum.

Development of Hyaluronate Tethered Magnetic Nanoparticles for Targeted Anti-Cancer Drug Delivery

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Abstract

Despite the tremendous progress in understanding the molecular basis of the disease, cancer still remains one of the leading causes of deaths. Recently, advances in nanotechnology are rapidly enabling the development of novel, multifunctional materials with combined cancer specific targeting, therapeutic and diagnostic functions within a single nanocomplex (NP) that address the shortcomings of traditional disease diagnostic and therapeutic agents. Among the myriad of nanocarriers, magnetic nanoparticles (MNPs) have sparked extensive promise as novel theranostic applications as these MNPs can be directly targeted to the diseased cells with effective therapeutic efficiency. For this, these MNPs should be modified with some highly biocompatible polymers (specially polysaccharides) exhibiting the cancer targeting properties that can strongly interact with receptors expressed on the target cancer to facilitate accurate detection of the specific cancer and enhanced delivery to the target site while reducing unintended side effects. Over the last few years, many groups have reported hyaluronic acid (HA) as the targeting agent as it directly delivers targeted MNPs to CD44 overexpressed cancer cells. In most of the cases, doxorubicin (DOX) has been used as the anticancer drug as it is largely utilized for treating a broad spectrum of cancers. In our work, we have designed a novel, intravenously injectable, CD44 receptor targeted MNP formulation, where the HA moiety of MNPs facilitate easy detection of cancer cells via receptor specific interactions, DOX can regress the cancer cells with simultaneous imaging efficacy. This theranostic MNPs led to the formation of novel nanoformulation, capable of performing concomitant detection, regression and imaging in in vitro CD44 over expressing cancer cells.

Keywords: Multifunctional, MNP; Hyaluronic acid; Doxorubicin, CD44.

High response of MoS_2 quantum dot by photoluminescence for sensing of As (III) over wide range

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Abstract

We describe the solvothermal production of MoS_2-based quantum dots (QDs) and the performance assessment of bare QDs for the detection of aqueous As (III) oxidative state over a wide range (0.1–1000 ppb) at room temperature and neutral pH. Up to 50 ppb, the QDs concentration-dependent photoluminescence (PL) is enhanced; after that, it is suppressed till 1000 ppb. It has two unique slopes for suppression and augmentation. The passivation of faults or trap states may be the cause of the amplification. Suppression could be caused by the growth of small, glassy As_2S_3 particles on the QD surface. Similar patterns of PL are followed by the optical absorption pattern of QDs. However, it exhibits elevated near UV absorbance below 300 nm, which rises with As (III) concentration up to 50 ppb and then falls in line with the PL pattern. Transmission electron microscopy, x-ray diffraction, UV-Vis, and PL spectroscopy were used to characterise the MoS_2QDs. The modified Stern–Volmer equation provided a good fit to both the enhancement and suppression data. These linear fit equations can be used as calibration curves to detect arsenic.

Keywords: MoS_2; Photoluminescence; Arsenic; Quantum dots.

Photoluminescence of Trivalent Lanthanides in the Context of Post-synthetic Modification of Semiconductor Nanoparticles

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Abstract

Post-synthetic modification of the inorganic nanoparticles (NPs) is a facile reaction strategy at or near ambient conditions that can access unique nanostructures. This, combined with the sharp emissions of trivalent lanthanide cations (Ln^{3+}), can access unconventional Ln^{3+} emissions using a less synthetically demanding fashion. Semiconductor NPs overcome challenges associated with inefficient direct excitation and environment induced emission quenching of Ln^{3+}. Motivated by these features, studies are designed in which the undoped ZnS, CdS, and CdSe NPs are post-synthetically modified by Ln^{3+} to generate the ZnS/Ln [Ln = Pr, Nd, Sm, Eu, Tb, Dy, Ho, Er, Tm, Yb], CdS/Ln [Ln = Eu, Tb], and CdSe/Ln [Ln = Pr, Nd, Sm, Eu, Tb, Dy, Ho, Er, Tm, Yb] NPs. Host NP sensitized Ln^{3+} emission is observed in the ZnS/Ln [Ln = Tb, Eu, Yb], CdS/Ln [Ln = Tb, Eu], and CdSe/Ln [Ln = Tb, Eu] NPs. These spectral properties can be rationalized by a charge trapping mediated dopant emission sensitization process. The synthetically Ln^{3+} doped, C(Ln)A, NPs can also be modified post-synthetically. Such experiments are performed by modifying the Zn(Tb)S NPs by Pb^{2+}, Hg^{2+}, and Cd^{2+} separately to investigate the Tb^{3+} emission properties. The relative reactant concentration ratio is systematically varied in these experiments for access to the pre-cation, partial cation, and completely cation exchanged NPs. These experiments reveal the existence of a rich photophysics even in the pre-cation exchange reaction conditions. Most importantly, in the NPs with [Zn(Tb)S] : [Pb^{2+}] = $1:10^{-2}$, a Pb^{2+} sensitized Tb^{3+} emission brightening is observed. Furthermore, it is observed that these pre-cation exchange reactions differ even in cases with occurence of complete cation exchange. Collectively, the experiments performed present a unique ground to use the post-synthetic modification strategy to either generate Ln^{3+} luminophores or modify their properties for potential luminescence based applications.

Keywords: Lanthanides; Photoluminescence; Semiconductor nanoparticles; Post-synthetic modification; Sensitized emission.

Recent Advances of Metal Oxides Nano Structures and Their Nanocomposites for Hydrogen Evolution

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Abstract

Hydrogen is one of the energy carriers with carbon-free and most people believe that hydrogen is the future energy source for many fields. Green hydrogen is one which can generate using electrocatalysis, in this process, the role of the electrocatalyst is crucial. The platinum group metals are used as standard electrocatalysts. However, the limitations of high cost and less availability of Pt are obstructing the wide-ranging of viable applications. Hence, significant research studies are happening for developing new electrocatalysts with earth-abundant materials (Pt-free materials) like Metal oxides, sulphides, phosphates and alloys, etc. and are cost-effective. Among these materials, metal oxides are getting interesting due to their compositional and structural diversity. However, these bulk metal oxides are inactive for hydrogen evolution reactions (HER) due to their poor conductivity and less active sites. The nanostructures of metal oxides are good in the HER due to the higher surface-to-volume ratio and the significant number of active sites on the surface. Here I am going to explain the various strategies like creating defects, change the phse and strctures, making composites for improving the electrocatalyst's properties. Some of the recent advances and my recent works on the HER using metal oxides and nano composites.

Keywords: Metal oxides; Nanocomposites; Electrocatalysts; Hydrogen evolution; Defects.

Innovative Chemical Engineering: Advancing Sustainable Solutions towards Air and Water Pollutants

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Abstract

The field of chemical engineering is leading the charge in developing sustainable solutions to global problems. In this talk, we look at an overview of our current work discussing the strategies and innovations involved in trying to mitigate pollution on two fronts, both water and air with greener approaches. One conscious effort has been to synthesize graphene from organic sources and concurrently developing a direct CO_2 capture device utilizing the same. Also actively working on functionalizing the graphene derivatives to enhance its CO_2 capture capabilities, aiming to contribute to the reduction of greenhouse gas emissions and the development of efficient carbon capture and utilization technologies, with promising results. Another focus is on the development and optimization of tempo-oxidized biological nanocellulose as CO_2 adsorbents. Additionally, testing amine functionalization of the same to enhance its CO_2 adsorption performance. Which also contributes towards the effort to create effective and sustainable adsorbents for mitigating anthropogenic CO_2 emissions. With the ensuing problem of deficit in clean water availability a major focus has also been on the development and design of nano-composites utilizing titania nanoparticles. Testing multiple groups as nitrogen suppliers in the as obtained composite catalysts, with a specific focus on achieving high performance photo catalysts. The studies further, involve the study of kinetics and thermodynamics involved in the dye degradation process to understand their efficiency. A gradual shift towards phenol water degradation is planned to help mitigate extensive contamination from industrial runoffs. The design of a naturally sourced activated carbon-based water pollutant removal system is also being actively developed aimed towards the removal of water pollutants. Through these ongoing projects, our research group is actively advancing sustainable practices in chemical engineering by exploring innovative materials, catalysts, and purification systems dealing with both the Air and Water Pollutants. The talk emphasizes the importance of developing sustainable routes towards shaping a more sustainable future.

Keywords: Graphene; Bacterial Nanocellulose; Nanocomposite; Activated Carbon; CO2 adsorption; Waste Water Treatment.

Effect of different dopants on Dielectric behaviour of $BaTi_{0.85}Sn_{0.15}O_3$

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Abstract

To study the effect of different dopants on dielectric behaviour of $BaTi_{0.85}Sn_{0.15}O_3$, La and Co doped samples were prepared. Compositions $(Ba_{1-x}La_x)(Ti_{0.85}Sn_{0.15})O_3$, $Ba(Ti_{0.85-x}Co_xSn_{0.15})O_3$ and $(Ba_{1-x}La_x)(Ti_{0.85-x}Co_xSn_{0.15})O_3$ with x = 0.01,0.03 and 0.05 have been synthesized by solid state ceramic route. Single phase solid solution was formed only for compositions x=0.01 and 0.03 in all the compositins. X-ray diffraction studies confirmed cubic crystal structure in these compositions at room temperature. Dielectric studies revealed that these compositions show diffused phase transition behaviour. Diffuseness of peaks were found to increase with increase in doping concentration of La and Co both. Composition $(Ba_{0.97}La_{0.03})(Ti_{0.85}Sn_{0.15})O_3$ falls under Z5U category of capacitors.

Keywords: XRD; Dielectric behaviour; Diffuse Phase Transition; Curie temperature; Hysteresis loop.

Synthesis of polymer electrolytes and it's application

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Abstract

An electrochemical device that converts the chemical energy into electrical energy through redox reactions is known as a fuel cell. It has certain basic components such as anode, cathode and an electrolyte (through which protons move between two sides of the fuel cell). Microbial fuel cell (MFC) is bio-electrochemical type of fuel cell which converts the energy present in organic compounds to electrical energy. Membrane, which acts as separator, is one of the most important factors in an MFC, and it has a significant effect on its performance. In present work, polymer is used to prepare proton exchange membrane (PEM) which replaces the salt bridge as well as liquid electrolyte by a single membrane. Advantage included as high energy density leak proof high electrical conductivity and thermal stability. PVC is water insoluble polymer and its water uptake properties are increased by addition of metal oxide. The membranes were prepared by using different concentrations of metal oxideand their corresponding water uptake was studied. For increasing the conductivity, organic acid have been used here. Power density curve was plotted to check the efficacy of the membranes. The power density obtained in case of the membrane showed encouraging results as proton exchange membrane.

Keywords: Fuel cell; Proton exchange; Microbial fuel cell; Waste water treatment; Ionic conductivity.

Transesterification of waste cooking oil for the production of biodiesel by microwave-assisted process

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Abstract

Biodiesel is a fatty acid methyl ester synthesized through triglyceride transesterificationThe raw materials commonly used in the production of biodiesel are non-edible oils (jatropha, neem, rubber seed oil and Karanja), waste cooking oil and animal fats.Several methods have been developed for the production of FAME, such as pyrolysis, box processing, supercritical fluid methods and transesterification.Transesterification of oil with methanol in the presence of a catalyst is widely used in biodiesel production.To improve biodiesel efficiency and reduce reaction time, transesterification can be combined with microwave heating, ultra-sound and membrane technology.Microwave heating is fast, economic, environmentally friendly, superior to conventional heating and energy efficient technology to produce biodiesel.Transesterification in combination with microwave irradiation is a selective heating mode in which the polar substance in a reaction mixture absorbs microwaves while non-polar ones do not absorb microwave irradiation.Microwave-assisted transesterification can greatly reduce reaction time and increase FAME efficiency.

Keywords: Microwave heating; Transesterification; Waste cooking oil; Biodiesel.

Role of semiconductor nanomaterial's using AI for efficient solar devices

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Abstract

The theme on using nanotechnology to convert energy focuses on using it to solve problems with energy conversion. It talks about how it can make things efficient, faster and safer. It also talks about how it can be made economically and in large quantities. The metal-based semiconductor layer is important for most thin-film solar cells. We have implemented artificial intelligence (AI) to accurately monitor the composition of nanomaterials. It acts as a mesoporous layer for active adsorption of materials, as a charge transport medium layer for electron transport.The electron transport efficiency based on titanium dioxide (TiO_2) iscurrently being analysed to develop high efficiency solar cells.In the present paper we summarize the latest developments are used in different solar cells, including dye sensitized solar cells(DSSCs), quantum dots sensitized solar cells(QDSCs), perovskite solar cells (PSCs), and organic solar cells (OSCs). Finally our research focuses on fabrication techniques to synthesize efficient nanostructured semiconducting electrodes and their applications in solar cells and their impact on their efficiencies and the role of different interfaces in these devices.

Keywords: Dye-sensitized solar cell; Perovskite solar cells; Metal-based semiconductor; Electron-transporting materials; Mesoporous materials.

Performance and Emission Characteristics of Cotton Seed Oil as NanofuelWith SWCNTs as Nanoadditives

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Abstract

Nanofuel was prepared by trans-esterification of the Cotton Seed Oil (CSO) mixed with ethanol and NaOH as a catalyst. The physical and chemical properties of nanofuels blended with Nano-additives and investigated for the possible fuel in the single-cylinder 4-stroke diesel engine.Single-Walled Carbon Nanotubes (SWCNTs) of purity greater than 85% were used to prepare the nanofuel blend. A CI diesel engine's performance and emission characteristics of best nanofuel blended with 50PPM, 100 PPM and 150PPM of Single-Walled Carbon Nanotubes (SWCNTs) with CSO at constant compression ratios were investigated. The performance and emission parameters calculated for experimental analysis were brake thermal efficiency (BTE) and specific fuel consumption rate (SFC). The emission parameters calculated for experimental analysis were Carbon monoxide (CO), hydrocarbon (HC), smoke density, and oxides of nitrogen (NOx). The use of an exhaust gas analyzer carried out the emission test. Biodiesel obtained from CSO satisfies the BIS standards and can replace diesel gasoline. The brake thermal efficiency of the CSOSWCNT50 increases by 3.5%, CSOSWCNT100 increases by 5.7% andCSOSWCNT150 increases by 9.3% after adding the SWCNTs. BSFC of the CSOSWCNT50 increases by 4.7%, CSOSWCNT100 increases by 8.9% andCSOSWCNT150 increases by 10.7% because of lower heating value and increased percentage of nanofuels in the blend increase BSFC. Biodiesel has similar performance and combustion characteristics as Diesel, and this can reduce NOx, particulate matter, smoke opacity, carbon monoxide, and carbon dioxide emissions, but HC emissions have increased slightly. CO emission in CSOSWCNT50 decreased from 0.56 to 0.37%, in CSOSWCNT100 from 0.56% to 0.32%, and in CSOSWCNT150 from 0.56% to 0.28% compared to CSO. A blend of SWCNT150PPM shows adverse results in all the cases.

Keywords: Nanofuel; Nanoadditive; Cotton Seed Oil; Carbon Nanotube; Diesel Engine.

Modifications in metal oxide based semiconductors for application as photo anode in Photovoltaic cells

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Abstract

The overall improvement in the photovoltaic performance could be associated with visible light absorption, improved dye adsorption, quick electron transport, and minimal carrier recombination. To enhance the light harvesting efficiency of Dye-sensitized solar cells (DSSCs) focus is primarily on the synthesis of photo anode material. In DSSCs, photoanodes consisting of a variety of metal oxide semiconductors, including TiO_2, ZnO, SnO_2, Nb_2O_5, etc., have been employed. The most suitable material for DSSC use is anatase TiO_2 with a band gap of 3.2 eV that is chemically stable, non-toxic, and easily accessible. The synthesis of TiO_2 nanoparticles and their morphological variation are described in detail in the paper. The nanoparticles exhibits a tetragonal crystalline structure with lattice parameters a= 3.74 Å and b= 9.39 Å. The effect of sintering temperature on phase transition and on electrical properties affecting particle size and surface area is investigated and optimized. Characterization techniques including scanning electron microscopy (SEM), transmission electron microscopy (TEM), differential scanning calorimetry (DSC), and UV-Vis spectroscopy are employed to analyze the TiO_2 nanoparticles. These techniques provide insights into the morphology, size, and optical properties of the coated TiO_2 nanoparticles. The Nyquist plot of TiO_2 reveals two semicircles, which are attributed to bulk and grain boundary effects. These effects are related to different time constants arising from different relaxation phenomena. The paper also reports the efficiency achieved (~1.5%) by fabricated DSSCs using a natural dye. Additionally, it reviews recent advancements in TiO_2-based nanomaterials, particularly through doping, to further enhance the efficiency of DSSCs using natural dyes. Overall, the study highlights the importance of optimizing the synthesis and properties of TiO_2 nanoparticles for improved performance of DSSCs, and it discusses potential strategies for enhancing the efficiency of DSSCs through modifications in TiO_2-based nanomaterials.

Keywords: Dye-sensitized solar cells; Metal oxide semiconductors; TiO_2 nanoparticles; Nyquist plot.

Chlorotoxin-decorated Therapeutic Nanomicelles for the localized therapy of Experimental Arthritis

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Abstract

Rheumatoid arthritis (RA) is an autoimmune disorder affecting about 1% of global population and in severe cases, disease may lead to permanent disability. Its pathogenesis implicates synoviocytes hyperproliferation, angiogenesis, formation of pannus, along with cartilage and bone degradation, which causes damage and disability. Besides substantial progresses in treatment standards, some limitations are there still there such as enhanced drug metabolism and high clearance leads to low bioavailability of anti-rheumatic drugs. We have developed a new type of nanomedicine in which we conjugated caffeic acid with polyethylene glycol-polycaprolactone (PEG-PCL) to make it therapeutic nanocarrier by conjugation caffeic acid as caffeic acid has potent anti-arthritis and anti-inflammatory effects and it inhibits NF-kB molecule. Moreover, we have entrapped 9-aminoacridine (9-AA) drug which has been reported to possess anti-inflammatory effects by activating NR4A1 molecule. Therefore, our developed nanomedicine has dual targeting nanoparticles and exhibited significant efficacy against collagen-induced arthritis. The plausible therapeutic action of nanomedicine might be due to the inhibition of NF-kB and NR4A1 molecules.

Keywords: Rheumatoid arthritis; 9-aminoacridine; Caffeic acid; Nanomedicine.

Metal organic framework encapsulated noble metal nanoclusters in catalytic nitrophenol reduction

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Abstract

Metal organic frameworks (MOF) are a class of organic- inorganic porous coordination polymers composed of metal ions containing secondary building units and organic linkers. They are definite in sizes, shapes with tunable pores and active surfaces that are important for the multifunctional nanohybrids formation. On the other hand, noble metal nanoclusters occupy a privileged catalytic property due to the fine tuning of size, and composition.1-2 Hence, the combined properties of MOF and metal nanoclusters in nanohybrids are important for their exposed active sites and effective interaction between MOF and nanoclusters. These hybrid nanostructures effectively catalyze the reduction of industrially generated organic nitro compound pollutants from wastewater. Nitrophenol and its derivatives contaminates environment as important byproduct from various industries, agrochemicals and pharmaceuticals products, and synthetic dyes. The nanohybrids of MOF-noble metal nanoclusters exhibited significant catalytic efficiency with high rate constant and turnover frequency.3 The easy and scale-up synthesis, low cost, high catalytic activity, and selectivity demonstrate next generation advanced catalytic materials for potential commercial applications in wastewater treatments.

Keywords: Metal organic framework; Noble metal nanoclusters; Nanohybrids; Nitro compound reduction.

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Bioconjugation detection using mobile phone spectrometry

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Abstract

In this report, we present the operation of a smartphone-based sensor utilizing localized surface plasmon resonance (LSPR). By combining lightweight and simple laboratory optical components with the smartphone's camera module, we initially developed a visible spectrophotometer with a pixel resolution of 0.336 nm per pixel. Our smartphone spectrophotometer effectively captured the wavelength shift in LSPR peak absorption resulting from the bioconjugation of gold nanoparticles (AuNPs) with the analyte (protein and enzyme). This wavelength shift in LSPR peak absorption can be used to determine the concentration of attached biomolecules. The limit of detection (LOD) for quantifying BSA protein and trypsin enzyme using our sensor was found to be 19.2 μg mL−1 (equivalent to 0.28 μM) and 25.7 μg mL−1 (equivalent to 1.10 μM), respectively. We compared the results obtained from our designed sensor with a standard UV-VIS spectrophotometer used in laboratories and observed a high level of reliability. Due to its compact size, simple optical design, and utilization of affordable optical components, we anticipate that this proposed sensing system could serve as a cost-effective handheld LSPR sensing tool suitable for various in-field applications.

Keywords: Localized surface plasmon resonance (LSPR); Smartphone-based sensor; Spectrophotometer; Bioconjugation; Camera.

Recent advancements on the antibacterial properties of gold nanoparticles

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Abstract

The appearance of multi-drug-resistant pathogens has grown to be a significant worldwide community health threat. Drug-resistant bacterial infections are the reasons of morbidity and mortality of millions of people annually. So, the rapid growth of bacterial resistance to existing antibiotics is a worldwide concern for human health. To solve this issue, the development of antibacterial nanomaterials can prove to be an effective method. Now days, nanotechnology offers distinctive approaches to manage a wide assortment of biological and medical routes that take place at nanometer length and it is assumed to have a successful impact on biology and medicine. Recently, nanoparticles have turn out to be a promising candidate instead of traditional materials with numerous applications in the area of science and engineering. The exclusivity of nanoparticles is because of the elevated surface-to-volume ratio and the improved number of atoms at their grain boundaries. They demonstrated as substantial materials in the progression of varied novel devices which find use in different physical, biological, biomedical and pharmaceutical applications. Among different nanometals, gold nanoparticles (AuNPs) are extensively being used as a catalyst in gene therapy, medical therapy and biological and diagnostic functions. AuNPs are potential drug delivery carriers on account of their better stability, minute size, high surface area for drug loading, good cell penetration and their unique multifunctional and biocompatibility properties which can improve the antibacterial effects of loaded antibacterial drugs. Their antibacterial activity can be improved by altering their size and structure or adding up ingredients. Gold nanoparticles can act as better antibacterial agents following the modification and combination with other antibacterial drugs for efficient antibacterial approaches against some resistant bacteria. AuNPs have photo-thermal effects, and customized AuNPs will prove to be a good medium for photothermal treatment of bacteria. Addition of functionally customized gold nanoparticles to some materials can improve their much needed antibacterial efficacy. Therefore, the present report provides a brief account on antibacterial properties of gold nanoparticles.

Keywords: Nanotechnology; Gold nanoparticles; Nanometals; Antibacterial.

Conventional D-shaped optical fiber alcohol sensor based on LSPR phenomenon

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Abstract

An alcohol sensor has been established based on localized surface plasmon resonance based phenomenon that has been used to sense alcohol. To perform the experiment D-shaped fiber has been used on which noble metal nanoparticles (AgNPs and AuNPs) have been coated to observe the variation with respective change in absorption wavelength. It is well known that alcohol has the tendency to volatile due their unstable nature that leads to change the effective refractive index of the medium nearby to coated D-shaped optical fiber probe (i.e., coated with noble metal nanoparticle). Concentration of each volatile liquids (or alcohol) nearby the coated probe increases gradually and tend to change the absorbance thereby the output responses. Using photo-detector change in responses can be noted and consequently the plasmonic behaviour of volatile liquids has been studied. The whole experiment has been carried out in a very low cost environment to enable the cost effectiveness.

Keywords: Nano-particle (NPs); Localized surface plasmon resonance (LSPR); Volatile liquid (VL).

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Engineering Emerging Perovskite Materials As New Generation Solid State Sensors & Detectors

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Abstract

In recent past, there is considerable serge in exploring of this emerging class of material like, Perovskite halides due to their high carrier mobility, long carrier diffusion lengths, and tunability of the band gap exhibit several interesting electronic & optical properties hence leads to basic research as well as technological applications potentials. The main focus of this report will be, how the family of Halide perovskite leading to new platform for solid state detectors/sensors based on paper electronics namely, gas detector, photo detector and radiation detectors. Very recent developments of a visual colour change based gas sensor made using hybrid perovskite halide as working material led to detection of hazarders gas like ammonia with concentration < 5 ppm with very high selectivity at ambient temperature. There are not too many visual (color change type) sensors that can easily detect hazardous gas with comparable sensitivity. It is a portable sensor for rapid, easy and selective detection of the atmospheric ammonia in open or closed environment by a simple color change effect, without any other instruments. Sensor will be useful food grain storage facilities, waste disposal sites and perishable materials storage facilities as well as refrigeration industries. The visual sensor shows quick response (~ 10 sec for 10 ppm NH3 gas) and selectivity whereas; electrical sensor shows sensitivity ~ 55% for 1ppm ammonia gas.These sensors with proper electrical readout can even be used for non-invasive diagnosis of disease using the technique of breath analysis. Apart from gas sensing, we focused on the optoelectronic properties of halide perovskite by fabricating paper based stable broadband (UV-NIR) (300-900nm) photo detector; a new approach of halide perovskite towards smart paper optoelectronics. Moreover, we investigated the radiation detection (γ Ray) by halide perovskite using single crystal of perovskite halide. The detector traces radiation by electrical red out and shows quick response (< 10 sec for ~ 1kCi radioactivity) with high mobility-lifetime product ($\mu\tau$)compared to conventional scintillators (HpGe) detectors. Moreover it exhibits excellent stability towards sustained gamma exposure making new approach towards direct tracing of (γ Ray) as compared to commonly existing γ detectors based on energy resolution technique.

Applications of nano engineered materials in addressing environmental pollution

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Abstract

The health hazards and toxicity allied with environmental pollutants results from many human activities. There is a need to develop an economic solution to this challenge. Present approaches used for the remedial of these pollutants from environment can not remove tiniest toxins from the environment. Use of nanotechnology is an appropriate alternate to the conventional methods as it has very effective, economic and highly specific approach. Its distinct chemical and physical characteristics make nanostructured materials appropriate for broad range of environmental applications. New nanomaterials are promising for reducing green house gases, cleaning toxic wastes and building alternative energy sources. Advancement of nanotechnology has resulted in a greater level of innovation. Nanostructured materials are one of the most commonly engaged techniques in this area.

Key words: Environmental pollutants; Nanomaterials.

An overview of gold nanoparticles as potent antifungal agents

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Abstract

At present, one of the biggest issues confronting humanity is the increase in antibiotic-resistant microbes.Antibiotics for drug-resistant microbes, particularly multidrug-resistant (MDR) pathogens are at serious risk of becoming scarce or nonexistent in the near future. Nanotechnology offers an excellent platform for modifying and developing the characteristics of metals by transforming into nanoparticles which has applications in wide range of disciplines including diagnostic, antimicrobial agents and treatment of various diseases. Recent developments in nanotechnology have made it feasible to produce effective broad-spectrum antimicrobial nanoparticles. Now days, owing to the special characteristics like biocompatibility and high stability, gold nanoparticles have proven to be effective augmentation agents against drug resistant microbes. Moreover, due to their basically inert and harmless nature, gold nanoparticles (AuNPs) displayed very excellent antimicrobial action. In addition, gold nanoparticles exhibit a variety of remarkable physicochemical characteristics because of their potency of multifunctionality and sub-micronic size. Due to the impact of their larger surface area and quantum size compared to ordinary metal atoms, gold nanoparticles have become the most popular and desired metal nanoparticles. Numerous biological and industrial uses for gold nanoparticles include drug delivery and disease diagnostics. They can also be important adjuvant in the medical area, enhancing the immunogenic effects, minimizing the toxic effects and providing the storage stability of medications and other substances connected to immunizations.It is becoming impossible to ignore the therapeutic uses of gold nanoparticles in microbial research as either delivery agents or broad range inhibitors. Over the past few years, the gold nanoparticles were extensively reflected the significant antifungal activities. The current review thus emphasizes on the value of gold nanoparticles (AuNPs) as antifungal metallic agents.

Keywords: Antimicrobial; Antifungal; Gold nanoparticles; Nanoparticles.

Binary and Ternary Metal Oxides Based Non-Volatile Resistive Random Access Memories

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Abstract

Metal oxides consisting one or more metals find numerous applications in almost every field. For example, binary oxides like ZnO, TiO_2, Fe_2O_3 being biocompatible are useful in biomedical applications. While oxides like SiO_2 and HfO_2 are promising gate dielectrics in CMOS technology. Ternary oxides like manganites, spinel, garnet and hexa ferrites are useful for high frequency applications, magnetic storage etc. Our work is based on exploration of these binary and ternary oxides for non-volatile random accesmemories(RRAM). We have studied resistive switching behaviour in $La_{0.67}Ca_{0.33}MnO_3$(LCMO) and HfO_2 based metal-insulator metal (MIM) devices to use them as potential resistive random access memories. In first part of my talk, abricaton and processing strategies along with their effect on resistive switching behaviour for LCMO based MIM devices would be discussed. In second part, I would introduce a relatively newer and multifunction binary oxide HfO_2 which has shown significant potential for resistive random acces memories.

Keywords: Resistive Random Access Memory; Metal Oxide; Resistive Switching; Thin film.

Assessing Friction and WearBehaviour of Epoxy Composites Filled with Chopped Carbon Fibers

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Abstract

The study assesses the ability of chopped carbon fibers on the tribological performance of the epoxy composites reinforced with them. The chopped carbon fibers having a diameter of ~7-8 microns and an average length ranging from 100 to 500 microns were recycled from industrial waste carbon fibers. In this present work, the liquid epoxy resin was reinforced with varying wt% of chopped carbon fibers followed by degassing to remove the entrapped air. The liquid resin was then mixed with hardener and cast into a silicone mold to form a cylindrical shaped pin. The cured cylindrical-shaped pin having a 10 mm diameter and 50 mm length was then studied under a Pin-on-Disk tribometer at 15 N load according to ASTM standards. Since friction and wear is an important parameter thatgoverns the tribological behavior of any materials therefore, the epoxy matrices containing 0.5, 1.0, and 1.5 wt% of chopped carbon fibers respectively were studied under tribometer and it was found that the addition of these reinforcements significantly reduces the coefficient of friction and wear rates of resulting epoxy composites. The 1.5 wt% of chopped carbon fibers helps to lower the coefficient of friction and wear rate by 62% and 29% respectively compared to that of the control specimen without any reinforcement. The worn surfaces were then characterized under SEM to understand the wear mechanism. It was observed that friction and wear behavior was significantly influenced by the fiber orientation, where fibers oriented parallel to the sliding direction showed the lowest friction and wear rates.

Keywords: Chopped carbon fibers; Epoxy Composites; Wear; Coefficient of friction; Tribology.

Heterojunction and doping effect on ferroelectric polarization driven photocatalytic activity and photocurrent studies of spin coated $0.6Ba(Zr_{0.2}Ti_{0.8})O_3$ -$0.4(Ba_{0.7}Ca_{0.3})TiO_3$ thin films

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Abstract

In this work, the ferroelectric polarization driven photocatalytic activity of paraelectric $SrTiO_3$ (STO), ferroelectric $0.6Ba(Zr_{0.2}Ti_{0.8})O_3$ - $0.4(Ba_{0.7}Ca_{0.3})TiO_3$ (BCZT) films, STO/BCZT,BCZT/STO heterostructures and 0.8BCZT-0.15STO films deposited on glass substrate using spin coating has been investigated using Rhodamine B as a analyte . The x-ray diffraction analysis (XRD) confirms the pure perovskite phases of STO (cubic) and BCZT (tetragonal).The STO/BCZT heterostructures show the better crystallinity as STO act as a buffer layer and is in good agreement with scanning electron microscope (SEM) studies. The STO photocatalyst exhibited a low efficiency of 39% only even after the irradiation time of 2 hrs.This could be attributed to its paraelectric nature as it lacks the internal field to drift the charge carriers to surface of films. When it is coupled with BCZT ferroelectric layer in form of BCZT/STO and STO/BCZT heterostructure, its efficiency is boosted up to 80 and 87 % respectively. The enhanced efficiency in heterostructures is attributed to charge coupling between the ferroelectric BCZT and paraelectric STO layer at interface. Compared to heterostructures, 0.85BCZT-0.15STO monolayers exhibited higher efficiency. It is observed that photodegradation is dominant during first 60-80 min of irradiation time of light and then decolourization is dominant with further increase of irradiation time. The photocurrent studies suggest that the charge coupling between ferroelectric BCZT and paraelectric STO layer and contribute to photocatalytic activity. Further, the internal field generated under the light due to charge accumulation under UV-Visible light is more in 0.85BCZT-0.15STO compared to BCZT-STO heterostructures. Thus, this study confirms that ferroelectric based photocatalysts are attracted for photocatalytic activity.

Keywords: Heterostructures; Photocatalytic activity, Photocatalyst; Efficiency; Irradiation time.

Synergistic effect of iron and cobalt doped ZnO Nanoparticles using Alpinia galangal against Candida Parapsilosis

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Abstract

In this investigation, nanoparticles such as ZnO, Fe doped ZnO and Co doped ZnO NPs prepared by co-precipitation method was tested against the pathogenic yeast. The spectroscopic analyses were carried out to identify the morphological and chemical composition of the synthesized nanoparticles. The result of XRD analysis revealed that the synthesized nanoparticles were crystalline in nature with average size ranges between 32 – 34 nm approximately. EDX and SEM analysis were carried out to identify the element composition (Co, Fe and Zn) and spherical shape of nanoparticles. The functional group that is responsible for capping and stability of nanoparticle was confirmed by FTIR analysis. To compare the antifungal efficiency of ZnO, Fe doped ZnO and Co doped ZnO from the resultant zone of inhibition.

Keywords: Antifungal activity; Candida Parapsilosis; Copper; Iron and Zinc.

Experimental investigations to examine the potential of additive based eco-prudent cutting fluids applied to CNC machining using Machine Learning algorithms

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Abstract

This work is intended to discuss the prospects of cutting fluids mixed with amylum in CNC machining. The cutting fluids are prepared using vegetable oils and amylopectin additive at varying percentage inclusions (0.3% to 1.2%). The parameters considered for performance analysis are viscosity, specific density, thermal conductivity, absorbance by way of thermo-physical, rheological, and spectral properties. After, testing and predicting the basic properties, the prepared cutting fluids are applied to machining zone while turning, American Iron and Steel Institute 1040 type material on CNC lathe machine. Machining performance was investigated by considering machining temperatures. Viscosity is modeled using Andrade equation. Surface plots of thermal conductivity confirmed the rise in thermal conductivity with an increase in additive percentage. Thermal conductivity for Cocus Nucifera (CC) cutting fluids is 10% better than Rapeseed (RPS) dispersed fluids. Cutting temperatures are modeled using novel machine learning algorithms including SVM, ANN, GPR and comparative analysis of the results reveals that optimum GPR is the best of the three considered with 87% fit while for SVM and ANN it is 82% and 63%.

Keywords: Eco-safe cutting fluids; Machine learning algorithms; Temperatures; GPR; SVM.

Tb incorporation in ZnO nanoparticles: A novel way to govern the structural and electronic properties

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Abstract

In order to enhance and control the optical properties, Tb is incorporated in ZnO nanoparticles, which have a tremendous potential for various optoelectronic applications. Our systematic structural and optical studies reveal that Tb accumulates mostly on the particle surface for Tb mole-fraction up to a certain value and above that it gets incorporated in the core. The surface accumulation results in a substantial enhancement of the near band-edge ultra-violet luminescence (UVL) over defect related green-luminescence (GL) by influencing the attachment of the hydroxyl groups on the surface, which is shown to be the primary cause for GL emission. In the core-incorporation regime, GL is found to originate mainly from certain point defects generated due to Tb incorporation, resulting in a high GL to UVL ratio. The luminescence characteristics of these nanoparticles can therefore be controlled through Tb doping. Furthermore, the surface accumulation of Tb has been shown to enhance the band gap energy by introducing a hydrostatic compressive strain in the nanoparticle lattice. Interestingly, the hydrostatic pressure is estimated to be as high as around 13 GPs even when only a few percent of the surface atoms are replaced by Tb. The technique, therefore, provides a unique way to study the influence of pressure on the electronic properties of these nanoparticles. Our study shows a reduction of the pressure coefficient of the band gap with the particle size. Moreover, the exciton-phonon coupling strength has been found to decrease significantly with the increase of pressure, implying that the luminescence efficiency of UVL can also be enhanced through Tb incorporation.

Keywords: PL; ZnO; Tb doping; Band gap; Rare earth.

Two dimensional Magnetic Nanocomposites Properties and their Applications

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Abstract

The magnetite nanoparticles possess good useful properties and in the form of nanocomposites with carbon based two-dimensional (2D) nanomaterials like as graphene (G), graphene oxide (GO) and reduced graphene oxide (RGO) have been synthesis by using different method and used for many applications. Here, mainly the structural, optical, magnetic and electrical properties of carbon-based nanomaterials and their magnetic nanocomposites was illustrated. After that, we have outlined various modification proposed in the 2D nanomaterials based magnetic nanocomposites. Furthermore, the detailed studies achieved on the effect of swift ion irradiation induced modification on important structures of graphene oxide and reduced GO sheets with magnetic nanoparticles has been discussed. With the useful potential applications of carbon-based magnetic nanocomposites were momentarily deliberated.

Keywords: Carbon material; Magnetite nanoparticles; PL and 2D properties.

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Advancements in Magnetoelectric and Energy Storage Performance of Spinel Ferrite Composites for Hydroelectric Cell Applications

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Abstract

Composites are a class of materials which provide a scope of tailoring properties that are not possible amongst its constituents. Magnetoelectric composite materials exhibit product property arising as a consequence of mutually connected electric and magnetic phases. The systematic and comprehensive study on structural, dielectric and energy storage study of spinel ferrite based composites has been reported. The phase purity is estimated from powder X-ray diffraction studies and also confirm composite formation. The dielectric studies reveal the presence of Maxwell Wagner interfacial polarization. The ferroelectric studies reveal improved ferroelectricity in composites. The electrical energy storage and efficiency measurements show the enhancement in energy storage properties. The composite has been fabricated as hydroelectric cell and its performance is studied extensively.

Keywords: Composites; Ferrite; Dielectric; Hydroelectric cell.

Solvent Mediated Synthesis and Biophysical Characterization of a Peptide Based Delivery System for Potential Therapeutic Applications in Tuberculosis

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Abstract

Host directed therapies gain importance due to the advantages in the management of excessive inflammation during tuberculosis (TB) disease that leads to irreversible lung tissue damage. The peptide based nanodelivery vehicles with intrinsic anti-inflammatory and antioxidant properties are preferred choice as they simultaneously manage inflammatory homeostasis and tissue damage. The carnosine, a natural dipeptide with anti-inflammatory and antioxidant properties that can self-organize itself into nanostructure upon solvent treatment was investigated for its potential uses as a nanodelivery vehicle in TB.In this current work, a tailor made multiscale self-assembly approaches wereused to develop functional nanostructures from native carnosine dipeptide oligomers, and further to prepare nanocomposites with first line anti-tubercular dugs namely Rifampicin, Isoniazid, Pyrazinamide and Ethambutol. In this solvent mediated process, the effect of hexafluoro-2-propanol (HFP) was studied on the self-assembly process of carnosine and carnosine anti-TB drug nanocomposites.The presence of the HFP attributes to the formation of strong hydrogen bonds between the fluoroalcohol donor and heteroatom acceptors, which was confirmed through spectroscopic analysis. In the carnosine anti-TB drug nanocomposites the functional moieties represents the involvement of hydrogen bonding and electrostatic force of attraction between carnosine and ant-TB drugs. The core sequence of this self-assembly process was confirmed through X-ray diffraction, Fourier-Transform Infrared Spectroscopy and scanning electron microscopeanalysis. This work provides method for the preparation of nanostructures through peptide self-assembly, and demonstrates a scope to introduce structural diversity with no chemical modifications. Solvent-mediated manipulation of the intermolecular forces driving self-assembly represents an important route to the rationaldesign of functional nanodelivery system for potential therapeutic application in TB.

Key words: Host directed therapies; Tuberculosis; Nanodelivery; Anti-inflammatorypeptides.

Linear Stability Analysis of Thermal Convection of Non-Newtonian Jeffrey Nanofluid Layer in Porous Medium

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Abstract

This paper deals with the thermal convection of nanofluid layer in porous medium. The behavior of nanofluid is described by Jeffrey fluid model. The employed model incorporates the effects of Brownian motion and thermophoresis. The momentum-balance equation is modified due to the presence of Jeffrey parameter and nanoparticles. The stress-free boundaries are used here. The Eigen-value problem is solved analytically as well numerically using Normal mode analysis and Galerkin Weighted Residuals Method (GWRM). Mathematica version 12.0 is used to calculate the values. The effects of the Jeffrey parameter, Lewis parameter, modified diffusivity ratio, Nanoparticles' Rayleigh number and medium porosity are discussed analytically and numerically. Outcomes are also presented graphically.

Keywords: Convection; Nanofluid; Brownian Motion; Galerkin Weighted Residuals Method; Porosity.

Ecofriendly nanomaterials for the removal of emerging contaminants from water

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Abstract

Water is the most crucial natural resource for life on earth, but its regular contamination by emerging contaminants (ECs) such as pharmaceutical contaminants (PCs) and heavy metals has turned it into a dire ecological issue. The present work aimed to develop carbon-based adsorbents with exceptional adsorption performance, non-toxicity, stability, reusability, low-cost along with high yield scalable synthesis for the efficient removal of emerging contaminants such as pharmaceutical compounds and heavy metals from water. The comparison of removal efficiency of carbon-based materials such as carbon nanosheets (CNS), Activated carbon (AC), and graphene oxide (GO) has also been investigated to compare their commercial applicability for water remediation. The batch mode adsorption experimental conditions comprising pH, contact time, adsorbent dosage, initial contaminant concentration and stirring rate were optimized to attain maximum adsorption efficiency. The structural and chemical properties of the synthesized materials were systematically characterized using X-ray diffraction (XRD), Raman spectroscopy, Fourier-transform infrared spectroscopy (FTIR), and scanning electron microscopy (SEM). The results displayed rapid removal of contaminants from water involving pore-filling effect, electrostatic interactions, H-bonding, π-π stacking interacting forces of carbon-based materials. This study offers carbon-based materials to be eco-friendly, economic, and promising adsorbent that could be used at a large scale for industrial water remediation applications.

Keywords: Nanomaterials; Nitrogen-doped graphene nanosheets; Adsorption; Pharmasuetical contaminants; Heavy metals; Waste water treatment.

A Numerical Study on the Ballistic Trauma of B_4C ceramic backed UHMWPE Composite Armour System

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Abstract

A ceramic-based armour system is required to stop bullet penetration and effectively dissipate high impact energy. Exceeding the threshold value of behind-armour ballistic/blunt trauma (BABT), which refers to the momentum transferred to the human body, can result in severe injury or fatality for the wearer, even without target penetration. This study numerically investigates the ballistic response of body armour consisting of a boron carbide (B_4C) plate backed with a unidirectional ultrahigh molecular weight polyethylene (UD-UHMWPE) fibre composite. The armour is subjected to an impact velocity of 800 m/s. A block of gelatin is used as a substitute model to simulate the human torso. The ASNSYS/AUTODYN® software is employed for numerical analysis of three-dimensional nonlinear deformations in a system. It utilises the full integration rule to calculate the elemental matrices. The projectile, ceramic, and composite materials were characterised using the Johnson–Cook, Johnson–Holmquist, and orthotropic material models, respectively. Gelatin is a viscoelastic material that can be described using the Mie-Grüneisen equation of state and the Johnson-Cook failure model. The material parameters were obtained from existing literature. The evaluation of the deformation mechanism of the ceramic composite target was conducted. The gelatin block exhibits a maximum cavity depth of 24.65 mm. The calculation also includes the impact pressure resulting from the transfer of momentum to human tissue. A maximum pressure of 15.2 MPa was observed in the vicinity of the cavity region, with a gradual decrease towards the rear face of the gelatin block. The analysis conducted in this study allows us to determine the extent of boy injury caused by impact by considering the highest pressure and depth of the temporary cavity formed in the gelatin.

Keywords: Boron Carbide; UHMWPE; Numerical Simulation; Behind Armour Blunt Trauma.

Studies of strutural and optical properties of SiC thin films

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Abstract

The present study explored the deposition of SiC thin films on Si (100) and glass substrates using RF-magnetron sputtering. The working pressure (argon gas) is changed from 5 to 25 mTorr to study its influence on the characteristics of SiC thin films. The structural properties of SiC thin films were characterized by X-Ray diffraction and Raman spectroscopy. Raman spectroscopy reveals the formation of SiC as well as carbon clusters. The film deposited at 10 mTorr clearly shows the presence of both TO and LO phonon modes and low carbon concentration. The average roughness of the SiC films found to follow an increasing trend with increase in the sputtering pressure. The optical band gap of the SiC films measured by UV-Visible spectrophotometer was found to increase up to 2.45 eV with decrease in sputtering pressure from 25 to 10 mTorr but decrease with further decrease in sputtering pressure. The average transmittance of all samples was about 90%. The UV-Visible spectroscopy results were in agreement with the data observed by Photoluminescence (PL) spectroscopy.

Keywords: SiC thin films; Magnetron sputtering; Raman spectroscopy; PL spectroscopy.

Fascinating Role of Organic and Inorganic Ligands on The Shape Control And Reactivity of the Nanoparticles

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Abstract

Water soluble molecular metal-oxide cluster-anions (polyoxometalates, or POMs) showed exclusive redox activity and acts as covalently coordinated inorganic ligands for individual anatase nanocrystals, giving isolable anionic clusters uniquely positioned between molecular macroanions and traditional colloidal nanoparticles. Sodium salts of the water-soluble polyanionic structures are obtained by reacting TiO_2(s) with the 1-nm size mono-defect Keggin ion, $Na_{(12-n)}[\alpha\text{-}X^{n+}W_{11}O_{39}]$, $X^{n+} = P^{5+}$, Si^{4+} and Al^{3+}at 140 ºC, after which, an average of 55 ± 10 $\alpha\text{-}[PW_{11}O_{39}]^{5-}$ anions are found as pentadentate "capping" ligands for complexed Ti(IV) ions still linked—via their sixth coordination site—to 6-nm single-crystal anatase-TiO2 cores. Multiple lines of evidence reveal that the POM-protecting ligands are covalently bound to the surface of anatase nanocrystals. EDS and XPS data suggest that numerous POMs are associated with each 7-nm anatase nanocrystals, and high-resolution TEM, cryogenic-TEM, and HAADF-STEM images clearly show POM-protecting ligands bound to anatase surfaces. Solid state NMR, ESI-MS and MALDI-mass spectra unambiguously identify the covalently-bound POM-protecting ligands as $[TiPW_{11}O_{40}]^{5-}$-derived clusters. The surface-bound cluster-anions are reversible electron acceptors, whose reduction potentials shift to more negative values by simply changing the central heteroatom, X^{n+}, from P^{5+} to Si^{4+} to Al^{3+}. Hence, just as POM cluster-anions control the reactivities of metal centers in molecular complexes, directly coordinated POM ligands with tunable redox potentials could provide options for rationally controlling the reactions of TiO_2 nanocrystals. This control over charge separation and electron-transfer pathways within the composite materials has been utilized to control release of H_2 gas from water-splitting using methanol as sacrificial agents under UV conditions. This tunable redox property can be further extend to other metal-oxides, such as, Iron Oxides.

Keywords: Polyoxometalates; Hydrogen Evolution; Photocatalysis; Water Splitting.

Janus-Metal-Organic Framework (J-MOF) Boat as a Nascent Conglomeration in the Arena of Solar Driven Desalination

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Abstract

The deterioration of freshwater to be utilised as potable water for domestic and industrial purposes have been a critical issue for several years and the amelioration of industrialisation in countries such as, India, USA, Iran, Pakistan, China has accounted for 67% exploitation of groundwater. Along those lines, photothermal desalination emerged as a promising method of tackling water scarcity on a global magnitude. Thus, we investigate an avant-grade conglomeration approach of decorating a neoteric phase-change induced Ni-doped copper based metal-organic framework (Ni-HKUST-1) over a Janus membrane architecture (membrane layers of opposing wettability) via facile route, to result in a cost-effective and eco-friendly photothermal desalination device. The solar absorber recorded a robust photothermal conversion efficiency of 95%. Moreover, the J-MOF boat demonstrated an exciting evaporation rate of 1.5 and 1.3 kg/m^2h with pure water and simulated seawater, respectively to influence the diminution of salt concentrations to <10 ppm. This phenomenon was ascribed to solar absorber as inducing phase change generated biphasic CuO/Cu_2O caged in N-doped graphene oxide (NGO) sheets. The doping of Ni influenced to ameliorate the 1 pyrrolic nitrogen (PN) of NGO sheets, thus improving the photothermal feature of the solar absorber, concomitantly promoting Cu^{2+} species and improving the p-type nature of the biphasic configuration for enriched nonradiative relaxation of electrons. Furthermore, the boat-like nature of the Janus architecture facilitated the device to float and induce photothermal interfacial evaporation at the water/air interface, by uniformly distributing localised heat by means of the 3D porous hydrophobic layer to evaporate the intercepted salt-rejected water transported by the hydrophilic layer via capillary action as seen in mangrove trees.

Keywords: Photothermal desalination; Metal-organic framework; Janus-membrane; Interfacial evaporation.

Refractory Transition Metal Nitrides Plasmonic Nanomaterials for Bio-Sensing

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Abstract

Refractory transition metal nitrides (RTMNs) such as zirconium nitride (ZrN) and titanium nitride (TiN) and ternary alloys ($Ti_{1-x}Zr_xN$) have emerged as alternating plasmonics materials as compare to conventional plasmonic material like gold(Au), silver(Ag), Aluminium (Al) etc. In the present work, we focus on sensing characteristics of transition metal nitrides due to: (I). low cost compared to noble metals, (II). high melting point (HfN~2151 °C , ZrN ~2981 °C, TiN ~2931 °C), (III). chemical stability, (IV). resistivity against corrosion, (V). bio-compatibility, (VI). compatibility of growth with CMOS technology, (VII). non-stoichiometry originated spectral tuning, (VIII). broad resonance extending to biological window, and (IX). well established processes of synthesis and characterization of these materials. The refractory transition metal nitrides exhibit superior plasmonic characteristics that of noble metals in terms of real permittivity (smaller magnitudes of real permittivity) and leads to exhibit superior tuning capabilities as their optical spectra can be fine tuned in the desired spectral region through control of metal or nitrogen stoichiometry.It is evident that the transition metal nitrides exhibt better sensing charaterstics the conventional noble metals. The optical loss.The less optical loss of RTMNs due to moderate magnitude of real part of permittivity in optical region shown greater flexibility for designing optoelectronic devices for bio molecular sensing/detection at sub-wavelength scale.

Keywords: Plasmonics; Transition Metal Nitrides; Bio molecular sensing/detection.

Photocatalytic Application of Metal oxides based Nanocomposites

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Abstract

Water pollution is a global issue as a consequence of rapid industrialization and urbanization. Organic compounds which are generated from various industries produce problematic pollutants in water. Recently, metal oxide and ferrites based semiconductors have been explored as excellent photocatalysts in order to degrade the organic pollutants in wastewater. However, their photocatalytic performance is limited due to their band gap and high recombination time of photogenerated electron-hole pairs. Strategies for improving the performance of these materials in the fields of photocatalysis have been explored. To improve their photocatalytic activity, researchers have investigated the concept of doping in metal oxides, nanocomposites of metal oxides and ferrites, core shell nanostructures of these materials. Spinel ferrites (MFe_2O_4, M divalent metallic ion) and their nanocomposites with specific metallic oxide (ZnO, TiO_2, CeO_2) has attracted the interest of researchers for doing away with the decontamination of wastewater by using photocatalysts, due to the fact MFe_2O_4 nanoparticles (NPs) are stable and handy to separate after being used due to its incredible magnetic behavior. Particularly, much interest has been rising on MFe_2O_4/metal NPs, MFe_2O_4/metal oxides, MFe_2O_4/polymers, MFe_2O_4/carbon-based materials, and MFe_2O_4/other compounds for the photocatalytic decomposition of dyes. This study has explained the advantageous pathway for the generation of free radicals with the help of these catalysts in the presence of visible and UV light. Hence, it can be concluded that MFe_2O_4 based nanocomposites with metal oxide have valuable application in purification of water.

Keywords: Metal Oxides; Photocatalysis; Spinel Ferrite; Magnetization.

Synthesis and charecterization of nanostructured antimicrobial coating

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Abstract

Coatings that are based on nanoparticles are not solely limited to dispensing a shield against deformity or imparting beautification, rather, deliver a spectrum of functionalities, making the material superhydrophobic, resistant to corrosion, wear, bacterial & fungal invasion.Nanosilica based sol was prepared and further modified hydrophobically. Prepared coating solution was charecterized by IR spectra and particle size analyzer to evaluate functional groups and particle size. Further coating solution was coated on glass and plastic substrate to develop antimicrobial surface. Hydrophobicity of the coated surface were evaluated by contact angle measurement and surface free energy. All coated subtrateshowed hydrophobic to superhydrophobic whereas Antimicrobial activity of coated surface were evaluated against *E-Coli* and found apriciable antimicrobial property after coating.

Keywords: Nanosilica; Hydrophobic; Antimoicrobial; Coating; Contact angle.

Structural, electrical and optical properties of pure and Ru doped ZnO nanocrystals

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Abstract

Undoped and 0.5 wt% and 1 wt% Ruthenium doped specimens of nano-particulate ZnO were prepared through chemical route method. Structural characterizations of the samples wereperformed with XRD and it established that all the nanoparticles are of zinc oxide having polycrystalline nature. FESEM were conducted on the samples for morphological studies to confirm the grain size and texture. Electrical measurements showed that the ac conductivity increases with frequency but decreases with increasing concentration of ruthenium. In optical studies, it is found that the absorbance does not significantly change with doping. The above fact is further confirmed from the bandgap calculations using the reflectance graphs. It was found that the bandgap decreases from 3.42 to 3.19 eV with increasing Ru concentration. Thus it is concluded that the samples can be an important and advantageous materialfor potential visible light photocatalytic applications involving metal oxide nanostructures.

Keywords: ZnO; Ru-doping; Structural studies; Electrical properties; Optical properties.

Enhancement of magnetic properties of Soft and Hard Spinel Ferrites (Nickel & Cobalt Ferrite) via Zn doping

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Abstract

Spinel ferrite nanoparticles have gained popularity due to their intriguing features, such as their excellent electro-optical and catalytic capabilities, simplicity of production, and magnetic behaviour. Nickel ferrite, a kind of soft magnetic material, and Cobalt ferrite, a type of hard magnetic material, are two of the most appealing groups of materials owing to their unique and significant features, and they have numerous technological uses, such as catalysis, shielding, storage devices and sensors. The sol-gel method was used to create pure and Zn doped Nickel Ferrite and Cobalt Ferrite nanoparticles ($Ni_{1-x}Zn_xFe_2O_4$, $Co_{1-x}Zn_xFe_2O_4$, x = 0.0 - 0.4). X-ray diffraction analysis was used to assess their phase formation and structural characteristics. Vibrating Sample Magnetometer was used to measure magnetic characteristics at room temperature. The magnetic behaviour revealed that magnetization rises initially up to Zn = 0.3 concentration and subsequently drops. The Neels two sublattice model may be used to explain this reaction. These ferrites' highly adjustable and customizable magnetic response makes them an attractive alternative for a variety of applications.

Keywords: Spinel Ferrite; Sol-Gel; Shielding.

Greener Approaches in Textile Industry

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Abstract

Green reactions are sustainable, highly efficient (fewer steps, fewer resources, less waste), much easy-to-use (stable under ambient conditions) and very much eco-friendly (non-hazardous solvents and less hazardous minimized waste). The textile industry is considered as ecologically one of the most polluting industries in the world. Recently a number of steps have been taken to make textile processing greener. These include use of greener fibre, greener dyes and auxiliaries, greener solvents, eco-friendly, optimized and efficient processing, bio-processing, recycling of textile, water and chemicals and elimination of hazardous chemicals.

Keywords: Green chemistry; Textile fibres; Textile dyeing; Textile finishing; Ionic liquids.

Role of Low temperature Plasma exposed Bamboo charcoal/ $FePO_4$ composite in energy storage applications

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Abstract

The cathode element with the optimum morphology will be used to determine the ability of energy storage devices. Transition metal phosphate-based compounds, such as $FePO_4$, have currently gained prominence in the fields of catalysts, sensors, energy storage, and photonics. The Bamboo Charcoal (BCC) was prepared and activated using the pyrolysis process. By exposing the surface to DC glow discharge plasma, surface attributes like wettability, adhesion, and conductivity were improved. The CV analysis of pure $FePO_4$ and composite $FePO_4$/air plasma treated BCC was made with two different electrolytes at various scan rates. Comparing the two materials, it can be seen that the $FePO_4$/plasma treated BCC material has a significant specific capacitance/capacity and that the b-value has switched from capacitive to diffusive.According to these results, FePO4/Plasma exposed BCC might be a good cathode component for energy storage applications.

Keywords: $FePO_4$ nanoparticles, CV analysis, Low temperature plasma; Bamboo charcoal; Scan rates; Cathode material.

Enhanced hydrogen evolution using CeO_2 based nanomaterials as a photocatalyst

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Abstract

The need of alternative sources for energy has become prominent in the current scenario. The rational design of sustainable noble-metal-free heterojunctions remains a key challenge for highly efficient and durable photocatalytic H_2 production. In this study, it was revealed that the CZTS (Cu_2ZnSnS_4) nanoparticles may serve as a cocatalyst and a p-type semiconductor at the low (1.5 wt%) and high (10 wt%) loading contents, respectively. Both CZTS cocatalyst and semiconductor could evidently boost the visible-light-driven photocatalytic H_2 production over the CeO_2. Comparably speaking, the heterojunction effects between p-type CZTS and n-type CeO_2 are speculated to play a more prominent role in dramatically boosting the photocatalytic H_2 production than the electron-sink roles of surface CZTS cocatalysts. Impressively, among all the as-fabricated photocatalysts, the high quality 10 wt% CZTS could achieve the highest photocatalytic H_2-production rate of 2930 µmol g-1h-1, which is approximately 59 times higher than that of pristine CeO_2. In cycling experiments, CeO_2-10 wt% CZTS exhibited an acceptable photostablity. More importantly, it was further demonstrated that the earth-abundant dual-functional CZTS nanoparticles could markedly facilitate the separation of electron-hole pairs and H_2-evolution kinetics, thus achieving the distinctly boosted photocatalytic H_2 generation. This work will provide new insights into the rationally designing environment-friendly CeO_2-based hybrid nanoheterojunctions for visible-light-responsive photocatalytic H_2 generation through loading the noble-metal-free bifunctional cocatalysts or semiconductors.

Keywords: Hydrogen evolution; Photocatalyst; Heterojunctions; CeO_2; Semiconductor

MWNCTs embedded Polyaniline based Composites for Electrical Applications

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Abstract

Multiwalled carbon nanotubes (MWCNTs-8wt.%) embedded polyaniline (PANI)-based nanocomposite in its emeraldine salt form was synthesized through the chemical oxidative polymerization process. Therefore, due to their higher electrical conductivity, it is expected to utilization of this sample in various electrical applications such as supercapacitor, vapors detection and electromagnetic shielding materials. The storage ability of this nanocomposite sample was examined using the cyclic voltammeter at different scan rates.This sample contains the excellent specific capacitance i.e., ~447 F/g at 40 mV/s scan rate. Moreover, this nanocomposite sample also utilized as electromagnetic shielding materials and their electromagnetic shielding interference (EMI) properties were investigated in the X-bands (8.1-12.4 GHz) frequency region. This nanocomposite sample contains the efficient value of total EMI shielding effectiveness i.e., ~49 dB at 12.4 GHz frequency, and this value of total shielding effectiveness is greater than essential value for industrial application i.e., 30 dB. Also, the vapors detection sensor was also fabricated using this nanocomposite sample to the detection of alcoholic vapors of methanol at two different concentrations (50 and 100 ppm levels) at room temperature. This sample contains the good sensing response (%) i.e., ~42% even at 100 ppm of methanol vapors. Therefore, the utilization of PANI/MWCNTs (8wt.%) nanocomposite sample in various electrical application make them suitable candidate for industrial use.

Keywords: PANI; MWCNTs; EMI Shielding; Cyclic Voltammeter; Sensor.

Investigating structural and DC conductivity properties of aged copper sulphate doped polyaniline

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Abstract

The aging effect on the conductivityand structural properties of polyaniline prepared via chemical oxidative polymerization with potassium dichromate as an oxidizing agent and resulted doped with copper sulphate with different concentrations is the subject of present investigation. DC conductivity measurements obtained using two probe method on doped polyaniline composites shows different behavior compared with previous measurements with same dopant concentrations, pellet form and powder form. However the structural form shows pattern of semi crystalline to amorphous one with aging irrespective of concentrations, as exhibit by analysis of resulted XRD patterns.

Keywords: Polyaniline; DC Conductivity; XRD pattern; Aging effect.

Conjugated Polymers based Nanocomposites for various Electrical Applications

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Abstract

In the last decade, the conjugated polymers-based nanomaterials built-up the evolution in the field of materials science at the scientific and industrial level, and significantly replaced the semiconducting and metallic materials in the wide range of commercial applications including the EMI shielding, sensors and actuators, supercapacitors, biomedical devices, etc. As the results, the scientists and researchers have devoted close attention to conjugated polymers in order to investigate the new fundamental nanostructures such nanoparticles, nanofibers, nanoflakes, nanorods, nanopores, etc.,synthesizedthrough the various approaches using various types of capping agents. Furthermore, the development of nanomaterials has resulted in the enhancement of several properties of conjugated polymers including the structural, morphological, thermal, electrical properties.However, the enhancement in electrical properties of conjugated polymers make them suitable candidate for various electrical applications such as electromagnetic interference (EMI) shielding, supercapacitors, sensors, etc. The variation in morphology of nanostructure materials gives the different values of response (%) under the same ppm level of any gas/vapors. In the EMI shielding properties, the nanostructure materials should be highly conducting or magnetic which gives the shielding effectiveness more than 30 dB which is minimum requirement for the industrial application. Also, these conjugated polymers-based nanostructures contain the good charge storage properties with the efficient values of specific capacitance.Finally, the most recent uses and future aspects of conjugated polymers are examined in order to illustrate their exceptional potential features among metals and semiconductors.

Keywords: Conjugated Polymers; Nanostructures; EMI Shielding; Cyclic Voltammeter; Sensor.

Interspecific Divergence of Adh enzyme, ethanol &acetic acid tolerance in Three Cosmopolitan Drosophila species from India

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Abstract

The three cosmopolitan & domestic species of Drosophila collected along latitude28̊ 54 N from Rohtak of the Indian subcontinent for this study. The pattern of Adh genetic variability, ethanol & acetic acid tolerance in adult & in larval individual revealed significant genetic divergence in these three species. Adh (Alcohol Dehydrogenase) locus was found to be effectively polymorphic & was represented by two common allele & high heterozygosity in D. melanogaster& D. ananassae while D. busckii revealed one frequent and one rare allele &low heterozygosity. D. melanogaster revealed highest ethanol as well as acetic acid tolerance level as compared with the D. ananassae &D. busckii. Due to ethanol utilization, increased longevity periods were found to be 84.5 hrs, 165 hrs. & 300 hrs. in D. busckii, D. ananassae & D. melanogaster respectively. However, the increase in longevity on the basis of acetic acid utilization was found to be 66 hrs., 110 hrs., 216 hrs. in D. busckii, D. ananassae & D. melanogaster is significantly different. Thus, the interspecific differences for these metabolites' tolerance could be adaptively maintained by natural selection mechanism & patterns of resource utilization are species specific.

Keywords: Interspecific Divergence; Drosophila species; Adh polymorphism; Ethanol & acetic acid tolerance; Resource utilization; Natural selection.

Eco friendly and simple methodology for the synthesis ofCobalt-TMAmetal organic framework (Co-MOFNP), characterization and their extended application

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Abstract

Metal-Organic Frameworks (MOFs) represent an emerging new class of functional crystalline solid-state materials. The interesting feature is their porosity that allows the diffusion of guest molecules into the bulk structure. The enormous surface area and pore volume yielding open frameworks brings out tremendous application in the field of catalysis, sensors and dye degradation.Coblat –TMA Metal oxygen framework nano particle (Co-MOFNP) can be synthesized using a simple solvent free environmentally benign combustion method. The structural characterization of synthesized nano particles are carried out using XRD, FT-IR and SEM. The XRD results show that Zn-MOFNP is in single phase. The SEM results show that Co-MOFNP is highly porous with nano sheet appearance. The EDAX studies were also carried out. The optical characterization was carried out using UV and Photoluminescence spectrofluorimeters. The FT-IR studies clearly indicate the formation of the compound. The compound shows antibacterial and antimicrobial properties in par with the standard. Further substitution can enhance the antimicrobial properties. The compound also bring about dye degradation.

Green Synthesized Metal/Metal Oxide Nanomaterials as Efficient Catalysts for Environmental Remediation

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Abstract

In this report, we have utilized *Cucumis maderaspatanus* L. (*Cm*L) leaves extract to synthesize silver nanoparticles (*Cm*-Ag NPs) and zinc oxide nanoparticles (*Cm*-ZnO NPs) by an easy and environment-friendly green method. The prepared Ag and ZnO NPs were characterized by different techniques like UV-Vis, XRD, FE-SEM, FTIR, XPS, TEM with EDAX, zeta potential, TGA, and BET analysis. FTIR peaks confirmed the reducing and capping potential of *Cm*L. leaves extract. The surface plasmon resonance at 442 nm has been attributed to the *Cm*-Ag NPs formation. The XRD result showed that both nanoparticles are crystalline in nature. FE-SEM analysis exhibited the spherical morphology of the nanoparticles. Moreover, the TEM image also indicated a spherical shape with an average particle size of 15.85 nm and 8.6 nm for Ag and ZnO NPs respectively. XPS confirmed the oxidation states as Agº and Zn2+. The thermal stability of nanoparticles was studied using TGA analysis. The surface area of the nanoparticles was calculated to be 14.96 m2/g and 19 m2/g nm for Ag and ZnO NPs respectively using BET. The efficacy of *Cm*-Ag NPs as a catalyst was tested on the reduction of nitroarenes such as 4-nitrophenol (4-NP), 3-nitrophenol (3-NP), 2-nitrophenol (2-NP), 2,4,6-trinitrophenol (2,4,6-TNP), 2,4-dinitrophenol (2,4-DNP), 4-nitroaniline (4-NA), 3-nitroaniline (3-NA) and 2-nitroaniline (2-NA) using sodium borohydride ($NaBH_4$) as a reducing agent and the rate constant 'k' was measured. The reduction reactions followed pseudo-first-order kinetics. The kinetic studies were also performed with different concentrations of nitroarenes [0.5 × 10-4 M to 1.5 × 10-4 M], NaBH4 [1 × 10-3 M to 10 × 10-3 M], and *Cm*-Ag NPs [5 mg to 25 mg]. Similarly, the photocatalytic efficiency of *Cm*-ZnO NPs was measured by degrading the textile dye, orange-G under sunlight using H_2O_2 as a photosensitizer. In addition, the effect of varying dye, H_2O_2, and catalyst concentrations on photodegradation was also studied. In conclusion, the obtained data demonstrated that the produced nanoparticles can be employed as an efficient catalyst for textile industrial effluent treatment.

Key words: *Cucumis maderpatanus* L.; Ag NPs; ZnO NPs; Nitroarenes; OG dye; H_2O_2; Kinetics.

Enhancement in Light Absorption of Organic Solar Cell using Diffractive Grating

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Abstract

Organic solar cells (OSCs) have attracted remarkable interest in recent years due to their advantages of low cost, easy fabrication, light weight and good flexibility. Extensive efforts have been devoted during the last decade to organic solar cell research that has led to remarkable progress and achieved power conversion efficiencies (PCEs) in excess of 15%. A considerable portion of the incoming light is lost, due to reflection for organic solar cells with reflective electrodes, and through transmission for semitransparent organic solar cells. Further improvements in efficiency of organic solar cells beyond the currently achieved 15% can be expected upon reduction of such losses. The light trapping structure is one of the potential ways to improve the light absorption of OSC by increasing the effective optical length within the active layer without altering its physical thickness. Numerous schemes and structures have been developed to achieve light trapping in solar cells, such as photonic crystals, gratings and nanostructure. Also, light trapping structures in direct contact with thin active layer is most likely to introduce defects and contamination into the organic solar cell. We propose an alternative approach to trap the light in organic solar cells. Our approach leaves the active layer itself planar while altering the layers around it. In this work, we propose to incorporate the periodic dielectric SiO_2 diffraction grating between the glass substrate and top transparent anode (ITO) to increase the optical absorption of OSCs. Diffraction techniques describe the mechanism of changing the direction of the incident light into different directions and hence can increase the optical absorption in the cell. We have used the finite difference time domain electromagnetic simulation method to calculate the optical absorption. Keywords: organic solar cell, light absorption, diffraction grating, FDTD simulation.

Modeling of Schottky Barrier Dual Gate CNTFET and Investigation of Short Channel Effects

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Abstract

Wireless technology and portable electronic devices have permeated every aspect of modern life. According to a report published by the World Health Organization (WHO), diseases like as brain tumors, infertility, hearing loss, vision problems, and foetus disorders are caused by the dangerous radiations generated by portable electronic gadgets. Thus, we required electronic and wireless gadgets that would only dissipate aultra-low power.The main device in the manufacturing of integrated circuit is the complementary MOSFET (CMOS). Traditional CMOS have undergone vigorous scaling, with gate oxide thickness decreased to below 3 nm and channel length lowered to below 10 nm leads to Short Channel effects (SCEs). Complications including the tunneling effect, gate oxide thickness effect, threshold voltage roll-off, subthreshold swing (SS), drain induced barrier lowering (DIBL), and subthreshold leakage current are brought on by the scaling down of silicon integrated circuits (I_{OFF}). This issue has created an opportunity for the emergence of novel materials.A promising material in the next MOS technology age is carbon nanotubes. This paper, a Double-Gate Carbon Nanotube Field-Effect Transistor (DG-CNTFET) modelling with ohmic and Schottky Barrier (SB) was presented. The SB-DG-CNTFET demonstrated 75% greater drain current at the same nanoscale parameters as the DG-CNTFET, including 14 nm channel length, 1 nm oxide thickness, 0.2V threshold voltage, and 300K temperature. At V_{DS} = 0.1V, the SB-DG-CNTFET has an I_{on}/I_{off} ratio of 800×10^3, whereas the DG-CNTFET has a ratio of 314×10^3. This is 154 times bigger than the value of DG-CNTFET.At 300^{o}C temperature when compared to a MOSFET, the subthreshold swing of a CNTFET is 55mV/Dec, the DIBL is 38.5, and the I_{on}/I_{off} ratio is ten times larger. SB-DG CNTFET has a substantially higher I_{on}/I_{off} ratio than CNTFET (133x) and DG-MOSFET (250x). Finally, the simulation findings show that the CNTFET outperforms the MOSFET in the Nanoscale regime for high-speed and low-power electronic switching applications.

Keywords: CMOS; Short Channel Effects; CNTFET; Double Gate CNTFET; Nanomaterials; Nanoelectronics.

Enhancing Hydrophobicity of Silicon Carbide Nanowhiskers by Surface Treatment for Improved Microwave Welded Joint

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Abstract

Silicon carbide nanowhiskers (SiCNWs) have been recognized as an excellent microwave susceptor for microwave welding, contributing to the formation of high-strength nanocomposite welded joints. However, due to the low hydrophobicity of SiCNWs, SiCNWs and highly hydrophobic thermoplastics are incompatible, and this subsequently deteriorate the mechanical properties of the nanocomposite welded joints. To address this problem, surface treatment using a silane coupling agent was employed to enhance the hydrophobicity of SiCNWs prior to their application as microwave susceptor for the joining of thermoplastics. In this study, trimethoxy[3-(methacryloxy)propyl] silane (KH570) was selected as the silane coupling agent for the surface treatment of SiCNWs. Both the untreated and treated SiCNWs were first characterised using fourier transform infrared spectroscopy (FTIR) and then subjected to water contact angle (WCA) measurement. The results revealed that the KH570 surface treated has improved hydrophobicity. Subsequently, both untreated and treated SiCNWs were utilised as susceptor for the microwave welding of polypropylene (PP), and the cross-sectional microstructures of the nanocomposite welded joint were examined using energy dispersive x-ray equipped scanning electron microscopy (EDX-SEM). The SEM images demonstrated an improved compatibility between SiCNWs after methacryloxy group of KH570 was grafted onto the surface of SiCNWs. Therefore, this study proposes an additional step to further improve the compatibility of between SiCNWs and PP and the mechanical properties of microwave welded joint without altering their overall nanocomposite microstructure.

Keywords: Surface treatment; Silicon carbide nanowhiskers; Silane; Nanocomposite; Microwave welding.

Facial Detection and Attendance Management system using Artificial Intelligence unconventional computing

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Abstract

In present times, face recognition has becomenone of the best technologies for computer vision. Face recognition is always a very difficult task in computer vision, illumination, pose, facial expression. Face recognition tracks target objects in live video images taken with a video camera. In simple words, it is a system application for automatically identifying a person from a still image or video frame. In this paper we proposed an automated face recognition system. This application based on face detection, feature extraction and recognition algorithms, which automatically detects the human face when the person in front of the camera recognizing him. We used KLT Algorithm, Viola-Jones Algorithm face detection which detect human face using Haar cascade classifier, however camera is continuously detecting the face every frame, PCA algorithm for feature selection. We apply a model combining to match the geometric characteristics of the human face. In this paper, after experimenting several techniques all technique is working well face recognition. Face Recognition Systems is based on face recognition. This system can be used to identify unknown person. In real-time scenarios, PCA outperforms other algorithms. The future work is for the recognition of the algorithm. In the system developed only by recognizing the 30-degree angle variations that should be improved. Gait recognition can be fused with face recognition systems. Poor lighting conditions. Our system will perform well but it is not a perfect solution.

Keywords: Face Recognition; Face Detection; PCA; Artificial Intelligence; Unconventional Computing.

Effectiveness of Glass Fiber-Reinforced Mortar for Improving Durability in Structures

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Abstract

Enhancing the durability, usability, and effectiveness of structures is crucial in modern civil engineering. The aim of the study is to investigate how the properties of cement are altered by the addition of glass fibre (monofilament). In the study, the effectiveness of mortars with different amounts of glass fibre added (at concentrations of 1%, 2%, 3%, 4%, and 5% by weight of cement) is compared. Based on the results of the compressive strength tests, it can be shown that adding glass fibre to mortar mixtures typically increased their compressive strength at various ages for all mix proportions (1:3, 1:4, and 1:5). Glass fibre enhanced the compressive strength for the 1:3 mix percentage, with the 4 percent GF mix displaying the greatest strength values throughout all test time periods. The data for mortar mixtures of 1:3, 1:4, and 1:5 with varied amounts of glass fibre demonstrate that the inclusion of glass fibre often causes an increase in the rate of strength gain. The ideal glass fibre content, however, may change according to the particular curing time and application needs. The inclusion of glass fibre, particularly at proportions of 2 and 3 percent GF for 1:3 and 1:4 blends reduced drying shrinkage in mortar mixes. The findings show that the addition of fibres significantly changes a mixture's mechanical properties, whereas the effect is less pronounced when fibres are added to a less dense mixture. Overall, the results point to glass fibre-reinforced mortar as a potentially useful material for use in civil engineering applications because of its capacity to boost the durability and effectiveness of modern construction projects. Enhancing the durability, usability, and effectiveness of structures is crucial in modern civil engineering.

Keywords: Glass fibers; Reinforced mortar; Compressive strength; Water absorption; Drying shrinkage.

Effective designs of monitorable nano-carriers with the ability to control the drug release

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Abstract

Nowadays, a delivery platform that provides control over the release of a drug at a target site is highly desirable. To achieve an efficient regulatory drug delivery platform, two different novel approaches were formulated. The first was a one-step electrospray approach to fabricate Poly (D, L-lactide-co-glycolide) (PLGA) nano-carrier (PLGA-Tg) by encapsulating 6-thioguanine (Tg), which is an anti-proliferative drug via the formation of the thioester bond between them. The second was a state-of-the-art multi-step approach to synthesize anti-proliferative drug methotrexate (MTX) conjugated inherently fluorescent PLGA nano-carrier (PLGA-PBA@MTX) by forming acid labile amide bond. The inherent fluorescence of the drug delivery platform helps monitoring the drug release mechanism, and the acid labile amide bond helps drug release in a pH-dependent manner. The thioester-bonded Tg shows a steady diffusion rate for a prolonged time (60 days) in in-situ. However, the thioester bond hydrolyzes rapidly inside the cell cytoplasm and releases the active drug molecules. These synthesis methods achieved homogeneous distribution with very high encapsulation efficiency. The highest drug loading was attained in the MTX conjugation method, which is prominently reflected in the in-vitro study of the therapeutic effect on MTX-resistant metastatic breast cancer cell lines. These studies demonstrate the usefulness of an engineered nano-formulation to control the drug release mechanism and its therapeutic responses.

Antibacterial Study of Tin-Oxide – Graphene Derivatives

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Abstract

The inherent ability of Metal oxide-graphene composites to inhibit the growth of bacteria is drawing great attention during these years and is considered as next-generation antibiotic to deal with multi-drug-resistant pathogens. The present study aimed to investigate the antibacterial efficacy of the synthesized nanostructures against disease-causing pathogens. In this study, Tin oxide (SnO_2),Graphene Oxide (GO) and reduced Graphene Oxide (rGO) are synthesised separately by nitrate-citrate gel combustion technique and Hummer's method respectively. The various concentrations of SnO_2-Graphite, SnO_2-GO and SnO_2-rGO were prepared by the one-step hydrothermal method and were characterized by XRD, FTIR, Raman Spectroscopy, SEM and TEM. The antibacterial activity of the nanostructures is measured using a MIC assay with an agar dilution method against two gram-negative bacteria (*Escherichia coli* and *Pseudomonas fluorescens*) and two gram-positive bacteria (*Bacillus subtilis.* and *Staphylococcus aureus*.). The as-synthesized nanoparticles were analysed for antibacterial activity against the bacteria and the study reveals that the Tin oxide -graphene composites have better antibacterial activity than their individual compound. The highest inhibition of growth was seen with the highest concentration of SnO_2. Among all the cultures, *E. coli* was affected more by SnO2 as single and in combinations.

Keywords: Tin oxide-graphene composites; Antibacterial activity.

Ultrasonic and spectroscopic investigation of aqueous polyvinyl (PVA) alcohol solutions

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Abstract

Polyvinyl alcohol solutions of different wt.% were prepared using distilled water as a solvent and were investigated using ultrasonic pulse echo technique, Fourier transform infrared spectroscopy and ultraviolet-visible spectroscopy. Ultrasonics has become an important and powerful research tool in physics. The ultrasonic study of liquid mixtures has been gaining importance in assessing the nature of molecular interactions and understanding the physicochemical behaviour of liquid.It also provides an effective and reliable tool to investigate properties of polymer solutions in the light of phase separation studies. Ultrasonic velocity (u), Density (ρ) and Viscosity (η) for aqueous polyvinyl alcohol have been measured at 5 MHz ultrasonic frequency at temperature range 288K- 308K and at concentration range 0.05 to 0.3wt.% by Pulse Echo technique. From this data, acoustic parameters such as adiabatic compressibility (β_a), acoustic impedance (z), relaxation time (τ) and free length (L_f) of aqueous polyvinyl alcohol (PVA) solution are calculated. The results are interpreted as per molecular interaction in the aqueous polyvinyl alcohol solution and compared with the results obtained from FTIR and UV-visible spectroscopy. Due to investigated interactions polyvinyl alcohol can be used as tablet binder in pharmaceutical industries.Thermo-acoustic parameters such as ultrasonic velocity, density, viscosity, adiabatic compressibility, acoustic impedance, relaxation time, free length, etc. indicates the strength of molecular interactions in the aqueous polyvinyl alcohol solution.

Keywords: Ultrasonic and Acoustic; Ultrasonic velocity; Density; Viscosity, FTIR, UV-Visible.

Review of Thin-film Solar cells using $Cu(In,Ga)Se_2$ based Nanomaterials

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Abstract

Thin film solar cells are expected to provide a cost-effective, flexible alternative to conventional Silicon-based solar cells addressing widespread energy demands. $Cu(In,Ga)Se_2$ (CIGS) is promising absorber material for thin film solar cells owing to its excellent thermo-chemical stability and demonstration of stabilized high power conversion efficiency of 23.35% on a lab scale. Despite the excellent performance, commercialization of CIGS solar cell technology has been hindered due to various issues related to the fabrication of absorber thin film. The manufacturing of CIGS thin films needs innovative technological development to be simplified and cost-effective to make them commercially competitive. In the connection, solution process utilizing CIGS nanomaterial precursor is non-vacuum, low-cost, non-toxic and scalable approach for developing CIGS thin film absorber layer has a high potential. The typical processes comprising two steps, starting with synthesizing high-quality CIGS nanomaterials with desired phase, composition and morphology. The synthesis process is followed by printing precursors in thin film form by scalable, simplified, inexpensive techniques such as doctor blading, screen-printing, spin coating and inkjet printing. Subsequently, thermal/photonic post-treatments of the printed precursors to transform into a high-quality photovoltaic-grade absorber layer.

In the present work, we critically review hot injection, solvothermal, sonochemical, microwave, laser ablation and mechanochemical techniques for synthesizing CIGS nanostructures with desired phase, size, shape, stability, composition, and optical properties, necessary for device quality. In this chapter, we also in detail discuss the strategies and influence of ligands on physical characteristics and its consequent impact on device performance. Here we are presenting a comprehensive review and comparison of various printing techniques and process parameters for their enability to control absorber layer properties, material utilization, scalability and device performance. We are presenting a critical investigation on the thermal processing of printed thin films to realize a high-quality CIGS absorber layer suitable for thin film photovoltaics. The thermal processing parameters such as post-treatment temperature, annealing atmosphere, Selenium source, ramping rate, holding time, and alkali doping strategy are discussed to understand its impact on composition, morphology and optoelectronic properties and on device performance. Unlike conventional thermal treatment, novel photonic sintering techniques utilizing millisecond-intense pulsed light and pulsed lasers offers various advantages to sinter nanocrystalline CIGS precursor films. Correlation between photonic process parameters to absorber layer properties and subsequent device performance is reviewed thoroughly and presented here. The findings and related reviews afford critical insight into the absorber thin film design to improve the performance of solution-processed chalcopyrite solar cells. Finally, Current challenges, as well as prospects for effective technology implementation, are discussed.

Keywords: CIGS nanomaterial; Selenization; Laser Annealing; Solar cells; Alkali doping.

Influence of Ag doping on structural, optical and photoluminescence properties of zirconium titanate nanoparticles

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Abstract

In this paper, Photoluminescence properties of Ag (1 mol%) doped $ZrTiO_4$ nanoparticles prepared by solution combustion method using Aloevera leaves extract as a reducing agent and calcinated at 720^0C.The synthesized samples were characterized with powder X-ray diffraction (PXRD), scanning electron microscopy (SEM), Energy dispersive analysis of X-ray (EDAX), Fourier transform infrared spectroscopy (FTIR) and UV-visible spectroscopy. The Bragg's reflection of PXRD pattern clearly confirms the formation of orthorhombic structure with no impurity peaks. Scanning electron microscopy results indicate that, the prepared NPs showed irregular shaped surface morphology. FTIR analysis indicates the presence of various functional groups in the materials. The energy bandgap was estimated by using the Wood and Tauc's relation and was found to be 3.28eV. The Photoluminescence spectra shows the radiative emission peak at 440nm which confirms that the present nanophosphor might find applications in display technology.

Keywords: Combustion; Aloevera; Silver; Photoluminescence.

Theoretical modelling of electrostatic wave excited by an ion beam in a plasma cylinder with negative ion

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Abstract

Electrostatic ion acoustic modes are driven to instability through Cerenkov interaction when an ion beam is made to propagate through magnetised plasma cylinder consisting of K^+ions, electrons and SF_6 negative ions. The phase velocity of unstable wave frequencies and growth rate of acoustic wave increases with the relative density of negative ions both in presence of positive and negative ions. The growth rate of both modes in presence of positive and negative ion scales to one third power of beam density. The calculations are carried using the parameters of song *et al*. [Phys. Fluid B 3, 284 (1991)]

Keywords: Acoustic waves; Instability, Plasma, Beam density.

Effect of Stearic Acid on Poly(MethylMethacrylate) Hybrid Nanocomposites

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Abstract

The properties of organic filler composites are often affected by the nature of the filler. In this study, the palm kernel shell (PKS) filled poly(methyl methacrylate) (PMMA) was added with nano-calcium carbonate (nano-$CaCO_3$) to form a hybrid composite with the aim to improve the properties of the composites. The effect of nano-$CaCO_3$ loading, with and without stearic acid treatment on mechanical, morphological, thermal and water absorption properties of PMMA/PKS composites were studied through tensile test, SEM and DSC. It was found that the tensile strength of the hybrid composites was gradually improved with addition of nano-$CaCO_3$ up to 0.6 php loading. The Young's modulus of hybrid composites was found to increase with nano-$CaCO_3$ loading, but elongation at break showed an opposite trend. This enhancement was due to the improved interaction between nano-$CaCO_3$ and matrix which was proven through SEM images. The glass transition temperature (T_g) and melting temperature (T_m) also increased with the addition of nano-$CaCO_3$ but reduced with the stearic acid treatment. Water absorption test revealed that by increasing the nano-$CaCO_3$ loading and with the chemical treatment of stearic acid, the presence of hydroxyl group on the surface of nano-$CaCO_3$ was reduced, as evidenced by FTIR, leading to the reduction of water update. The addition of nano-$CaCO_3$ and use of stearic acid was found to enhance the properties of PMMA hybrid composites. Therefore, it opened the ways for PMMA/PKS composites to be used in many applications such as packaging and advanced biocomposites.

Keywords: Poly(methyl methacrylate), Palm kernel shell; Nano-calcium carbonate; Hybrid composites; Stearic acid.

Destabilization of a glassy magnetic state and observation of metal-insulator transition in nanometric $Nd_{0.8}Sr_{0.}2MnO_3$ manganites

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Abstract

A detailed investigation of the magnetic, electronic- and magneto-transport properties of $Nd_{0.8}Sr_{0.2}MnO_3$with the variation of grain size (down to 42 nm) has been carried out. Interestingly, we observe thatthe ferromagnetic insulating state is suppressed and a metallic state is stabilized as the grain sizeof the sample is reduced.A rigorous measurement of linear and non-linear ac magnetic susceptibility inthe bulk-like $Nd_{0.8}Sr_{0.2}MnO_3$ confirms the existence of a glassy phase in the low temperature regime.The effect of size reduction on this glassy state is addressed here. This glassy phase is found tostrongly destabilize on reduction of grain size. Based on our experimentalresults, the glassy phase has been attributed to the phase separation effect and interaction between theferromagnetic clusters. The destabilization of this glassy phase has been argued to be due to themodification of the phase separated state on size reduction. Furthermore, the lowest grain size sampledisplays a Griffiths-like phase. The evidence of the emergence of this phase has been obtained fromdetailed dc and ac magnetization studies. On the other hand, a metal–insulator transition is observed in the nanoparticles of this low-dopedmanganite which is insulating in nature in its bulk form. Destabilization of polaronic order inthe ferromagnetic insulating state due to enhanced surface disorder on grain size reduction isattributed to this effect. A phenomenological model is proposed to represent the concept ofdestabilization of the glassy state as well the polaron formation in the surface region of the nanograins. Further, resistivity andmagnetoresistance data are carefully analyzed employing different suitable models.

Multifunctional Emerging Resistive Switching Devices

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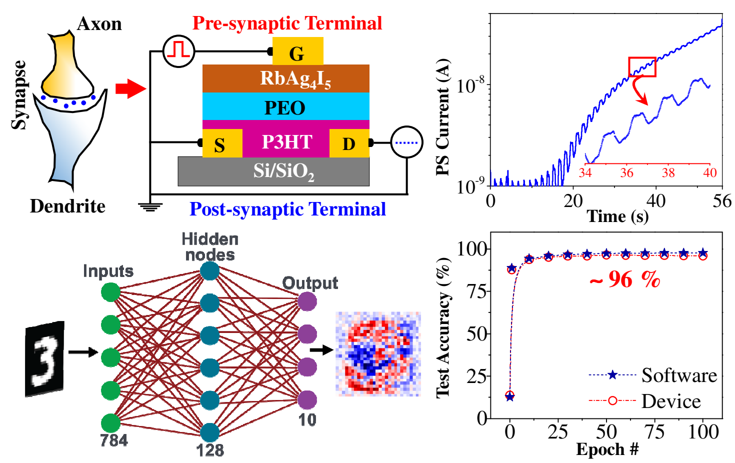
Abstract

The human brain is the most efficient machine around us in size, power efficiency, self-learning capability, decision-making, and simultaneous data storage and processing.[1] Additionally, our brain performs all operations analogously by consuming energyof about 1 – 100 fJ per synaptic event. Even though the conventional computer works much faster than the brain, the von-Neumann bottleneck and memory wallissues limit the performance and energy efficiency due to the physically separated storage and processing unit. After discovering the memristor (MR), a two-terminal device with multiple conducting states at a particular bias voltage, efforts are already underway toward developing machines similar to brain functionality.[2] Despite massive progress in semiconductor technology, it is still challenging to mimic the functionality of synapses and neurons, the basic building blocks of our brain. Memtransistor (*mem*T), a gate-controlled memristor or memory transistor, is also coming up rapidly to the limelight for mimicking functionalities of synapses and neurons more controlled way as the building block of the artificial brain. Among various approaches, the redox-controlled MR and *mem*T are becoming very attractive to accomplishing the desired metrics for developing efficient neuromorphic computing tools. In this talk, I will introduce a few unconventional redox reaction-dependent molecular MR and organic *mem*T devices that are very efficient for data storage and mimic various synaptic and neural functions electronically.[3]



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Novel Flame retardantfor improved polyurethane properties for thermal applications

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Abstract

It is widely accepted that using flame retardants can improve PU characteristics. To reduce the amount of flame produced during the fire, flame retardant (FR) fillers were utilised. In most cases, they were added to products like fabrics, plastic coatings, and surface finishes to slow down combustion. Flame retardants or chemically attaching it to the polymer are two possible strategies to customise the basic material. In contrast to FRs based on minerals, which are typically additive, organohalogen and organophosphorus compounds were either additive or reactive. It is possible to adjust qualities like as crystallinity, solubility, bioactivity, and surface characteristics, and the usefulness of a material as a non-burning FR depends on the aforementioned properties. The heat and breakdown behaviour of materials like FRs, carbon nanotubes, and organoclay has been studied. The performance of composites can be improved by utilising all these FRs features. The properties of the resulting composites can be completely altered by combining two or more FRs in small amounts, which cannot be accomplished with a single FR. As a result, these FRs have a wide range of applications that can be employed to enhance the final product.

Keywords: Flame retardants; Polyurethane.

Investigation on Multifunctional Properties of Lanthanum Ferrite Nanoparticles for Bismuth Substitution

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Abstract

The materials having multifunctional characteristics are considered as the principal base materials in multifunctional and nano-dimensional devices industries. Multiferroics are the combination of more than one ferroic characteristic (ferroelectric, ferromagnetic/antiferromagnetic and often ferroelastic) in the same phase. There is a coupling between spontaneous polarization and large magnetization. Research interest in multiferroic has increased in recent days because of their potential application in microelectronic and nano-electronic devices like transducers, spintronics, sensors, actuators, etc. Interestingly, it was found that Lanthanum Ferrite ($LaFeO_3$), a member of the centrosymmetric rare earth ortho-ferrite ($RFeO_3$) family (having a distorted orthorhombic perovskite structure), possesses magnetically tunable ferroelectricity due to the exchange striction mechanism.

The structural properties are analyzed by XRD pattern using Rietveld refinement. TEM images confirm that the average particle decreases with Bi doping concentration. The DC and AC charge transport mechanisms are analyzed, and the experimental data is well supported with the theoretical model, i.e. Mott's VRH model, and CBH model. M-H hysteresis loops reveal the antiferromagnetic ordering of the samples. Positive magneto-dielectric coupling is observed in the samples where coupling increases with doping which states that the Bi-doped $LaFeO_3$ can be a good candidate in magneto-electric industries.

Keywords: Multiferroics; Lanthanum Ferrite; Electric Properties; Magneto-Dielectric Coupling.

Structural, Optical and Surface properties of Rare-Earth and Transition metals doped Metal Oxide Nanoparticles

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Abstract

Metal oxide nanoparticles (NPs) such as TiO_2, CeO_2 and ZnO have been widely explored as efficient photocatalysts for the degradation of organic pollutants as well as treatment of water and waste water due to their remarkable optical, structural, morphological and electronic properties [1, 2]. The pure and Rare Earth and Transition metals doped SnO_2 nanoparticles synthesized by using Chemical precipitation method. The structural, optical and Surface properties of Rare Earth and Transition metals doped SnO_2 nanoparticles are also discussed.

Keywords: Powder XRD; Optical; SEM; Rare-Earth; Transition metals.

Theory of thermal conductivity in low-dimensional structures

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Abstract

The in-plane and cross-plane thermal conductivities of layered structure (heterostructures) have been investigated on the basis of a modified Callaway model. The relaxation times of various scattering processes involved in the thermal transport have been evaluated in terms of line widths with the help of many-body quantum dynamics of phonons and electrons, by adopting the versatile double time temperature dependent phonon Green's functions, which have been obtained via a Hamiltonian that comprises the effects of electrons, phonons, impurities and anharmonicities. The thermal conductivity of semiconductor layered superstructures has been numerically analyzed over a wide temperature range. The obtained results make fairly agreement between theory and experimental data.

Keywords: Layered structures; Superlattices; Relaxation times/lifetimes; Phonon Green's function.

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Optical tuning of polymer functionalized zinc oxide quantum dots as a selective probe for specific detection of antibiotics

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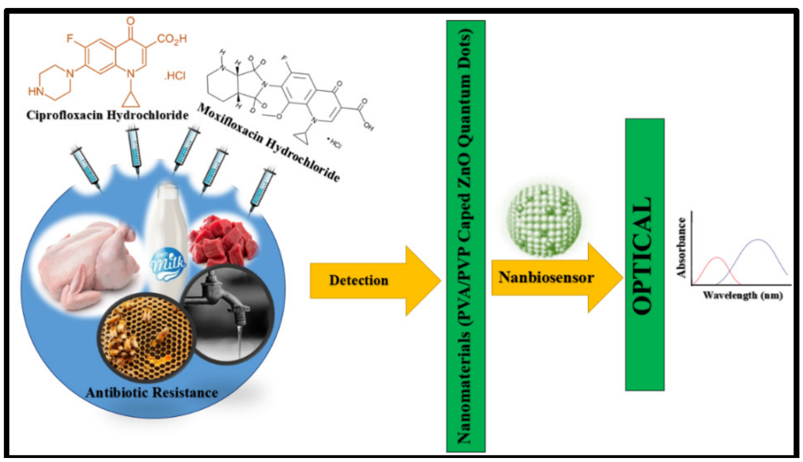
Abstract

It is crucial to monitor the antibiotic levels in the environment like water, food products in the current scenario as the antibiotic concentration above threshold is harmful for the human health. Excess consumption of antibiotics leads to antibiotic resistance that hinders the control and cure of microbial diseases. So, these challenges motivated to devise an optical nano-senor which can sense the ultra-low concentration of antibiotics.In this proposed research work, emphasis is to develop a method which is simple and selective to analyze the detection and presence of antibiotics in various samples like tape water milk etc. using fluorescent ZnO QDs based nano-sensor. For this, fluorescent and different polymers (polyvinylalcohol – PVA and polyvinylpyrrolidine – PVP) capped ZnO QDs were synthesized using modified sol-gel technique. These were used as fluorescent probe to monitor the presence of antibiotics. The optical characterizations of synthesized QDs were performed using UV-Visible absorption & fluorescence spectroscopic methods while structural characteristics were analyzed by using FTIR, XRD and EDX. Charge on the synthesized QDs were obtained with the help of ZETA potential. Here ten different antibiotics were targeted among, Ciprofloxacin and Moxifloxacin have shown excellent sensing and specificity with PVA-ZnO QDs and PVP-ZnO QDs respectively.



Keywords: Ciprofloxacin; Moxifloxacin; Antibiotic resistance; Optical Sensing; Quantum Dots.

Optimization of flux for high impact strength and low heat affected zone width In SAW

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Abstract

Selection of flux in submerged arc welding is very important as it affects the weld metal properties like impact strength, hardness and tensile strength. This study has been conducted to find the optimal composition of flux for high impact strength and low HAZ. In this study twenty fluxes were designed and made by agglomeration technique. Bead onplate weld were made using submerged arc welding. The mechanical properties are affected by the transfer of elements to the welds, composition of flux and welding parameters. In this study welding parameters such voltage, current and travel speed were made constant. The optimal flux which has been suggested using fuzzy logic are also verified by doing confirmatory tests. The study suggest that the optimal flux constituents are CaF_2, FeMn and NiO are in the ratio of 2;8;2.

Keywords: Submerhed arc welding; HAZ; Fluxes; Impact strength; UTS; Impact strength; Percentage elongation.

Fabrication of chitosan decorated magnetic nanoparticles for effective removal of dyes employing an experimental modeling tool

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Abstract

Toxic dye contaminants are increasingly becoming prevalent in surface water bodies owing to inefficient management of industrial effluents and their uncontrolled release into surface water bodies. In the present study, chitosan decorated magnetic (CS@nZVI) nanoparticles were synthesized to investigate its high efficacy against two anionic model dyes, namely Bromocresol green and (BCG) and Brilliant blue (BB). The chitosan functionalization of nZVI protects the nanoparticles from oxidation, and fast aggregation while maintaining their uniform nano size of 13.12 nm. The CS@nZVI were characterized for XRD, FESEM, EDS, and FTIR to investigate their crystallinity, surface morphology, elemental composition and attached functional groups. The batch experiments showed that CS@nZVI nanoparticles have high adsorption efficiency of 84.96% and 86.21% for BCG and BB dye, respectively. RSM-CCD model was employed for optimizing experimental runs by taking an adsorbent dose (2–4 mg), pH (4–8), time (20–40 min), temperature (35–65 0C), and initial dye concentration (40–60 mg/L) and study their independent as well as combined interactions through the obtained response, i.e., percentage dye removal. Moreover, the experimental data fitted well with Langmuir isotherm and pseudo first order kinetics, with a maximum qe value of 426.97 and 452.4 mg/g for BCG and BB dye, respectively. CS@nZVI also displayed good reusability potential with high proficiency for real water samples.

Keywords: Azo dyes; Chitosan; Nanoscale zerovalent iron; Response surface methodology; Adsorption.

Photoluminescence properties of lanthanides activated Borate based phosphor for environmentally friendly solid-state lighting application

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Abstract

The rare earth activated borate based were prepared by combustion synthesis method. The phosphor was characterized by photoluminescence spectrophotometer for excitation and emission spectra. The phosphors $Ca_3B_2O_6$: RE (RE=Dy^{3+}, Eu^{3+} Sm^{3+} and Tb^{3+}) were prepared by a combustion method. Phosphors were characterized by X- ray diffraction, Scanning Electron Microscopy, CIE cordinates and Photoluminescence. The particle size is within the micrometre range, according to the scanning electron microscope magnification. Concentration quenching effect was observed in entire the phosphor system. Photoluminescence results suggest that phosphor could be used as ecofriendly solid state lighting applications.

Keywords: Borate; Solid state lighting; Combustion method; Phosphor.

Optimization on the Process Parameters of AA2519 and AA6063 Joints by Friction Stir and Tungsten Inert Gas Process Welding using Response Surface Methodology

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Abstract

In this research, Tensile strength (TS), percentage elongation (EL) and micro-hardness (HV) at a Tungsten Inert Gas and Friction Stir Processing (TIG+FSP) welded connection of AA2519 and AA6063 were all predicted using empirical relationships with a 95% level of confidence. The models generated highlight the importance of the tool's rotating speed and tilt angle. During TIG+FSP welding, the heat input to the joint increases as the traverse speed slows and the tool rotational speed rises. Faster tool rotation, as shown by the confidence interval, increases tensile strength and hardness while decreasing residual stress. With a tool rotational of 1500 rpm, a traversal speed of 40 mm/min, and a tilt angle of 1°, the nugget zone (NZ) of a TIG+FSP weldment had the lowest compressive residual stress (21.1 MPa). Hardness (110 HV) was also good (58 HRC) and tensile strength (270 MPa) was strong. Input processing factors tool rotational speed (A), traverse speed (B), and tilt angle (C) are best set at 1130.62 rpm, 52.49 mm/min, and 0.16350 respectively, leading to optimal values of 221.4 MPa for tensile strength, 24.72 percent for EL, HV at the NZ, and 91.47HV for residual stress at the NZ.

Keywords: Friction Stir Processing; Tungsten Inert Gas; Response surface methodology; Rotational speed; Micro- hardness.

Optimization on the Operating Parameters of Electrical Discharge Machining of AA5128/SiC Composites

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Abstract

Optimizing and simulating wire-cut electric discharge is the focus of this work. The impact of pulse on-time (Ton), voltage gap (Vg), pulse off-time (Toff) on the machinability of silicon carbide (SiC) reinforcement in an aluminium alloy AA5128. Aluminum metal matrix composite (AMMC) was made employing the stir casting method, and nanomaterial was synthesized utilizing planetary high energy ball milling. To investigate whether or not the cast composite can be machined. Central composite design (CCD) using a face-centered approach is used to design experiments based on the Response Surface Methodology (RSM). Surface roughness (SR) and Kerf width (KR) were examined to evaluate the best settings for input. Analysis of Variance (ANOVA) is employed to examine the robustness of the formulated model, while regression analysis is employed to characterize the processing variables. According to the findings, kerf breadth narrows with increasing Toff and widens with rising Ton and Vg. As Vg and Ton both rise, the two trends cancel each other out, with rougher surfaces being produced as higher values are produced.

Keywords: Electric discharge machining; ANOVA; Kerf width; Surface roughness; SiC; Gap voltage.

Multi Parametric Optimization on the Wire-Cut Electric Discharge Machining for Boron Carbide Graphene Oxide/Aluminium Composites

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Abstract

In this research, the authors propose a strategy that integrates elements of the Taguchi technique, Grey relational analysis (GRA), and principal component analysis (PCA). Wire Electrical-Discharge Machining (WEDM) is used to evaluate and estimate the output responses of scrap aluminium-based metal matrix composites in order to learn the effect of machining settings. The aim of this study was to determine the best combination of process parameters for minimizing both material removal rate (MRR) and surface roughness (Ra). With Taguchi's technique, it was determined that the WEDM of developed composite specimens was L27 orthogonal array (OA), with the main control factors being the percentage of reinforcement weight, the percentage of Doping, the time of the ON pulse (TON), the time of the OFF pulse (TOFF), and the wire feed rate (WFR). The findings of an ANOVA analysis, the two factors that have the greatest impact on MRR and Ra are the weight percent and the degree of paralysis percent. After applying GRA to standardize multi-objective responses, principal components analysis was used to assess how well each performance metric was weighted. Depending on the ideal combination, the highest MRR was determined to be 17 mm^3/min, while the lowest Ra was found to be 3.12 µm.

Keywords: Wire feed rate; Material removal rate; Surface roughness; Scrap aluminium; Boron carbide; Graphene oxide.

Investigation on the Mechanical Properties of Hybrid Composites using Ramie Fibre and Silica Particles

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Abstract

The purpose of this research is to investigate the physical and mechanical characteristics of hybridized composites made from Ramie fibre, nano-silica, and epoxy. A hybrid composite containing 0%, 2%, 4%, and 6% Silica by weight and four layers of the Ramie fibres was prepared using the hand layup procedure and then compression moulded. Mechanical qualities were determined by doing tests for hardness, flexural strength, tensile strength, and impact resistance. Hybridized composites with up to 4 wt. % silica and Ramie fibre have significantly better mechanical characteristics. According to the results of Rockwell Hardness testing, composites' hardness (at the R4 level) has increased by up to 29% since the R0 level. At 4 wt. % Silica, the tensile strength is roughly twice that of neat laminates. The R4 now has a 50% greater impact strength than before. Up to 4wt% Silica reinforcing, flexural characteristics are also improved. For the development of material qualities, wear tests were conducted on density, water absorption, and thickness swelling.

Keywords: Ramie fibre; Silica; Mechanical characteristics; Hardness; Water absorption.

Investigation on the Mechanical Behavior of LDPE/Pea Pods Particulate Bio-Composites

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Abstract

In this paper, Composites made from LDPE were tested to see how adding Pea pod particles altered their performance characteristics. Both a compounding process and a compression moulding process were used to create the LDPE/Pea pod particles composites. Optimization was achieved through a factorial experiment design and ANOVA. The mechanical characteristics of the composites were studied. Composites had greater hardness, flexural strength, and tensile strength than the polymer matrix. The increased mechanical performance is partly because to the composite extraordinarily homogeneous dispersion of Pea pod particles. The synthetic composites created can be utilized to make environmentally friendly outdoor and indoor fixtures. Since the optimal condition yields findings that are consistent with the qualities of composites typically employed for this function.

Keywords: Mechanical Properties; ANOVA; Factorial design; Tensile strength; Flexural strength.

Investigation on the Mechanical and Tribological Properties of AA6063 Hybrid Metal Matrix Composites and Optimization of Wear and Friction Behaviour by Taguchi Method

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Abstract

In order to evaluate the effectiveness of inoculating Fly Ash into aluminium composites to increase their functionality, the wear properties of AA6063/Silicon Carbide (SiC) /Fly Ash (FA) composites under varied loads are characterised. In this study, authors use a stir casting method to inoculate Fly Ash into AA6063/SiC functional composites with various blends of reinforcements (0.5, 1 & 1.5wt%). The innovative aspect of this study is the use of Fly Ash as a functional inoculant, which, coupled with the SiC, is sure to affect the composites' tribological properties. Several process factors were investigated to establish how they influenced the wear characteristics of the produced composites, with consideration given to the real-time operating demands of the composites in question from the prior research investigations. The percentages of SiC and Fly Ash weights, as well as the distance and speed at which the load was slid, were also considered. The wear regimes that emerge from characterising the samples at various loads are then employed in an analysis of variance (ANOVA) to provide statistical support for the experimental findings. The findings provide substantial support for the hypothesis that immunisation can reduce wear rate. At a load, sliding velocity, sliding distance of 20N, 6m/s and 3000m, respectively, the L27 experimental trial yielded a wear rate (WR) of 0.00118 mm3/m and a coefficient of friction (COF) of 6.8783 for composite synthesised by reinforcing each 1.5wt % of SiC, and Fly Ash. Micro isolation of Silicon carbide and homogenous distribution of FA to the AA6063 are responsible for the composite's enhanced tribological properties.

Keywords: Optimization; Fly ash; Coefficient of friction; SiC; AA6063; Wear rate; ANOVA.

Synergistic Impact of Silane-Modified Nano-CaCO3 Particles on the Mechanical Behavior of Kevlar Fiber/Epoxy Composites

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Abstract

In this research, flexure, Mode-I, and Mode-II strengths, as well as the interlaminar shear strength (ILSS), of Kevlar fiber/epoxy composites are tested, as are the effects of adding silane-treated nano-$CaCO_3$ particles. The silane coupling agent 3-Glycidyl oxy propyl trimethoxy silane (GPTMS) can be used to modify the surface of nano$CaCO_3$ particles. Some of the tests performed on the composite samples include three-point bending, double cantilever beam (DCB), end-notch flexure (ENF), and short beam shear, all of which are mandated by the applicable ASTM standards. Experimental results show that when silane-treated nano-$CaCO_3$ particles make up 5% of the composite's weight, the flexural modulus, flexural strength, Mode-I fracture toughness, Mode-II fracture toughness, and ILSS values are improved by 17.2%, 14.2%, 26.3%, 20.1%, and 20.4%, respectively, when compared to reference composites. When silane is applied to nano-$CaCO_3$ particles, they gain 15.3% in storage modulus. The composites' glass transition temperature was little impacted by the incorporation of silane-treated nano-$CaCO_3$ particles.

Keywords: Kevlar fiber; Epoxy; Nanoparticle; Silane; Mechanical properties.

Demineralised fish bone as a matrix for periodontal regeneration

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Abstract

A novel tissue regeneration matrix was developed by controlled demineralization of Tuna fish bone. SEM images of the matrix confirmed three-dimensional porous structure and excellent pore inter connectivity. FTIR profile confirmed the collagenous nature of the matrix. *In vitro* biocompatibility assessment using MTT as say proved that the material is not cytotoxic.The demineralized bone matrix exhibited good bio-compatibility *in vitro,* and did not elicit any strong inflammatory response after implantation. Fishbone matrix was able to promote the cellular adhesion, migration, proliferation, differentiation, growth, also several biochemical reactions such as osteogenesis, vasculogenesis, and matrix degradation. The *in vivo* bio-compatibility and tissue regeneration potential of demineralized fishbone was evaluated in Spargue Dawley rats. *In vivo* analysis demonstrated normal inflammatory response without any unfavourable tissue reactions. New bone formation in the defects filled with demineralized fishbone scaffolds was significantly higher than the defects which were unfilled. Cone beam computed tomography (CBCT) of the samples exhibited more bone formation in the sample treated with demineralized fishbone. Overall there sults of the study suggested demineralized fish bone as a promising substitute for auto genous soft tissue grafts in period on tal plastic surgery and guided tissue re-generation.

Keywords: Demineralised fish bone; Periodontal regeneration, *in vivo*biocompatibility, Bone graft.

A Study on doped and co-doped zinc aluminate nanocrystals

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Abstract

Zinc aluminate is a spinel oxide structure widely used as photocatalyst, optical sensor and photonics applications. It is a non-hazardous, hydrophobic and chemical stable material. The transition metal ions as dopant stimulate the structural and optical properties. Manganese (Mn) and Nickel (Ni) are the two transition metal ions having ionic radii comparable to zinc ion. Hence, it can influence the structural and optical properties at low concentration. Here in, Mn doped and Mn-Ni co-doped zinc aluminate nanocrystal prepared by combustion method using urea as fuel. Further the samples were annealed at 900^0C. The effect of the ratio of Mn and Ni on zinc aluminate nanocrystals were analysed by XRD, FTIR, UV and photoluminescence. The structural parameters were evaluated and analysed by Rietveld refinement method. The results showed that crystalline size, strain lattice parameters and crystallinity were modified with Mn and Ni dopant ions. Further chemical bonding and Zn-Al, Al-O bonding were confirmed by infra-red spectroscopy. UV-visible absorption spectra presented the change in the absorption edge with increasing Ni concentration. Moreover, the effective band gap calculated by Tauc plot indicated increased band gap as compared to bulk zinc aluminate crystal. From the PL, blue and deep red emission were observed from doped zinc aluminate nanocrystal. The presented results are shown the positive approach to use co-doped zinc aluminate for various applications.

Keywords: Zinc aluminate; Nanocrystals; Combustion synthesis; Rietveld analysis; Optical study.

Contemporary voltammetric techniques and its application to pesticide analysis

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Abstract

The objective of the paper is to access the usefulness of contemporary voltammetric methodologies using various classical and modified electrode system and surface-active agents for wide range of application. Although in industrial sector the voltammetric techniques have certainly lesser explored than spectroscopic, chromatographic and electrophoretic techniques but offer superior solution for specific tasks due to its qualitative as well as quantitively characterisation ability. Voltammetric methodologies are one of the emerging contemporary assay procedures that allows a easy and fast discrimination and its voltammogramic equivalence with a spectrum in spectroscopy provide ample information on the chemical characteristics of electro active species involved in redox processes. Application of voltammetry is widely explored and exploited in the fields of science and technology inclusive of environmental analysis of pesticides at commercial and residue levels (10^{-12}–10^{-1} M). However, in recent intervals the classical voltammetric techniques have almost been vanished and are being substitute by more advanced voltammetric methodologies for numerous analytical and mechanistic studies.

Keywords: Voltametric techniques; Pesticides analysis.

Fabication of Keratin-ZnO nanoparticle Nanogel as a sustainanble wound dressing material

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Abstract

Nanotechnology has recently become recognized as a promising field for the creation of enhanced wound healing treatments. One such revolutionary finding is the utilization of nanogels as an adaptable platform for applications in wound healing. Nanogels are hydrogel particles with a nanometer scale that have great biocompatibility and high-water content. They also have variable porosity. These characteristics make nanogels an excellent candidate for the targeted and controlled release of bioactive substances at the wound site, together with their innate capacity to encapsulate and distribute a wide range of therapeutic medicines. In this study, we prepared keratin-alginate (Ker-A)a multifunctional composite nanogel, by mixing keratin extracted from chicken feather waste, along with a co-polymer aliginate, and ZnO nanoparticles prepared using the green method. A wound healing Ker-A-ZnO nanogel was prepared, antibacterial effects against both Gram-positive (Staphylococcus aureus) and Gram-negative (Escherichia coli) bacteria. The developed nanogel has reactive oxygen species (ROS)–scavenging abilities. MTT assay approved the biocompatibility of the produced nanogels for potential use in wound dressing. *In-vitro* study on cell lines showed induced angiogenesis, cell proliferation and movement in the presence of Ker-A-ZnO nanogel.

Keywords: Waste Valorisation; Nanogel; Keratin; Zinc oxide nanoparticles; Wound healing; Anti-microbial.

Mn^{2+} ions doped Ni-Zn Ferrite Nanoparticles for Sensing Volatile Organic Solvents Vapor

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Abstract

The versatile uniform size manganese doped Ni-Zn mixed soft ferrite nanoparticles of composition $Ni_{0.5}Zn_{0.5-x}Mn_xFe_2O_4$ (where x = 0.0, 0.1, 0.2, 0.3, 0.4) were derived hydrothermallyto explore their gas sensing propertiesfor hazardous volatile organic solvents vaporgenerally used for the synthesis and cleaning purposes. The mixed spinel structured ferrimagnetic Ni–Zn nanoparticlesexhibit high electrical resistivity, low magnetic coercivity, moderate curie temperature along with good chemical stability properties.The as synthesized magnetic nanoparticles were characterized for structure, morphology, size distribution and magnetic properties using different analytical techniques to confirm their formation and reveal the effect of Mn^{2+} ions concentration. The narrowing of XRD diffraction peaks on increasing Mn^{2+} ions concentration predicts the enhancement in crystallinity, crystallite size and lattice strain in Ni-Zn ferrite doped analogues. TEM images showed uniform distribution of polyhedral shaped nanoparticles with sharp edges and vertices which concludes the co-existence of mixed spinel states in these prepared Mn^{2+} ions doped Ni-Zn ferrite nanoparticles. The broad EPR resonance spectrum of pure Ni-Zn nanoparticles revealed their ferromagnetic nature and its peak-to-peak line width reduces on doping with Mn^{2+} ions due to increase in super-exchange interactions via easy movement of electrons along Fe^{2+}-O-Fe^{3+} bonding group.The sensing properties of the best composition Mn^{2+} ions x=0.3 doped sample are presented for the detection of isopropyl alcohol, acetone, benzene and diethylene glycol in 20 °C to 40 °C temperature range at an interval of 5 °C and different concentration of solvents from 10 ppm to 50 ppm range. The best sensitivity and fast response time of all these samples are observed at 25 °C and at 20 ppm concentration.

Enhanced photocatalytic degradation of organic dye by CeO_2/CNT/GO hybrid nanocomposites under UV-light for wastewater treatment

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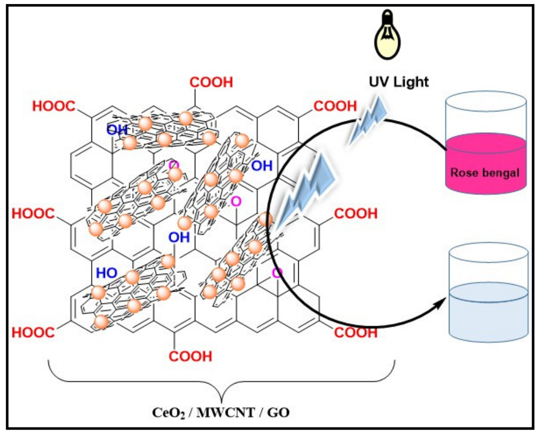
Abstract



Development of nanocomposites as efficient photocatalysts for the removal of hazardous organic pollutants is always in dire demand due to increase in water pollution. The uncontrolled growth of human population, hike in agriculture and industrialisation have resulted in extensive increase in limited freshwater demand. On the other hand, water has been extensively depleted by the hazardous organic wastes from textile, printing and pharmaceutical industries. These organic wastes include methylene blue (MB), rose bengal (RB), rhodamine-B, *p*-nitrophenol, *p*-chlorophenol, phenol red, methyl orange, congo red, etc. The prime objective is to protect the natural water-resources and, to reuse the wastewater with the help of existing technologies or to develop innovative technologies. Photocatalysis has become one of the most promising methods for wastewater treatment to degrade the hazardous pollutants in the presence of sun light or UV light by generating electron–hole ($e^{-} – h^{+}$) pairs.

The facile sol-gel method has been used to synthesize cerium oxide (CeO_2) nanoparticles followed by their decoration over multi-walled carbon nanotubes (CNTs) and graphene oxide (GO) to construct binary as well ternary hybrid nanocomposites using ultrasonic treatment. The oxygen vacancy defects have been depicted using X-ray photoelectron spectroscopy (XPS) that may result into improved photocatalytic efficiency. The ternary hybrid nanocomposites (CeO_2/CNT/GO) showed excellent photocatalytic efficiency towards degradation of rose bengal (RB) dye up to 96.9% in 50 minutes. CNTs and GO provides the interfacial charge transfer which inhibits the electron-hole pair recombination. The results obtained here indicates that these composites can be effectively utilized as promising materials for the degradation of harmful organic pollutants for wastewater treatment.

Keywords: Nanocomposites; CeO_2; Graphene oxide; CNTs; Photocatalysis; Rose Bengal.

Grey-fuzzy logic-based technique for multi-response optimization of micro-EDM drilling of Titanium alloy

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Abstract

Fuzzy logic-based multi-criteria decision-making techniques have been used significantly more recently in the optimisation of EDM (Electric Discharge Machining) and other industrial processes. Combining fuzzy-logic based optimisation methods with other optimisation methods can boost their usefulness.In this paper, drilling rate (DR) and tool wear rate (TWR) for EDM micro-hole drilling on Titanium alloy have been explored experimentally. The grey-fuzzy integrated technique is used to find the optimal parametric setting of EDM process and optimized the responses. The experiments have been designed by response surface methodology (RSM) based central composite design (CCD) taking current (I_p), pulse-on-time (T_{on}) and pulse-off-time (T_{off}) as input parameters; and drill rate and tool wear rate as performance measures. Grey fuzzy reasoning grade (GFRG) is determined using grey relational analysis (GRA) combined with a fuzzy-based technique.The optimal setting of parameters is found to be I_p= 5 A, T_{on}=70 µs, T_{off}= 60 µs. The analysis results illustrated that pulse-on-time is the most influencing parameter followed by discharge currentfor multi-objective responses.

Keywords: Electric discharge machining; Tool wear rate; Drilling rate; Central composite design; Response surface methodology.

Nanoparticles based FSW welds to Improve the Metallurgical Strength

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Abstract

This study investigates the effect of reinforcement strategy on nanoparticle distribution in terms of mechanical and metallurgical properties of FSW welds. Limitations of nanoparticles evolution during FSW/FSP is reduced with the novel proposed procedure that helps in reducing ejection from joint interface and improvement in RPs uniformity and joining of aluminum alloy via a single FSW pass. The new deposition strategy is proposed in which a slurry of RPs was employed to embed in Zig-zag holes drilled in an array form on adjoining faces of 6061-T6 aluminumsheets. The size and dispersion of reinforcement particles in various zones of the FSW process were analyzed using optical microscopy (OM), scanning electron microscopy (SEM), and transmission electron microscopy (TEM). The micro-hardness of unreinforced and reinforced samples was evaluated with more emphasis on the processed zone (nugget zone) which is further correlated with grain size and particle morphology. The findings revealed that refinement of grain size is more significant in the nugget zone of the FSW- Al_2O_3 sample compared to the FSW-TiO_2 sample which is attributed to the Zener effect that occurred via small-sized nanoparticles. The micro-hardness in NZ was increased due to an increase in uniform Al_2O_3 nanoparticles distribution with peak micro-hardness of 89±3HV in comparison with the parent metal, whereas surface defects occurred because of a decrease in TiO_2 nanoparticles distribution leading to an increase in grain size that results in a decrease in material strength with average micro-hardness of 78±5HV.The results revealed that the high density of uniform Al_2O_3 nanoparticles distributed in the nugget zone increases tensile strength, yield strength, and wear resistance with appreciable increment in ductility, whereas, the TiO_2 nanoparticle's presence results in a decrease in tensile properties due to nanoparticles cluster formation which leads to decrease in ductility and wear resistance and increment in frictional coefficient.

Keywords: AA6061-T6; Friction stir welding; Reinforcement particles; Microhardness distribution; Mechanical characteristics; Wear characteristics.

Assessment of Hemolytic Potential of Oxide Nanoparticles as a Marker for Potential Drug-induced Hemolytic Anemia

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Abstract

Hemolysis is rupturing of erythrocytes (red blood cells) and the release of their contents (cytoplasm) into surrounding fluid (e.g. blood plasma). For the nanoparticles to be used as drug-delivery vehicles, they need to be intravenously administered. Since the first physiological system they interact with is blood, interaction of nanoparticles with blood constituents deserves particular attention. In the systemic circulation, the interaction of the nanoparticles with blood constituents can result in significant toxicity. Hemolysis in vivo can lead to anemia, jaundice, and other pathological conditions. Hemolytic potential of all intravenously administered pharmaceuticals must be evaluated as the prime criterion.In this study, we evaluated the toxicological effects of TiO_2, CeO_2 and In_2O_3 nanoparticles on human erythrocytes (RBCs) through hemolysis assay. The motivation for choosing titanium oxide is that the biosafety and biocompatibility of nanosize TiO_2 materials have already been studied in vitro as well as in vivo settings. Further, nanocrystalline cerium oxide (CeO_2), which is a unique material having a wide range of applications owing to unusual physicochemical properties has been explored. The special attention to ceria is due to the unique ability of its crystal lattice to accentuate reversible redox processes.For comparison, the interaction between indigenously synthesized pristine SiO_2 nanospheres and RBC was studied, given that MSN is widely considered as a potential vehicle for the targeted delivery of therapeutics.Finally, we have examined the nanoparticles of indium oxide (In_2O_3), the toxicity of which was explored rarely. A dose-dependent hemolysis was apparent from the eventual pallidity of the supernatants with the decreasing concentration of the nanoparticles. For SiO_2 nanospheres, as the particle concentration increased from 50–1000 µg/ml, the degree of hemolysis increased monotonically from 19–57 %. In comparison, the hemolysis caused by CeO_2 nanoparticles was found to be in the range of 1–12 % when the particle concentration was varied in an identical way. Our experimental data corroborates to the fact that only minimal or no hemolytic activity is observed for cerium oxide nanoparticles.

Keywords: Nanoparticles; Silicon dioxide; Titanium dioxide; Cerium oxide; Indium oxide; Haemolytic potential.

Introduction to Liquid Crystals and its Applications

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Abstract

Liquid crystals have attracted enormous interest not only because of their peculiar nature but also due to its technological importance. The name liquid crystal has been christened, because of their specific characteristic of having the properties of liquid as well as crystalline state. The existence of a matter in both the liquid and crystalline state was observed for the first time by an Australian botanist Friedrich Reinitzer in 1888. During an experiment, while heating choleseryl benzoate, he found a new state of matter in which a weak orientational order like solids and no positional order like liquid exist together. Liquid crystals uses in various applications such as optical imaging and recording, nondestructive mechanical testing of materials under stress, optical disks, full colour "electronic slides" for computer-aided drawing (CAD), light modulators. Liquid crystal displays are common in calculators, digital watches, oscillaographic systems, television displays. polyester liquid crystals were developed for fire resistant, and are used as coating for multifibre, optical cables. In This Talk I, cover history, development and applications of Liquid crystal materials.

Keywords: Liquid crystal phase; Mesophase; Nematic Phase, Smectic Phase, AFLC.

Student Talks

Triethoxyoctylsilane (TEOS) modified silica as potential superhydrophobic coating for corrosion resistance applications

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Abstract

Over the last few decades, the development of superhydrophobic coatings (SHCs) have gained immense industrial and engineering importance due to their excellent properties like self-cleaning, anti-fogging, oil-water separation, anti-drag, anti-corrosion and as protective coatings for materials ranging from soft materials to metals and alloys. SHCs developed using various methods have been reported in literature that reveals the potential application of such coatings over a wide range of substrates. However, despite the extensive research, the durability of SHCs for materials exposed to various environmental conditions is still a field for research and development. In the present work, Sol-Gel dip coated SHC synthesized through tetraethoxyoctyl silane (TEOS) functionalized silica has been developed with an aim to achieve better durability and structural stability to the materials in industrial applications. Modified coatings were developed using Sol-Gel process producing hydrophilic silica functionalized by co-hydrolysis and co-condensation of silane precursors-tetraethylorthosilane (TEOS). Surface Modified functionalized coating was dip coated over the brass substrate for corrosion resistance applications. Morphological results show the formation of developed coatings over the substrate where modified silica exhibited raspberry like hierarchal morphology attributing to superhydrophobic surface. Resulting SHC were characterized using Contact angle (CA) goniometry, AFM, Corrosion test to indicate and analyze surface roughness and the superhydrophobic behavior. The brass surface coated with SHC showed high CA and better roughness over the un-coated brass substrate. Our results show that the TEOS modified silica with low surface energy forms a potential SHC material for anti-corrosion applications.

Keywords: Superhydrophobic coating; TEOS; Anti Corrosion; Silica; Metal/Alloy.

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Influence of ionizing radiation on bio-synthesis of colloidal SF-AgNPs: Their characterization

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Abstract

Recently, biosynthesis of silver nanoparticles using aqueous silk solution has emerged as a simple and viable alternative to more physical and chemical methods. The present investigation explains rapid and extracellular synthesis of silver nanoparticles using Bombyx mori silk and exposed to Gamma irradiation. The synthesized silver nanoparticles are confirmed by UV-vis, SEM, E-DAX, XRD, TEM, FTIR, TGA and DSC. UV-vis spectra show the presence of silver nanoparticles, as the irradiation time increases spectra also increases. XRD study confirms that resultant particles are face cantered cubic structure of metallic silver nanoparticles. SEM analysis shows the formation of AgNPs in the aqueous solution. E-DAX results confirms the formation of silver nanoparticles. Silver nanoparticles are spherical or nearly spherical in shape confirmed by TEM. The FTIR studies showed major peaks of proteins involved in the synthesis of silver nanoparticles. The TGA and DSC studies of SF/AgNPs revealed that the nanocomposites having more stability.

Keywords: Bombyx mori silk; Silver nanoparticles; UV-vis TEM; TGA DSC.

β-cyclodextrin polymer reinforced with nanosize zinc ferrite: synthesis, characterization, thermal stability, and adsorption application

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Abstract

A porous polymer based on β-cyclodextrin crosslinked with aromatic teterafluoroterephthalonitrile and epichlorohydrin was synthesized and reinforced with hydrothermally produced zinc ferrite nanoparticles. The produced nanocomposite was characterized using Fourier-transform infrared (FTIR) spectroscopy and powder X-ray diffraction (XRD) technique. The surface characteristics of the nanocomposite were investigated using Brunauer–Emmett–Teller (BET), Barrett-Joyner-Halenda (BJH), filed emission scanning electron microscopy (FE-SEM), and dynamic light scattering (DLS). The thermal stability of the synthesized polymer and polymer nanocomposite was studied using thermogravimetry (TG) and derivative TG analysis at 5, 10, 15, and 20 °C min^{-1} heating rates. The activation energy corresponding to the thermal degradation of the polymer and its nanocomposite was calculated using non-isothermal isoconversion methods. The obtained polymer nanocomposite was used as an adsorbent material to remove non-ionic bisphenol-A (BPA) from the synthetic wastewater. FTIR and powder XRD confirmed the successful synthesis of β-cyclodextrin based polymer, nanosize zinc ferrite, and their nanocomposite. The FE-SEM confirmed uniform dispersion of zinc ferrite within the polymeric matrix. The BET and BJH studies revealed polymer nanocomposite has a moderate specific surface area with micro and mesopores. The thermal degradation kinetics revealed that although polymer nanocomposite decomposed at a lower temperature, it possessed a high activation energy barrier than the pristine polymeric matrix, suggesting a thermally stable nature of polymer nanocomposite. The adsorption studies revealed the polymer nanocomposite possessed a high adsorption capacity for BPA, which was highly driven by physical adsorption. The synthesized polymer nanocomposite can be successfully used as an adsorbent for BPA removal with low thermal degradation.

Keywords: Adsorption; Cyclodextrin; Zinc ferrite; Polymer nanocomposite; Thermal analysis.

Synergetic effect of silver molybdenum tungsten oxide heterostructures for enhanced photocatalytic reaction

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Abstract

A plasmonic $Ag/Mo_xW_{1-x}O_{3-y}$ heterostructure was synthesised using a solvothermal followed by photodeposition method. The resulting plasmonic $Ag/Mo_xW_{1-x}O_{3-y}$ heterostructure displayed high localized surface plasmon resonance (LSPR) after detailed characterisation by using XRD, XPS, TEM, and UV-Vis measurements. The high LSPRs were attributed to crystal vacancies, particularly mutual doping vacancies of molybdenum and tungsten ions, as well as oxygen vacancies. We also investigated into whether such plasmonic $Ag/Mo_xW_{1-x}O_{3-y}$ might be employed as a highly efficient catalyst for ammonia borane (NH_3BH_3; AB) dehydrogenation and catalytic destruction of RhB and MB under visible light irradiation as well as in dark condition. As a result when irradiated by visible light for 120min, it yielded 24µmol/min of H_2 and was very effective in destruction of organic dyes, degrading 90% of RhB and 98% of MB within 40min. This efficiency was not achieved by MoO_3, WO_3 or $Mo_xW_{1-x}O_{3-y}$ alone. These results demonstrates that $Ag/Mo_xW_{1-x}O_{3-y}$ is a promising a candidate for hydrolysis of ammonia borane and destruction of RhB and MB.

Keywords: Hydrogenation; Photocatalytic degradation; Ammonia borane; Localized surface plasmon resonance.

Graphene Based Thz Array (Dipole Elements) For High Speed Wireless Applications

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Abstract

In this paper, we elaborate the comparisons among different physical parameters of substrate materials that are used to design THz antennas with some specific properties. After the simulation of a Graphene based miniaturized dipole antenna array (4*1) design fed by discrete port with 50 ohm input impedance. This antenna array design has two dissimilar substrates (Silicon and Quartz) layers and annealed copper as a ground conductor. This dipole antenna array resonates between 1.9915 THz to 2.508 THz frequency range with 8.0977 dBi to 9.1273 dBi gain and above 93% efficiency. Extensive simulation and optimization have been performed by electromagnetic field simulation software 2019 in the time domain.

Keywords: Graphene; chemical potential; array antenna.

Cholesteric Liquid Crystal Microdroplets for Biosensor and Anti-Counterfeiting Applications

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Abstract

Cholesteric liquid crystal droplets monodisperse in nature are produced by fabricating a capillary microfluidic flow focusing device. These droplets which are stabilized in PVA/SC12S are sensitive to bile acids (cholic acid and deoxycholic acid). The competitive adsorption of bile acids onto the surface of the CLC droplets will cause the homeotropic-to-planar transition of the CLC droplets. This sensor can easily and quickly detect bile acids for a low cost. Our method's detection limit for CA is (1 M) 80% lower than the previously described method using nematic droplets for detection, while for DCA it is 50% lower. Additionally, the pH, bile acid volume, and droplet size can be used to modify the response times and detection limits of these bile acids. This innovative approach allows the detection of bile acids without the need for crossed polarizers.

The same CLC droplets in conjugation with synthesized fluorescent carbon quantum dots (CQDs) were used as anticounterfeiting material. Due to the structural chirality of CLCs, CQDs doped with CLC droplets exhibit a green reflection in natural light and a cyan colour when exposed to UV light (365 nm) as a result of the fluorescence emission of CQDs. When exposed to UV light in the sunshine, the fluorescent CLC microdroplets displayed photonic cross communication and centre spot reflection with a fluorescent cyan emission colour. Smart dual-mode displays, anti-counterfeit labelling, and smart decorations are potential uses for CLC microdroplets with fluorescent CQDs.

Keywords: Cholesteric Liquid Crystals; Biosensor; Quantum dots; Anti-counterfeiting; Cholic acid.

Roles of Solid waste derived Carbon for Supercapacitor Applications: A Review

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Abstract

Our future is at risk due to the common use of solid waste materials nowadays and also due to their harmful effects on nature, the environment, and human well-being. The overproduction of these solid waste materials is because of us. Due to rapid growth of the human community, the amount of solid waste is increasing day by day. To get better results with solid waste, the perfect way is to change solid waste into significant carbon-based nanomaterials (CNMs) like CNT, graphene, and carbon quantum dots (CQDs), which can also filled in energy storage devices. The carbon-based electrode materials are useful for supercapacitor applications because of their large surface area and permeable design. This article reviews the impacts on the electrochemical properties of supercapacitor applications and their prospects, as well as their scope. The continuous difficulties and future improvements towards this path for the construction of proficient energy storage devices are additionally added here.

Keywords: Supercapacitor; Carbon-based materials; Electrochemical energy storage; Solar energy.

Statistical Analysis of nanocomposite Membrane of polyester for EMI Shielding Applications

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Abstract

Recently, the advances in digital and wireless communications are increasing, due to its miniaturisation at circuit level & system level and achieving multifunctionality in their operations, which are of great demand. To realize this, one of the most hazardous barriers in communication system is electromagnetic interference (EMI) within the system generated by the same system and or generation by other system. Owing to this, efficiency of system may reduce; system gets failure, partial damage, complete damage and or may degrade system performance. To avoid this, an appropriate shielding / shielding material is very much essential for smooth functioning of system operations. In this paper, a novel nanocomposite membrane of polyester (NMP) for EMI shielding applications is presented. A 0.1 mm aluminium coating was sprayed on NMP to achieve the highest shielding; at thickness (t) = 0.2 mm & 0.25 mm of two samples. The detailed statistical parametric analysis for transmission loss (Lt), absorption loss (La), reflection loss (Lr), SEa, SEr, and total shielding effectiveness (SEtot) for WGM, ERM and OATS measurement methods have been presented. The achieved final SEa, SEr, and SEtot are – 0.34 dB, – 0.16 dB and 0.48 dB respectively for WGM are presented. In the OATS measurements, the achieved parameters i.e. Lr, Lt, La, and RCS are - 19.22 dBm, – 4.72 dB, - 14.48 dB and 9.92 m^2 respectively are presented. For the ERM method Lr, Lt, La and SEtot are - 4.78 dB, - 40.08 dB, - 45.30 dB and - 32.1 dB respectively are presented. For all measurements 0 dBm (i.e. 1 mw) input power was kept. The material design and obtained results have good agreement and suitable at 8 to 12 GHz frequency range (i.e. X - band) for EMI shielding and stealth applications.

Keywords: Electromagnetic shielding material; Measurement methods - wgm, Oats, Erm; Nanocomposite Membrane of polyester radar cross section; x – band frequency.

Forensic analysis of physical disruption of human hair after being treated with Henna and Dyes

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Abstract

People are going through a lot of cosmetic treatments nowadays. Certain chemical treatments including application of dyes and henna, are taken in order to enhance the texture, colour and other features of the hairs. Analysis of hair under microscope and scanning electron microscope can impart exclusive information about the trace evidence (hair) which may be recovered from a crime scene during forensic investigations. The henna and dyes are the non-permanent treatments which are applied to the hair. On application to the hair strand henna cover the cuticle and changes the colour and texture of the hair. Whereas, the dye covers the cuticle but also enters the cortex of the hair thus, resulting in the change of hair colour and texture. In this study, the microscopic analysis of henna and dye treated hair has been done to see the effect of henna and dyes on hairs within a time interval of 20 days. Hair samples treated with different brands of henna (*viz*. brans marked as H1, H2 and H3) were analysed under phase-contrast microscope, indicating the changes in the scale pattern, texture and colour of the hair. Hair samples treated with different colours (*viz*. burgundy) and different brands (*viz*. D1, D2 and D3) were analysed under microscope and scanning electron microscope, indicating changes in colour, texture, scale patterns of the hair strand. The level of damage was more in dyed hair compared to henna treated hair. Also, the level of damage differ depending on the colour and brands used. This study can provide a base of narrow downing the number of suspects using henna or dye treatments of hair.

Keywords: Brands; Cosmetic treatment; Dye; Forensic investigation; Hair colour; Hair scale pattern; Hair texture; Henna; Microscopic comparison; Scanning electron microscopy.

Comparative studies of Electrical, Magnetic & Dielectric Studies of Zirconium doped Barium Titanate based Mutiferroic Systems

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Abstract
This paper mainly focuses on electrical and dielectric characterization of Zirconium doped Barium Titanate. Barium calcium Titanate ($BaCaTiO_3$) has been synthesized using High temperature Hydrothermal method. XRD confirms the single phase of ofmultiferroic possessing perovskite structure with Tetragonal symmetry. The Crystalline structure is envisaged to be a tetragonal. The surface morphology of investigated sample ($BaTi_{1-x}Zr_xO_3$) is done by using scanning electron microscope of the samples. It is reported that the average grain size is decreased as we are adding the content of Zr^{4+} ion in $BaTiO_3$. The dielectric and electric properties are investigated within the temperature range of RT - 400℃ in the frequency range of (100Hz – 1MHz) of Zirconium (Zr) doped $BaCaTiO_3$(BCZT) which shows that the value of dielectric constant decreases with increasing the content of Zr. B-site substitution with the Zr^{4+} ions has been found to suppress the spiral spin structure of BCZT giving rise to the appearance of room-temperature weak ferroelectricity. Within the temperature range of RT - 400℃, Raman scattering spectra of Zirconium (Zr) doped $BaCaTiO_3$(BCZT) single crystals have also been measured. We have found drastic changes of Raman spectra at 600–700℃. In relevance to structural phase transition and magnetic ordering, such changes of Raman spectra have been discussed in combination.

Keywords: Ferroelectric ceramics; XRD analysis; Impedance spectroscopy; NTCR; Non-Debye.

Raman oscillations in weakly-polar magnetoactive III-V semiconductors

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Abstract

Raman oscillation (lasing) is studied analytically using coupled mode approach. An additional feedback is provided for generated Stokes signal by using a strong optical feedback Fabry-Perot resonator having weakly-polar magnetoactive (III-V) semiconductor as active Raman medium. Assuming that the origin of nonlinear interaction lies in effective Raman susceptibility arising due to nonlinear current density and molecular vibrational polarization of the Raman gain medium, the threshold condition for the onset of Raman oscillations is determined. Well above the threshold intensity, the parameters characterizing Raman oscillation, viz. the single pass Stokes mode power gain and the conversion efficiency of the proposed Raman laser are also determined. The tuning range of the proposed Raman laser is also explored. Numerical analysis is made for a proposed Raman laser consisting of a Fabry-Perot resonator having n-InSb crystal (~ milli-meter dimensions) as active Raman gain medium at 77K duly pumped by a pulsed CO_2 laser at 10.6 µm wavelength. The effect of free carrier concentration, applied magnetic field, excitation intensity, mirror reflectivity, and crystal (cavity) length on threshold intensity for the onset of Raman oscillation and the parameters characterizing Raman oscillation, viz. the single pass Stokes mode power gain and the conversion efficiency of the proposed Raman laser are explored in detail with aim to determine the suitable values of these controllable parameters to enhance the single pass Stokes mode power gain and the conversion efficiency of the proposed Raman laser at lower threshold intensityand to establishes the technological potentiality of weakly-polar magnetoactive (III-V) semiconductors as the hosts for fabrication of highly efficient and widely tunable Raman lasers.

Keywords: Raman oscillations; III-V semiconductors; Operational characteristics; Single pass Stokes mode power gain; Conversion efficiency.

Hot carrier effects on polaron induced parametric amplification in polar semiconductors

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Abstract

Due to the complete conversion of incoming photons into plasmons during parametric interactions, semiconductor plasma can be heated effectively. For modern optoelectronic device applications, such as the creation of tunable lasers with high conversion efficiency, photovoltaic effect, far-infrared diagnostic systems, and optical parametric amplifiers (OPAs), the parametric amplification of collective-waves in polar semiconductors such as phonons and polarons at the expense of the pump wave has already attracted much attention. In the current study, the analytical investigation of the hot carriers effect in polar semiconductors caused by parametrically interacting electron longitudinal optical phonons is presented. In the presence of external magnetic fields, it is discovered that the existence of hot carriers greatly modifies the threshold and amplification properties. Expressions for the threshold pump field necessary for the onset of the parametric interaction caused by the polaron are clearly given, as are the amplification characteristics. Hot carriers are found to have a significant impact on threshold and amplification characteristics at moderate magnetic fields and high carrier concentrations. It is discovered that the resonance between plasma frequency and polaron frequency is advantageous for the minimum threshold field. The effects of the magnetic field, hot carriers, and mass modulation are found to be cumulative and led to an increase in the parametric gain. The typical parametric gain dependence on carrier concentration and magnetic field could be used to build optical switches.

Keywords: Parametric interaction; Hot carrier effects; Polaron mode; Polar semiconductors.

Parametric interactions in ion-implanted semiconductor plasmas

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Abstract

One of the most popular methods for creating doped semiconductors with regulated impurity profiles is ion-implantation. In order to obtain a good level of lattice recovery and the electrical activation of the dopants, post-implantation annealing is required because the crystal lattice is disrupted during the implantation process. A little amount of ions may effectively change the host material's electrical characteristics by an order of magnitude. As a result, its primary use is in the production of semiconductor components. In the current paper, we present an analytical investigation on parametric interaction in magnetised piezoelectric semiconductor plasma, whose main constituents are the drifting electrons and non-drifting negatively-charged colloidal particles. We do this by using a hydrodynamic model of semiconductor plasmas and a coupled mode theory of interacting waves. The parametric interaction phenomena is viewed as a three-wave interaction process involving the medium's second-order nonlinearity. It is discovered that the presence of non-drifting charged colloidal particles alters the second-order optical susceptibility in ion-implanted semiconductor plasma. It's interesting to note that the gain profile is shown to be independent of the dispersion profile, whereas the latter is modified by charged colloids. According to the current research, choosing the right colloid density can also cause anomalous dispersion, which is therefore useful for producing squeezed states.

Keywords: Parametric interactions; Semiconductor plasmas; Colloids.

Mathematical study of nanocomposites for drug delivery in capillary

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Abstract

Silver nanoparticles (Ag NPs) are widely used in multifunctional drug delivery systems these days because of their antibacterial, antifungal and antiviral properties. Also, the association of Ag NPs in complexes for targeted delivery has evinced better biocompatibility and lower toxicity. The present work concerns the use of magnesium (Mg) and aluminum (Al) hydroxide layer adsorbed on silver nanoparticles (Ag NPs), collectively identified as nanocomposites, for drug delivery in a capillary. Nanocomposites dispersed in blood are recognized as nanofluids. The generalized dispersion model given by Sankarsubramanian and Gill has been used along with Hixson Crowell model to frame the mathematical model of drug release by nanocomposites in the capillary. The equations are solved to find the value of mean concentration. Graphs for mean concentration of Ag NPs diffusing with respect to time are plotted using MATLAB for different values of number of nanocomposite particles in blood, diffusivity, solubility and thickness of Mg-Al hydroxide layer. It has been perceived through results that the thickness of Mg-Al hydroxide layer adsorbed on Ag NPs of about 45-55 nm is highly effective in drug release. These outcomes shall be useful for developing mathematical models for nanodrug delivery in cardiovascular treatments.

Keywords: Nanocomposites; Dispersion; Nanofluids; Nanodrugs; Hixson Crowell model.

Superior electrochemical performance of SnSe-PPy nanocompositesfor Supercapacitor application

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Abstract

Over the past few decades, have observed an increasing research interest in the field of energy storage systems such as batteries, fuel cell and supercapacitors. Among them, great attentions have been focused on supercapacitors and possess promising properties such as long life cycle, high power density, high charge-discharge rate and light weight. Several nanomaterials have been synthesized using various methods and utilized as an electrode material for supercapacitors. In this regard, Metal chalcogenides from IV and VI group elements have been receiving considerable interest. Among of all metal chalcogenides, Tin Selenide (SnSe) material is gaining popularity due to its diverseapplication like thermoelectric, solar cells and energy storage.

In this work, SnSe-PPy nanocomposite has been synthesized by hydrothermal method and its supercapacitive behaviour is investigated.

The synthesized SnSe-PPy nanocomposite is analysed by X- ray diffraction, Fourier transform infrared (FTIR) spectroscopy, Scanning electron microscopy and electrochemical characterisation. X- diffraction analysis confirms the existence of orthorhombic structure of SnSe-PPy. FTIR analyses reveals the characteristics absorption peaks of SnSe and polypyrrole. SEM images shows spherical and triangular shape particle. The electrochemical characterization sucha Cyclc voltamerty, galvansotatic charge dioscharge measurements and electrochemical impedance analyses reveals the supercapcitive behaviour of the material. SnSe-PP_Y nanocomposite delivers the specific capacitance of 223 F g^{-1} at 10 mV sec^{-1}. The addition of polyprole increases the conductivity of the material and improves the electrochemical performance.

A Linearity Improvement with Low Reflection Coefficient LNA for WSN Applications

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Abstract

This paper illustrates a low input reflection coefficient (S_{11}< -15 dB) and high linearity low noise amplifier (LNA) employing current mirror circuit with cascode inductively degenerated topology in 180nm CMOS process technology. The design constraints of LNA are optimized for wireless sensor network (WSN) i.e., 2.4GHz frequency range. Implementation of the LNA circuit design in advanced design system (ADS) software. This topology provides high linearity and high input impedance matching features. The simulation results of LNA achieves high third intercept point (IIP3) of 16 dBm, input reflection coefficient (S_{11}) of -19.780 dB, maximum gain of matching circuit i.e., 18.182 dB, reverse transmission coefficient (S_{12}) of -46.876 dB with nominal noise figure of 3.594dB at 2.4GHz frequency band. The LNA achieves high stability factor 1.026 from a 1.8V power supply

Keywords: Wireless Sensor Network (WSN); Low Noise Amplifier (LNA); Low noise figure; Complementary Metal Oxide Semiconductor (CMOS); Inductively degenerated topology; Third Intercept Point.

Impact of Technology Scaling on CMOS Low Noise Amplifier Parameters:A Tuotrial

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Abstract

This paper addresses the impact of CMOS technology scaling on LNA parameters in a deep submicrometer (DSM) process. Optimum design of two distinct topologies of 2.4 GHz CMOS Low Noise Amplifier (LNA) intended for radio frequency (RF) applications is discussed in this paper. This is done through an investigation of the effect of different topologies on the performance metrics of RF CMOS LNA such as noise performance, gain, input and output reflection coefficient, respectively. It is demonstrated that the two methodologies such as common source (CS) with inductive source degeneration and cascode inductive source degeneration have been implemented and analyzed in Advanced Designed System software at 2.4GHz frequency band. These topologies implemented with different technology sizes such as 180nm, 130nm, 90nm, 45nm, and 22nm, respectively. Measured results observed the behavior of the different LNAs with different technology sizes are presented.

Keywords: Deep Submicrometer (DSM); Noise figure; Low Noise Amplifie (LNA); CMOS; S parameters; Common Source (CS); Inductively Degenerated.

Review on Performance Enhancement of Nano-Refrigerant ($R\text{-}134a/Al_2O_3$) in Vapor Compression Refrigeration System at Steady-state Condition

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Abstract

Nano refrigerants are generally a combination of a nano-particle with a refrigerant to improve the refrigeration process. It has been revealed that, when compared to conventional refrigerants, the addition of nanoparticles improves the heat transfer capacity. The combination of nano-particles and conventional refrigerants in a vapor compression cycle is a relatively new concept, and the resulting nano-refrigerants have been found to improve the thermo-physical properties of conventional refrigerants. Nano-particles can be used in conjunction with refrigerant. The paper presents comprehensive a literature review to learn about the performance enhancement of Nano-Refrigerant (R-134a/Al2O3) in Vapor Compression Refrigeration systems (VCRs) at steady-state conditions. This ensures that alumina (Al2O3) nanoparticles with a diameter of 50 nm are dispersed in the refrigerant R-134a to improve its heat transfer performance and to have improved thermo-physical properties over conventional refrigerants. Finally, this shows that nano-refrigerant (R-134a/Al2O3) is the best nano-refrigerant, as its COP is the highest of all with energy savings. Therefore this article aims to review the performance improvement of the VCR system using nano refrigerant and to indicate the natural convection and entropy generation has been considered.

Keywords: Nano-Refrigerant; R-134a/Al_2O_3; Nanoparticles; Nano-lubricants.

Synthesis of Mn-doped NiS_2 nanostructures and fabrication of high-performance asymmetric coin cell type supercapacitor

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Abstract

The abundance of redox electroactive sites and the remarkable conductivity of transition metal sulfides (TMSs) have been the first choice for supercapacitor electrodes. In this work, we propose a simple, one-step CTAB-assisted hydrothermal process for the preparation of Mn-doped NiS_2 (NMS) nanostructured material, which is found to be promising electrochemical energy storage material. The structural features of prepared materials are systematically characterised by using XRD, FESEM, EDS, Raman, BET, TEM and XPS. The MNS electrode performs admirably with a high specific capacitance of 951 Fg^{-1} at 1 Ag^{-1} current density and as well as remarkable cycling performance with 65 % capacitance retention after 5000 cycles. An asymmetric coin cell device was also fabricated using MNS as the positive electrode and activated carbon (AC) as the negative electrode (MNS//AC), which exhibit a high energy density of 39.65 $Whkg^{-1}$ and a power density of 4.3 $kWkg^{-1}$ with excellent cyclic stability of 61 % after 5000 cycles. The results reveal that, introducing Mn enriches the electrochemical conductivity, enhances the specific surface area required for electrochemical processes, modified the electronic active site structure of NiS_2, and which further helps in enhancing interlayer processes by providing new electrode reaction paths.

Keywords: Nickel sulfide; Supercapacitor; Mn-doping; Energy storage; Asymmetric supercapacitor.

Hybrid Sustainable Nanomaterials Using for Nanofluids of Advance Applications and Challenges of Future Scope

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Abstract

This paper is offers new social solutions that enhance user demand quality of lifestyles such that as education or school training , medical scientific , fitness, protection or safety, protection of personal records or social solution for growing international locations. Good Strength-efficient or low-carbon products of nanomaterials Such as resulting from eco-design evaluation or merchandise protected in cease-person programs that contribute to saving electricity or other source of environmental protection like that water or hydropower, chemical compounds or chemical bonding energy, emissions or producing renewable energy power. In support of the ambitions of the world Green Deals, aims of this paper to decreasing environments emissions by at least 50% by 2035 compared to 2020. The main advantages compared to standard nonmaterial's (TiO_2, SiO_2, and CO_2) substrates are decreasing lower power consumption, minimum application size and weight of sustainable nanomaterials. The first of this article's three major goals is to provide a survey of prospective renewable energy sources, together with information on their properties and potential uses. this paper describes a variety of applications. Finally, we discuss about the challenges and potential future study directions

Keywords: Nanotechnology; Nano-science; Sustainable Nonmaterial's hybrid sustainable nonmaterial; Application of nanomaterials.

Combustion synthesis and study of double charge transfer insol-gel synthesizedcool white-emitting Dy^{3+} activated vanadate-based nanophosphor for solid-state lighting

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Abstract

A series of highly efficient Dy^{3+}-activated vanadate-based nanophosphor emitting cool white light is fabricated sol-gel technique via using tartaric acid as fuel. The crystalline structure is refined via the Rietveld refinement program having R3c (161) space group and is found to possess trigonal phase. The near-UV excitation spectra present the double charge transfer from O^{2-} ions toDy^{3+} and V^{5+} ions with the latter being stronger due to the high positive charge of V^{5+} ions.Further, the photoluminescence emission spectra show a cool white emission owing to the grouping of two bands consistent with the electronic transitions $^4F_{9/2} \rightarrow$ $^6H_{15/2}$ (bluish) and $^4F_{9/2} \rightarrow$ $^6H_{13/2}$ (yellowish). A white emission of desired strength can be obtained by regulating the ratio of blue and yellow emissive peaks. The critical distance between adjacent Dy^{3+} ions was evaluated to be 22.88 Å and dipole-quadrupole exchanges were found accountable for the concentration quenching phenomenon. The energy bandgap is also investigated using diffuse reflectance spectroscopy. CIE coordinates, and thus CCT values, lie in the white zone of the CIE chromaticity graph, thus finalizing their potential contentions in single-phase WLEDs and other solid-state lighting applications.

Keywords: Nanophosphor; Photoluminescence; Concentration Quenching; Solid-state lighting.

Development of $NiCoO_2$ Nanoparticles based Electrochemical Sensor with Extremely Low Detection for Hazardous 4-Nitrophenol

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Abstract

In this study, we report the synthesis of Nickel Cobalt Oxide ($NiCoO_2$) nanoparticles by the solution combustion method using Citric acid, Glycine, Urea, and Glucose as green fuels, for the electrochemical detection of 4-nitrophenol (4-NP) . The synthesized $NiCoO_2$ nanoparticles were characterized using X-ray diffraction (XRD), Scanning Electron Microscopy (SEM) and Energy Dispersive X-ray Analysis (EDAX). It was found from XRD and SEM, that the $NiCoO_2$ synthesized using urea as a fuel had smallest crystalline size and promising morphology and hence this sample was used for electrochemical studies. Differential PulseVoltammetry (DPV) was employed to investigate the electrochemical behavior of the synthesized $NiCoO_2$ nanoparticles towards 4-Nitrophenol (4-NP) detection. It was found that the $NiCoO_2$ nanoparticles exhibited a strong electrochemical response towards the detection of 4-NP, with a linear range of 10-100 µL and the lowest detection limit of 6.71nM. Overall, the $NiCoO_2$ nanoparticles synthesized using the solution combustion method showed an excellent potential for the detection of hazardous 4-NP, which could be applied in environmental sensing applications.

Keywords: Electrochemical sensor; Nanoparticles; Nickel Cobalt Oxide; 4-Nitrophenol; Solution Combustion.

Study and Simulation ofScalable Multiplexer Hardwarefor Communication Networks

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Abstract

Multiplexing as a technique provided in a network is used to combine several input signals into a composite signal before it is sent over a shared medium. Multiplexed networks utilizediverse approaches of multiplexing, but conceptually all of them work similarly. A multiplexer generates a compound signal by combining the different network signals before transmitting it over a sharedchannel. The hardware chip design depends on the configuration of the multiplexer in the communication network.The study of this work is conferred as the digital logic design and simulation of various configurations of the multiplexer hardware. The evaluation of performance is also measured on the Virtex-5 series of Xilinx FPGA and the functionality of each configured design is checked logically on ISE 14.7 software. The simulation and current analysis of the chip design of various configurations of multiplexer assists the designers to check the chip performance, memory, timing, and hardware implementation parameters which can be further incorporatedwith specific networks.

Keywords: Multiplexer; Multiplex Network; FPGA; Xilinx ISE 14.7.

Upconversion and CIE colour coordinate study of 980 nm excited Er^{3+} doped molybdate based phosphor

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Abstract

The upconvertingphosphors have demonstrated their versatility and practicality due to their high efficiency, excellent thermal and chemical stability. When excited through a suitable excitation wavelength, the trivalent lanthanide doped inorganic phosphors can produceefficient upconversion emission due to the 4*f*-4*f* induced electric dipole transitions taking place in the doped activator ion because of the influence of the crystal field. In this article, the upconversion emission and CIE colour coordinate study of the Er^{3+} doped $NaY(MoO_4)_2$ phosphor via 980 nm excitation has been reported. Apart from satisfying the general criteria of a good host, like low phonon frequency, high thermal and chemical stability, non-hygroscopic nature, etc., the molybdate based host exhibit broad absorption bands in the near UV region. This property of the molybdates allows the charge transfer transitions between the metal ions and oxygen, hence, enhancing their luminescence intensity.In the present study, the $NaY(MoO_4)_2$ phosphor doped with different concentrations of the Er^{3+} ion were prepared using solid-state synthesis method. The crystal structure of the $NaY(MoO_4)_2$ phosphor doped with Er^{3+} ions were analyzed using X-ray diffraction (XRD). The optical energy band gap and absorption bands of the dopant ions were determined through UV-visible reflectance studies.When excited by a near-infrared 980 nm diode laser, the prepared phosphor exhibitstwo intense green upconversion (UC) emissionssituated at ~ 531 nm and ~ 553 nm. In addition to this, it also blue (~ 409 nm) and red (~ 657 nm) UC emission bands of relatively weak intensities. The involved UC mechanisms has been investigated through pump power dependence UC analysis and are depicted with the help of energy level diagram. The purity of the intense green light emitted by the sample was confirmed by using a CIE chromaticity diagram, which indicated that the chromaticity coordinates fell within the intense green region and the phosphor emits highly pure green colour (~ 99%). The prepared upconvertingphosphorcan have potential application in solid-state lighting, NIR to green upconverters and optical temperature sensing.

Keywords: Optical bandgap; Upconversion; Energy level diagram; CIE colour coordinates; Solid-state lighting.

Mg/Ag co-doped SnO_2 Nanoparticles for Optoelectronic Application

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Abstract

Researchers have been looking for new oxide materialsthat can be used in optoelectronic devices for a long time. The fact that these devices are thought to demonstrate higher performance than conventional semiconductors in a variety of ways, such as being non-volatile, analyzing data in a faster fashion, requiring less power, and having a larger storage capacity, is the primary reason for the interest in these kinds of devices.Optoelectronic devices use the properties of both optics and electronics in their design and functionality. Optoelectronics primarily concernshow light interacts with electronic materials, particularly semiconductors.In this study, we have explored the Crystalline nature, Raman spectrum, and Optical Properties of Mg/Ag co-doped SnO_2 polycrystalline compounds. The solid-state reaction technique was used to manufacture polycrystalline samples of $Sn_{0.94}Ag_{0.06-x}Mg_xO_2$ (with x = 0 and 0.04) to investigate the possibility of employing these samples in optoelectronics devices. The structural investigation conducted using XRD revealed the production of a single rutile phase characterized by a tetragonal crystal structure.Utilizing the renowned Debye-Scherrer formula, the average crystallite size (S_c) of 0 and 4 at.% Mg/Ag co-doped SnO_2 compound was determined to be 52.07 and 49.01 nm, respectively. Peaks at620, and 775 cm^{-1} in the Raman spectrum, which correspond to the Raman modes of A_{1g} and B_{2g}, respectively, show that Mg/Ag has been incorporated into the structure of the SnO_2 lattice. A UV-Vis absorption spectrophotometer was employed to investigate the optical property. Optical property measurements reveal that the bandgap for the Mg/Ag co-doped SnO_2 compound increases with increasing the doping concentrations,i.e.,going from 3.67 to 3.72 eV. Furthermore, it was noted that the transmittance value increased from 80 to 88% when the concentration of Mg doping increased.

Keywords: SnO_2; Mg/Agco-doped SnO_2; Crystal Structure; Raman Spectrum; Optical Properties.

Investigating the electronic properties of $CuBSe_{1-x}Te_x$(x = 0.125, 0.25) chalcopyrite semiconductors

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Abstract

In the last few decades, chalocopyrite semiconductor compounds have received increasing attention both theoretically and experimentally due to their potential technological applications. Here, the electronic properties of $CuBSe_{1-x}Te_x$ (x = 0.125, 0.25) are investigated computationally but have yet to be experimentally explored. A new type of crystal and a family of chalcopyrite semiconductors have been studied using the ultrasoft pseudo-potential based on the first-principle methods (DFT) implemented in the open-source Quantum Espresso package. We have considered the parent compound $CuBSe_2$ and doped a Te element as compounds with commensurate filling between Se and Te in a given unit cell at 12.5% and 25%, respectively. In this article, we have presented the band structure and the projected density of states of the $CuBSe_{1-x}Te_x$ compound. The analysis of the density of states curves shows that the valance bands are mainly formed due to the contributions of the B (p), Se (s,p), and Te (s,p) states, with a smaller contribution from the Cu (d) and B (s) states. On the other hand, the conduction band is formed due to the B (s, p) states and a small contribution from the Cu (p), Se (s,p), and Te (s,p) states. The estimated band gap energies are found to be 1.141 eV and 1.105 eV, respectively, which are less as compared to the parent CuBSe2 (E_g = 1.473 eV) compound.

Keywords: Crystal structure; Chalcopyrite; DFT.

A facile study to cobalt decorated MoS_2 sheets for enhanced electrochemical sensing applications

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Abstract

Molybdenum Disulphide (MoS_2) decorated with cobalt nanoparticles (Co-NPs), exhibits unique applications in the fields of electrochemical sensing beside others. Due to covalent and Van der Waals bonding, MoS_2 is utilized for various sensing applications.The sensing capabilities and response of the electrochemical sensors are significantly influenced by the catalyst selection. This work examines the characterisation of cobalt-based MoS_2nanosheets and the effects of their phase composition on features like selectivity, recyclability, sensitivity, and stability for electrochemical sensing applications.The rationalised design of the nanostructures has a significant impact on the analytical response of electrochemical sensing devices. The shape, phase, spatial characteristics, and chemical composition of the structure are all controlled by the decorating of cobalt NPs over MoS_2nanosheets, which has a significant impact on the nanostructure attributes like conductivity, adsorptivity, and electrocatalysis. We have investigated the superiority of the cobalt-based MoS_2nanohybrid structure over pure MoS_2, which demonstrated to achieve improved electrically active superficial sites and prevent unfavourable chemical reactions like oxidation and agglomeration. MoS_2nanosheets made of cobalt have a variety of characteristics that make it possible to use them in many types of sensing techniques.

Keywords: Cobalt-MoS_2; Electrochemical; Sensing; Electrocatalysis; Nanohybrid.

Nanostructured Materials for Solar Cell Applications

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Abstract

Nanostructure materials, particularly those used in solar cells, have recently paved the way for a bright future for renewable energy sources. The potential for using nanostructured materials in the energy sector is enormous. They can facilitate the mass production of innovative energy technologies and assist in lowering their cost.Photovoltaics (PVs) or solar cells (SCs) are the technologies that directly transform solar energy into electrical energy. Although solar PV technology is an environmentally benign method, it has a number of problems with some inescapable environmental elements, such as dust, reflection from cover glass, and various weather conditions, which affect the solar panel’s effectiveness. As a result of nature’s propensity for self-cleaning, the concept of “superhydrophobicity” was developed in order to prevent the buildup of dust on PV surfaces. The development of these coatings will boost solar PV cells efficiency. The PV technical and user groups have come to the realization that if PV technology is to be broadly adopted for primary and secondary energy demands, boosting cell efficiency while lowering the cost will be essential.Solar energy offers a wide range of potential uses because it is the most abundant permanent energy source on earth, helping to meet a sizeable portion of the sustainable need for future generations.

Keywords: Photovoltaic, Nanostructure materials; Solar cells; Nanomaterials; Hydrophobicity.

Silver Sulphide decorated graphene sheets for enhanced electrochemical sensing application

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Abstract

Due of its unique characteristics, graphene is widely considered a potential material for sensing applications. High conductivity, carrier mobility, wide surface area, high thermal stability, and high mechanical strength are some of the unique features of graphene. Due to its low working temperature, graphene-based sensor is extremely secure. Silver Sulphide nanoparticles (Ag_2S NPs) are used to adorn graphene, which further enhances its chemical sensitivity and selectivity. The creation of uniform sized Ag_2S NPs involves the application of ultrasonic irradiation. Ag_2S NPs can then be uniformly coated on graphene using the spin coating process. Ag_2S NPs is a useful material for chemical sensors thanks to its several amazing qualities. High absorption coefficient, narrow band gap, low hazardous effect, high chemical stability, and notable optical and electrical properties are some of these qualities. The bandgap of Ag_2S is 1.1 eV, while that of Ag_2S -graphene NPs is 1.75 eV. Ag_2S adorned graphene sheets perform hydrogen sensing much more effectively than Ag_2S. In experiments, it was found that Ag_2S -graphene NPs could only operate at a maximum efficiency of 45.5% when 150 ppm of hydrogen gas was present at room temperature. 19 seconds are needed to detect the Ag_2S -graphene NPs reaction, and 31 seconds are needed for recovery. The graphene sheets coated with Ag_2S NPs have the quickest response times and the highest sensitivities, which are crucial in electrochemical sensing applications.

Keywords: Graphene; Thermal stability; Sensing; Chemical sensitivity; Response time.

A study of iron oxide (Fe_2O_3) nanocomposites in advanced biomedical and sensing applications

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Abstract

Due to their ability to increase the stability and permeability of therapeutic agents through tissues, their capacity for loading drugs to provide controlled release of drugs, minimise toxicity, and prevent overdosage by increasing the accumulation of medications in unhealthy sites, iron oxide nanoparticles are attractive nanoparticles in biomedical applications. Due to its high surface-to-volume ratio and small band gap, hematite (Fe_2O_3) has the highest stability and is an environmentally friendly material with numerous uses in biomedical engineering, lithium-ion batteries, water treatment, gas sensors, and photocatalysis. They enable quick readout in redox-responsive drug delivery systems and quick release of encapsulated medications because of their electrocatalytic activity. The agar diffusion method was used to carry out their antibacterial activities. The potential for iron oxide nanoparticles to be used in biomedical applications like drug delivery, thermal therapy, MRI, etc. is increased by the fact that they have unusual magnetic properties (superparamagnetism), are more readily available, cost-effective, easy to separate, and have minimal toxicity. We have decorated $Fe_2O_3$with graphenenanosheets that make it possible to use them in many types of sensing techniques.

Keywords: Superparamagnetism; Biomedical; Iron-oxide; Sensing; Photocatalysis.

Green synthesis of Silver and Copper Nanoparticles using the different plants extracts of Indian habitat and their comparative study

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Abstract

Nano Science deals with the production of materials at nano scales (i.e. one of the three dimensions must be in the size range 1-100 nm), and the study of its properties and applications. At Nanoscale, the particles exhibit some extraordinary properties that make it an exotic material in the field of material science. Although there are numerous methods of synthesizing Nanoparticles, Green Method is a trending one in this field, because it promises an efficient way of nanoparticle production, in less time and more convenient & eco-friendly way. India is a country with variety of climate and vegetation at one place and is thus rich in floral resource. In the present study, Silver and Copper Nanoparticles have been synthesized using Cloves (Sygium Aromaticum), Cinnamon Bark (Cinnamomum Cassia) and Tulsi Leaves (Ocimum Aromaticum) and a comparative study between both the Nanoparticles in the very same circumstances have been done. Silver and Copper have been the most useful metals and also the part of India's medicinal values (in the form of Bhasmas) since ancient time. Cloves, Cinnamon Bark and Tulsi are the ingredients of Indian common kitchens, which have been used as reducing as well as capping agents of the Nanoparticles. The method adopted is quite simple, one pot- one step process and basic equipments and apparatus demanding. The color change is the first evidence of the formation of Nanoparticles which have been further confirmed by UV-Vis analysis and other characterisization tools. It can be concluded that the synthesis of Silver Nanoparticles is more compatible than the synthesis of Copper Nanoparticles, due to its noble metal properties. Also, among all the three plants extracts used, Clove is the most promising one in the synthesis of these metal Nanoparticles.

Keywords: Nanoparticles; Green Method; Silver Nanoparticles; Copper Nanoparticles.

Functionalized biogenic silica nanoparticles embedded hydrogel with enhanced antibacterial and cell proliferative properties

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Abstract

Silica (SiO_2) is the most abundant elemental form of silicon present in the environment. The plant absorbs silica with water in the form of silicates and deposits it into roots, leaves, and stems. Such photogenic silica (PhSi) reinforces plant cell walls, aids in environmental stress resistance, enhances plant mineral and water uptake capacity, and plays an important part in plant defense mechanisms. Natural silica resources offer a low-cost, environmentally friendly option for isolating silica for usage in medicinal and material fields. In this study, we have isolated plant-based crystalline silica nanoparticles (NPs). These NPs have undergone surface modification with cetyltrimethylammonium bromide (CTAB) and (3-Aminopropyl) triethoxysilane (APTES) that enhances its physicochemical properties *viz.,* solubility, and stability. These NPs were used for the formation of transparent, stable hydrogel with good antibacterial properties against gram-negative (*P. aeruginosa*) and gram-positive (*S. aureus*) strains. Further hydrogel has shown cytocompatibility against NIH-3T3 cell lines. Hydrogel can be used to treat wounded site as it has shown good cell migration and increased collagen release in NIH-3T3 cells. Characterization of NPs and hydrogel formed has been done using transmission electron microscopes (TEM), scanning electron microscope (SEM), Fourier transform infrared spectroscopy (FTIR), Powder X-ray diffraction (P-XRD), X-ray photoelectron spectroscopy (XPS).

Keywords: Silica NPs; Hydrogel; Antibacterial; Cell migration; Collagen.

Optical properties of Swamp Hibiscus

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Abstract

Due to synthetic dyes negative implications and threats, there has been a significant interest in natural dyes generated from plant sources in recent years. Colours obtained from plants pose less environmental impact. Hibiscus diversifolius (swamp hibiscus), a familiar dye source, is selected for this study. An attempt has taken here to separate natural dye from flowers. The extraction process of flowering plants using traditional methods and solvents is used to determine the optimal dye removal process. The present work mainly concentrated on the UV-VIS spectroscopic studies of the extracted dye. The absorption range, extinction coefficient, refractive index, dielectric constant, and optical energy band gap were measured by using UV-Visible measurements. The spectroscopic results on floral extract pigments revealed prominent absorption peaks in the visible area and obvious band gaps. The optical absorption for the dye was to be an allowed direct transition between the bonding and antibonding molecular energy states. The measurements presented here are crucial for understanding the capabilities of natural dyes to be suitable for optoelectronic device applications.

Keywords: Optoelectronic parameters; Natural dyes; Hibiscus diversifolius; Extraction.

Nerium oleander -Natural dye: Focus on optoelectronic properties

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Abstract

Natural dyes have a number of built-in benefits such as renewable resources, posing no health risks, generating any waste, affordable, widely accessible, and environmentally benign. There are numerous biological applications for them. In this research, we separated the natural pigments from the Nerium oleander and examined their optical characteristics. The natural dyes from petals of Nerium oleander were extracted by macerating them using Acetone as solvent. The extraction was conducted at room temperature with a pH of 7. The optical energy band gap, extinction coefficient, refractive index, Real and imaginary dielectric constant, and optical conductivity, Urbach Energy. The dyestuff showed a perfect opposite trend for real and imaginary dielectric properties, there is not much refractive index loss, and hence the path of light is all most the same for different regions of wavelength. Dye exhibited a direct bandgap of 1.90 eV and an Urbach energy value of 1.7 meV. It was found that the optical absorption in the dyes obeyed a direct permitted transition between the molecular energy levels. The findings here may be particularly significant for future organic electronics applications, including O-LEDs and sensors.

Keywords: Natural dyes; Optoelectronic parameters; Nerium oleander.

Artificial Intelligence based algorithms using nanomaterials for medical applications

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Abstract

Nanotechnology is an emerging field that focuses on the advanced method to solve problems. The creation and implementation of nanobots is one of the main characteristics of nanotechnology. We may employ artificial intelligence (AI)-based platforms and their algorithms to increase the effectiveness of the use of nanobots. Targeted medicine delivery is one of the most promising uses for AI-powered nanobots. AI-enabled nanobots can target the particular tissues that are needed and carry out the intended functions with their precise control and data processing abilities, minimising adverse effects and maximising therapeutic results. Nanobots with sensors and imaging capabilities can identify and analyse biomarkers, giving real-time information on a patient's health. These data can now be processed and used by AI algorithms to determine the next phase in the treatment. Such methods might facilitate early disease detection, early intervention, and better patient outcomes. The fusion of AI with nanobots has the potential to completely transform a variety of industries, including the healthcare sector. Personalised treatment, targeted drug administration, real-time diagnostics, and tiny surgery may soon be possible thanks to AI's processing capacity and nanobots ability to navigate the human body at a microscopic level. Despite all the advantages and breakthroughs brought about by AI and nanobots, it is still crucial for us to keep an eye on and follow the development of AI while keeping ethical issues and concerns in mind.

Keywords: Nanobots, Drug delivery, Nanomaterials, Artificial intelligence, Response time.

A Comprehensive Analysis of the Development of Bioethanol from Lignocellulosic Hydrolysates

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Abstract

Bioethanolas a viable option to meet the growing global demand for energy and address environmental problems has grown considerably in recent years.Bioethanol is replacing fossil fuels in a sustainable and renewable way. The readily available and abundant lignocellulosic biomass has shown remarkable potential as a sustainable feedstock for bioethanol production.This paper presents an analysis of the current state of research progress on the production of bioethanol from lignocellulosic biomass. The study highlights the various methods and processes used to convert lignocellulosic biomass to bio ethanol. There are so many barriers to the production of bioethanol from lignocellulosic biomass that are briefly discussed, including the strength of lignocellulose and the profitability of the production process.It also provides the opportunity to combine bioethanol production with other industries, such as pulp and paper, to increase the overall cost-effectiveness of the production process. Looking at all aspects, it provides a clear view of the current state of research in the synthesis of bioethanol using lignocellulosic biomass. It highlights the barriers that need special attention to make bioethanol production cost-effective, while demonstrating the potential of this technology to address growing energy demand and environmental concerns around the world.

Keywords: Renewable energy; Bioethanol; Lignocellulosic; Pretreatment methods.

Gallic acid functionalized fluorescent molybdenum disulfide quantum dots serve dual activity against amyloid and biofilm formation

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Abstract

Neurodegenerative diseases are a set of conditions characterised by the gradual deterioration and malfunctioning of neurons in the brain and spinal cord, and sometimes in the peripheral nervous system as well.In recent years, there has been growing interest in exploring the potential role of bacterial biofilms in the pathogenesis of these conditions.Bacterial biofilms are communities of bacteria that have clumped together, either on a surface or amongst themselves, and have entrenched themselves in a matrix that they have produced which is composed of Proteins (e.g., curli), lipopolysaccharides, and extra-cellular DNA (eDNA).One proposed mechanism is that biofilm amyloids such as curli can induce inflammation and activate immune responses in the brainwhereasLPS can contribute to neurodegeneration by promoting oxidative stress, damaging neurons, and disrupting normal cellular processes.Gallic acid, a triphenolic molecule with a low molecular weight that occurs naturally, has been proven to be an efficient antioxidant and inducer of apoptosis via its radical scavenging action, capacity to suppress lipid peroxidation, maintenance of endogenous defence mechanisms, and metal ion chelation.In this study we have synthesized gallic acid functionalized fluorescent molybdenum disulfide quantum dots due to its antioxidant property which provides dual activity against amyloid as well as biofilm formation.First, we have synthesized and modifies our quantum dots and characterization has been done using spectroscopic (*viz.*Fluorescence, Absorbance and FTIR) and morphology analyse through transmission electron microscope (TEM). Next, we have isolated and characterize the bacterial biofilm from gram-negative (*E. coli*) and gram-positive (*S. aureus*) through scanning electron microscope (SEM), Fourier transform infrared spectroscopy (FTIR), CD-spectroscopy, MALDI-TOF.

Keywords: Quantum dots; Anti-amyloid; Anti-biofilm.

Thermal annealing effects on crystallinity of MOVPE grown p-type GaN

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Abstract

Current technology utilizes the incorporation of Mg impurities as a p-type dopant in GaN. Mg in GaN layer is passivated by hydrogen during the metal organic vapour phase epitaxy (MOVPE) process. It exhibits high resistivity and p-type conduction is inhibited. Mg:GaN layer can be activated to achieve p-type conductivity by post-growth treatments such as laser-induced activation, thermal annealing, low energy electron beam irradiation (LEEBI) and rapid thermal processing (RTP). High temperature thermal annealing for optimum duration is a potential post-growth treatment as it facilitates Mg-H bond breaking and at the same time promotes efficient hydrogen out-diffusion. However, long duration thermal annealing may pose issues of deterioration of crystalline structure and surface. In the present study, thermal treatment of GaN epilayer grown with Mg concentration > 1019 cm-3 on sapphire substrate has been systematically investigated. One-step and two-steps annealing of samples were carried out in ambient conditions at different temperatures ranging between 420°C - 680°C. The effect of temperature, duration and thermal cycling has been studied on the structural, morphological and optical characteristics of the samples by HRXRD, AFM and Raman spectroscopy respectively. The intensity enhancement (~35%) and marginal decrease in the broadening of symmetric (002) and asymmetric (102) HRXRD rocking curve peaks indicate improvement in the crystalline quality of the Mg:GaN layer after the annealing. Raman measurements further support the retention of good crystallinity of epilayers and no adverse effect of thermal treatment on structural quality. Post-annealing features lead to nearly one order increase in the surface roughness of the samples from 3 nm to 11 nm. The sample subjected to a two-step annealing process at 420°C for 20 minutes followed by 680°C for 10 minutes exhibits minimal surface deterioration with a surface roughness of 3.6 nm only. In order to determine the Mg activation and p-type conductivity of the Mg-doped GaN layers, Hall measurements are being carried out as part of the electrical characterization process.

Keywords: GaN; MOVPE; Hydrogen passivation; LEEBI; RTP; AFM; HRXRD.

Gold nanoparticles modulate protein aggregation induced autophagic cell death

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Abstract

Accumulation of misfolded and aggregated proteins in brain is the major biological process involved in variety of neurodegenerative disorders (NDs) such as Alzheimer disease (AD) and Parkinson disease (PD). There has been enough reportage manifesting two species of amyloid aggregates viz., oligomers and amyloid fibrils responsible for the development of NDs. Amyloidogenic potential of proteins is stirred up by short, hydrophobic stretches of amino acid residues which have high tendency to form β-structures. In order to target these amyloidogenic stretches constituting majorly of bulky apolar residues with hydrophobic side chains and aromatic rings, we have substantially reported the synthesis and protective effect of an amino sugar conjugated gold nanoparticles on the oligomeric and fibril fraction of hen egg white lysozyme (HEWL). The synthesized NP was characterized by UV-Vis, ^{1}H NMR, FTIR, XPS, Raman, powder XRD, MALDI-TOF and the corresponding TEM studies suggested that the size of the nanoparticle was < 50 nm. Amino Sugars have been reported to act as an osmolyte and preserve the native biological structure and function of proteins and thus has broad implications in the understanding of neurological changes associated with aging. The synthesized NP inhibited transition of aggregated HEWL from lag phase to log phase by several folds which is congruent to the decrease in fluorescence intensity. Studies carried out with Neuroblastoma Cells suggested that the NP alleviated protein aggregation induced cell death via inhibition of oligomer formation, reduction of intracellular oxidative stress, and decreasing the cell-to-cell communication. The intracellular delivery of the NP has been found to modulate intracellular homeostasis and restricts autophagic neuronal cell death as studied by western blot studies. Overall, we predict that this approach of simultaneous targeting of early and late aggregates of non-pathogenic protein may serve as a better therapeutic strategy for the treatment of neurodegenerative diseases.

Keywords: Neurodegenerative diseases; Oligomers; Glucosamine; FRAP; Parkin; Autophagy; Cell-to-cell transmission.

Development of metal ion scavenging carbon nanomaterial to reduce neurotoxicity

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Abstract

Metal ions such as iron, copper, zinc and calcium serve many vital roles, including acting as secondary messengers in cellular signalling, stabilizing structures of proteins, catalyzing enzymatic reactions, and transporting dioxygen (O_2) throughout the body. Therefore, an aberration in metal ion homeostasis might cause various severe illness including neurodegeneration such as Alzheimer’s, Parkinson’s, Huntington’s disorders etc. Among them, transition metal ions (copper and iron) are potentially more dangerous for the cell as they can participate in redox reactions leading to the formation of reactive oxygen species (ROS) that can oxidize intracellular proteins, lipids, and nucleic acids. In Alzheimer’s disease, copper and iron concentration increases in brain upto 0.4mM and 1mM respectively because of dysregulation in their transport mechanism. Copper ion stimulate the di-tyrosine linkage of amyloid beta (Aß) protein and thus ultimately leads to the formation of amyloid fibrils, which are the characteristic hallmark of Alzheimer’s disease. In order to scavenge or reduce these extra metal ions, fluorescent carbon nanomaterial was synthesised from Himalayan bioresource and conjugated with a polyamine compound having strong binding affinity for specific metal ions. Because of its small size, this nanoconjugate can cross the blood brain barrier and scavenge metal ion from neurons. Quantum yield of fluorescent nanoconjugate decreased when bound to specific metal ion, thus with this conjugated nanomaterial, we are targeting both the approaches; scavenging metal ions to reduce toxicity and early diagnosis of Alzheimer’s disease simultaneously.

Keywords: Carbon nanomaterial; Metal ion dyshomeostasis; Neurodegeneration; Protein aggregation.

Recent Developments on Bimetallic Selenides Nanostructures for Supercapacitor Applications

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Abstract

Nanostructures based on bimetallic selenides have been considered as promising energy storage materials due to their promising electrocatalytic active sites. Various researchers synthesised Bimetallic selenides nanostructures for supercapacitor applications such as Nickel Cobalt Selenides(NiCoSe), Copper Cobalt Selenides(CuCoSe) and Zinc Cobalt Selenides(ZnCoSe). There are several methods to synthesize the nanoparticles such as hydrothermal method, solvothermal method, electrodeposition etc. Benefiting fromthe unique hierarchical structure, the Zinc-Cobalt-Selenide delivers a satisfied specific capacity of 394mAh g^{-1}, higherthan those of ZnSe, $CoSe_2$ synthesized under the similar conditions i.e., 166.1 mAh g^{-1}. It is also shown that equivalent Co and Ni in the composite NiCoSe (262mAh g^{-1}) shows the best supercapacitor performance, including high specific capacityand excellent cycling stability prepared by simplehydrothermal method.The main objective is to providenew insights for the rational design and construction of transitionmetalselenide-basedsupercapcitor electrodes for high-performance energystorage devices.

Keywords: Supercapacitors; Bimetallic Selenides; Nanostructures; Energy Density; Specific Capacitance; Power Energy; Hydrothermal Process.

Artificial Intelligence powered nanobots using nanomaterials for early disease identification

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Abstract

The combination of artificial intelligence (AI) with nanotechnology has the potential to completely transform the medical industry by enabling previously unheard-of improvements in procedures for surgical, therapeutic, and diagnostic treatments. The fusion of these technologies has led to the creation of AI-powered Nanobots, which are tiny robotic machines that can carry out difficult tasks at the microscopic level. The benefits that these AI-powered nanobots can offer humanity in the areas of early disease identification, their intervention, and surgical procedures are explored in this abstract. AI and nanotechnology work together to provide very accurate and effective early illness detection. These nanobots can access injured cells or tissues directly by utilising their small size and sophisticated capabilities, minimising negative effects and enhancing patient healing effectiveness. Nanobots with AI capabilities can considerably improve surgical procedures. By giving real-time feedback, improving precision, and reducing risks, they can help surgeons carry out delicate and intricate surgery. The possibility of creating AI-powered nanobots through the fusion of nanotechnology and AI is unfathomable for the medical industry. Their capacity for early illness identification, precise intervention, and support during surgical procedures has the potential to revolutionise healthcare and enhance surgical results compared to current practises.

Keywords: Nanobots; Nanomaterials; Artificial intelligence; Diasgnosis; Medical.

Nanoscale Communications and Nanonetworks for various domains

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Abstract

Nanoscale communication and nanonetworks consist of at least one synthetic network component of size ranging from 1 to 100 nm, exploit different nanoscale properties, and incorporate the basic elements of communication elements– transmitter, message, message carrier, medium, and receiver. With the rapid advancement of nanoscale devices and the demand for more efficient and versatile communication networks, researchers have turned their attention to exploring communication at the nanoscale. With the advents of Internet of Things (IoT) the use of the Internet has transformed, where various types of objects, sensors and devices can interact making our future networks connect nearly everything from traditional network devices to people.Nanonetworks hold immense potential in a wide range of applications, including biomedical systems(i.e.drug delivery, remote health monitoring, and nanosurgery), environmental monitoring(to collect real-time data on air quality, water pollution, and other environmental parameters), and industrial automation(enhance the efficiency and reliability of manufacturing processes by enabling communication and coordination among nanoscale devices). These techniques aim to overcome the limitations imposed by the nanoscale dimensions and enable reliable and high-speed communication between nanoscale devices. Researchers are actively investigating to ensure the seamless integration of nanoscale devices into larger communication infrastructures.In conclusion, nanoscale communication and nanonetworks present exciting opportunities for revolutionizing communication systems and significant challenges remain to be addressed, ranging from device limitations to network scalability and security.Consequently, we propose a set of functions and use cases that can be implemented by Nano-devices and discuss the significant challenges in implementing these functions with Nano-technology paradigm and the realization of advanced nanonetworks in various domains.

Keywords: Nanoscale communication; Internet of Things; Nanonetworks; Nano-devices.

Recent Developments on Nickel chalcogenides for Hydrogen generation

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Abstract

Nickel chalcogenides are found to be very promising water splitting electroctalyst, due to their outstanding electrocatalytic active surface are and tuneableredox nature. This research work aims to give new insights about potential of nickel-based chalcogenides for hydrogen generation. Nickel sulphides (NiS, Ni_3S_2), nickel selenides (NiSe, $NiSe_2$), and nickel tellurides (NiTe, $NiTe_2$) are among the nickel-based chalcogenide materials that are the subject of this study. There are several method to synthesize the nanoparticles such as hydrothermal method, solvothermal method, electrodeposition etc.The chalcogenides can be synthesized through hydrothermal process by optimising various parameters.According to recent research works, the nickel selenides,tellurides and sulphides had shown the overpotential around381 mV, 390 mV, 270 mV respectively at constant current density in alkaline medium. This is the reason amongst all the chalcogenides, Sulphides has gotten the most importance.This research may provide some new ideas for reducing the overpotential further which is the key factor for HER.Optimization is also done for a variety of parameters, including chalcogenide content, shape, and loading.The main objective is to provide remarkable insights for the development of efficient and durable nickel-based chalcogenide catalysts has the potential to drive the widespread adoption of hydrogen as a clean energy carrier, enabling a transition towards a greener and more sustainable future.

Keywords: Hydrogen evolution reaction (HER); Solvothermal Process; Electrodeposition; Overpotential; Hydrothermal method.

Design of Bone Health Detecting Biosensor: Advances in Materials, Technology, Challenges and Solutions

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Abstract

Bone health deterioration and its related issues significantly impact a large part of the world's population, especially those aged 65 years and older. Early detection and progressive treatment can considerably reduce the impact of such issues. However, existing technologies provide results in a time-consuming and expensive manner, hindering accessibility and early access to treatment. In this regard, biochemical markers of bone turnover are some of the best indicators of bone health, whose detection and analysis provide an accelerated method of detecting bone health and produce progressive conclusions in treatments of diseases such as osteoporosis. This paper outlines the method by which biosensors can be created to detect these markers, using carbon nanotubes and molecularly imprinted polymers. An analysis of the different types of biochemical markers has been discussed, from which a conclusion has been drawn as to what would be the best marker to be used for detection and whose analysis provides the best results, which, in this case, is the C-terminal telopeptide of Type-I collagen (s-CTx) bone resorption marker. Further, a comparison has been done to understand the usefulness of using biochemical marker detection over other existing technologies. The paper then proceeds to outline the design of a biosensor sensitive to the detection of the s-CTx molecule and the different methods and materials that can be used for the same, such as gold-coated carbon nanotubes and polymer-based artificial antibodies. The use of electrochemical impedance spectroscopy to quantitatively analyse results from the biosensor has also been highlighted. Finally, a conclusion has been drawn as to the effectiveness of such a biosensor in its use, and the best materials and methods for creating the biosensor have also been identified.

Keywords: Bone health; Bone resorption markers; Biosensor; Carbon nanotube; Molecular imprinting; Electrochemical impedance spectroscopy.

Novel Cerium (III) Sulphate Nanoflowers Decorated Reduced Graphene Oxide for Electrochemical Vitamin-C Sensor

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Abstract

In this study, cerium sulphate nanoflowers ($Ce_2(SO_4)_3$) decorated reduced graphene oxide (rGO) was synthesized through a rapid one pot hydrothermal method. The crystal structure and morphology of the as-preparednanohybrid composites were characterized using X-ray diffraction (XRD), field-emission-scanning electron microscopy(FESEM), Raman spectroscopy and Fourier Transform Infrared (FT-IR) spectroscopy. The electrochemical performance of the novel rGO/$Ce_2(SO_4)_3$ biosensor was investigatedvia cyclic voltammetry. The $Ce_2(SO_4)_3$/rGO (CSG) nanoflower composite were used to activate screen printed carbon electrode (SPCE). At +0.337 V, a well-defined oxidation peak of AA occurred in phosphate buffer solution of pH 7.A linear response of the CSG electrode was obtained under optimum conditions, for the concentration range of 10 - 1000 µM with sensitivity of 0.2973 µA/µM-cm^2 and the lowest detection limit of 0.9 mM for ascorbic acid. The excellent Vitamin-C detecting features of CSG sensor are attributed to the synergistic effect from the dimensional anisotropy of flower-like morphological features of $Ce_2(SO_4)_3$ as well as the interfacial structure. The CSG sensor was also validated for vitamin C tablets VeeCee-Z to scale up the adopted protocol for commercial applications. Furthermore, fabricated electrochemical sensor exhibited significant repeatability (98.63 %), optimum stability and reproducible monitoring performances. The significant findings of our work hold the prospect for sensitive and prompt determination of Vitamin-C in the industrial domains.

Keywords: Nanostructures; rGO; Cerium(III)Sulfate; Hydrothermal synthesis; Vitamin-C.

Structural, Optical and Electrical Properties of Cu doped ZnS Nanoparticles Prepared by Solid-State Reaction

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Abstract

Zinc Sulfide (ZnS) is one of the leading semiconductors for optoelectronic device applications. Here, we focused on producing the transitional semiconducting material of undoped and Cu-doped ZnS nanoparticles by the method of solid-state reaction for such applications. The prepared nanoparticles were studied for structural, morphological, elemental, optical, and electrical properties by XRD, FE-SEM, EDS, UV-visible spectroscopy, PL, and Keysight B2900 source meter, respectively. XRD revealed that the prepared nanoparticles have a cubical structure with a strong preferred orientation along (1 1 1) plane. The EDAX spectrum verifies that the synthesized nanoparticles include the host (Zn & S) and dopant (Cu) elements. The formation of spherical-shaped clusters was confirmed by FE-SEM images. Using absorption spectra energy band gaps were investigated. Novel luminescence features i.e., blue, green, and orange-red emission peaks were observed in the photoluminescence spectra.

Keywords: Nanoparticles; Solid-state reaction; Crystal structure; Semiconductor; Photoluminescence.

Ammonia gas sensing applications of Sn-doped NiO thin films

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Abstract

Nowadays, it's essential to develop ammonia gas sensors at room temperature because ammonia is a frequently used gas in several manufacturing sectors and a highly corrosive agent and destructive that can threaten human health and the habitat. Sn-doped nickel oxide Ni_{1-x} Sn_xO thin films have been prepared by spin-coating with various doping concentrations (0, 0.02, 0.08). Then we studied the effect of Sn doping on structural, morphological, and optical characteristics of NiO. Crystallographic results show samples are polycrystalline cubic structures with (200) predominant peaks. The crystallinity decreases with Sn Concentration, and size of crystallite, bond length of Ni-O, lattice constant, cell volume are increase with Sn concentration increases. The morphology is macro porous and spherical-shaped particles from SEM analysis, and nanoscopic surface roughness was observed from AFM analysis. The first-order phonon modes of vibrations of Ni-O are observed from Raman spectra. The transmittance of Sn:NiO film is about 75% in the visible range. After that, the gas-sensing performance was investigated of synthesized films towards various ammonia concentrations. The sensitivity response of films to ammonia is high when Sn concentration is at 8 mol%; the sensitivity is decreases for the lower percentage of Sn. The deposited films show a short response and recovery time of about NH_3.The prepared films are excellent sensitivity response at room temperature.

Keywords: Thin films; Spincoating; SEM; AFM; Ammonia.

Study and Simulation of Scalable Demultiplexer hardwareby using Different VHDL Modeling for Communication System

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Abstract

This paper give an overview of Multiplexer and Demultiplexer and the uses of these electronic devices. Both multiplexers and demultiplexers play an important part in the designing of Communication systems.Both have different work multiplexer combines different signals and through them over a signal channel.Whereas demultiplexer gives a single channel signal to multiple lines which depends upon the value of selection lines. In this paper, we have done designing of (1×16) demux, (1×32) demux, and (1×64) demux in VHDL with various types of VHDL modeling like data flow,Behavioral and structural modeling, and also done their Simulation to see its waveforms in ISE Design suite 14.7. Demultiplexer design helps the designers estimate the chip performance and timing, memory, and hardware utilization parameters. So we have done the Comparison of these three types of modeling on the FPGA Virtex-5 based onthe Number of Slices used, LUT used,Total combinational path delay, and the memory utilized by it. So it will help the researcher to know which type of modeling is better for the designing of demux (1×16), demux (1×32), and demux (1×64).

Keywords: Demultiplexer; Xilinix ISE 14.7; Virtex -5 FPGA.

Some common fixed point theorems using -metric space via simulation function

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Abstract
In this paper, our purpose is to prove some common fixed point theorems for generalized contraction mapping with respect to a simulation function and study the existence of points for such mappings in complete -metric space. Further, we have extended it to partially ordered complete -metric spaces. Some corollaries are also provided, which can be easily deduced from our result. Some examples is also provided in the support of our main result.

Keywords: Common fixed point; Contraction; Metric space.

Reinforce the surface properties of domestic garbage activated carbon by low temperature plasma accustomed in energy storage applications

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Abstract

Since activated carbon is a highly porous material with a sizable internal surface area, it is simple to adsorb a wide range of substances when used in energy storage devices, sewage treatment, water purification and other applications. This work focuses on the viability of using mixed fruit peels as a precursor for the carbonization process with physical activation to produce activated carbon. The Phase confirmation was examined using X-ray diffraction (XRD), Fourier transform infrared spectrometer (FTIR) concludes the functional groups present in mixed fruit peels activated carbon. Field emission scanning electron microscopy (FESEM) was used to analyze the morphological makeup and textural traits of the activated carbon that was produced. And Energy Dispersive X-Ray Analysis (EDAX) shows the elemental composition of nano powdered carbon. Raman spectra confirms the presence of graphene that appears at 1580 cm^{-1}. Carbon yield analysis were conducted and analyzed. Wettability of the mixed fruit peels were examined using contact angle. The Mixed Fruit peels activated carbon were subjected to DC glow discharge plasma or low temperature plasma to increase its surface properties, The outcomes were evaluated and contrasted.

Keywords: Mixed fruit peels; Physical activation; Low temperature plasma; Surface modification; Nano powder.

Reinforcement learning and edge intelligence using quantum structures

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Abstract

Computations may become time consuming and lengthy as the amount of complexities increases, which encompasses multiple possible action pathways and can be affected by a range of circumstances. The introduction of artificial intelligence (AI) has resulted in a significant shift in how problems are tackled. The notion of reinforcement learning gives a far more effective technique of problem solving when dealing with an issue that has numerous possible solutions. Reinforcement learning, a subset of machine learning, selects a pattern to produce the best coherent results. It collects feedback from an agent placed in an environment with pre-set environment status in order to maximise the result over time. Edge Intelligence focuses on developing AI-enhanced edge devices that can do intra-network computations, reducing reliance on cloud-based services and allowing the local network to function to some extent even in the absence of external networks. We can enable edge devices to do specific calculations and analyses at the network edge by combining reinforcement learning and edge intelligence. These devices would be able to selectively allow only necessary data transfers to the cloud, boosting data security and decreasing time complexity. After receiving the most effective feedback from the trial-and-error process within reinforcement learning, edge devices can perhaps formulate the forms of data transfers that it needs to do. Deep Q-learning is a new machine learning model that has just appeared in the field of reinforcement learning. We can also examine the formation of colour by dielectric nanostructures and show that this model can find geometrical features and optimise the colour generation.

Keywords: Artificial Intelligence; Edge Intelligence; Machine Learning; Reinforcement Learning; Nanostructures.

Simulation and Optimization of Optical Properties of Si-NWs for Hybrid Solar Cells

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Abstract

Recently silicon nanowires (Si-NWs) have been exclusively used as inorganic layer for the fabrication of hybrid solar cells due to its enhanced absorption optical properties. In this paper, metal assisted chemical etching (MACE) have been used for the fabrication of p-type <100> oriented Si-NWs. In the MACE method silver (Ag) is used as metal catalyst for the chemical etching process. Chemical etching solution contained ($HF/H_2O_2/H_2O$) at a defined concentration and all the fabrication process were carried out at room temperature. For the investigation of the growth parameter of the p-type Si-NWs, $AgNO_3$ solution concentration was varied from 10mM to 30mM and etching time was varied from 15 min., 30 min. and 100 min.The morphology of Ag nanoparticles and Si-NWs were studied using field emission scanning electron microscope (ZEISS EVO 50). From the morphology of Si-NWs it was found that the length of Si-NWs increases with the increase in etching time. It was observed that by changing the concentration of $AgNO_3$ solution the size of Si-NWs and gap between the Si-NWs changes with the increase in concentration of $AgNO_3$ solution. Diffuse reflection of the Si-NWs were also measured using UV-visible spectrophotometer (Shimadzu 2600i) and has been compared with the simulation results. Finite difference time domain (FDTD) simulation matrixes were used for the investigation of the optical parameters of Si-NWs and it was observed that Si-NWs show highly anti-refection properties. The reflection and absorption studies will play a significant role for achieving enhanced efficiency of hybrid solar cells.

Keywords: Silicon nanowires; MACE method; FDTD; Hybrid solar cells.

Influence of Ag doping on structural, optical, and magnetic property of ZnO compound

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Abstract

This study aims to examine how the Ag doping influences the structural, optical, and magnetic properties of ZnO compound. The studied polycrystalline sample of $\mathrm{Zn_{1-x}Ag_xO}$ (with x=0, 0.03, 0.06) were synthesized via the solid-state synthesis method. The analysis of XRD pattern clarify that all of the $\mathrm{Zn_{1-x}Ag_xO}$ compounds was crystallized into the wurtzite hexagonal structure with secondary (fcc) phases of metallic silver. The SEM microstructural analysis revealed that all compounds have a homogenous morphology, with particle sizes ranging from 200 to 300 nm. Band gap narrowing with increasing concentration of Ag-doping is observed in the prepared sample optical property analysis.From M-H curve analyses, we demonstrate that all Ag-doped compounds exhibit ferromagnetic behavior with $80\ \mathrm{Oe} \leq \mathrm{H_c} \leq 196\ \mathrm{Oe}$, whereas the undoped ZnO shows ferromagnetism embedded in diamagnetic matrix. The maximum Ms value was obtained for the 3% Ag-doped ZnOsample, however it declines for 6% Ag-doped ZnOsample.

Keywords: ZnO; Ag-doping; SEM; Band gap narrowing; Solid-state synthesis; XRD.

Synthesis, characterization and properties of nickel aluminium layered double hydroxide and carbon nanotubes composites for supercapacitor applications

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Abstract

Rapid development of modern electronic technologies has led to enthusiastic research on advanced energy storage devices, especially for supercapacitors. Herein, we synthesise hexagonal NiAl LDH /CNT nanocomposite using facile one step hydrothermal method. The morphology and structure of the samples were characterized by series of techniques including X-Ray Diffractometer (XRD), Transmission electron microscope (TEM), Raman spectroscopy, Fourier transform Infrared spectrometer (FT-IR), Brunauer-Emmett-Teller (BET), Thermogravimetric analysis meter (TGA) and Scanning electron microscope (FESEM). Electrochemical properties of these nanocomposites were further evaluated by using cyclic voltammetry, chronopotentiometry, and electrochemical impedance spectroscopy (EIS)and compared with pristine NiAl LDH. The NiAl-LDH/CNT electrode delivers remarkably high specific capacitance of 1524 Fg^{-1} at 1 Ag^{-1} and good cycling ability of 88% capacitance retention over 6000 cycles compared to only 1038 Fg^{-1} at 1 Ag^{-1} and 83% of the pristine NiAl-LDH.The results inspire us to propose our high-performance NiAl-LDH/CNT as a promising electrode for energy storage applications.

Design of Piezoelectric Material based Heart Rate Measuring Sensor System

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Abstract

Piezoelectric materials made huge progress in entering commercial mass markets throughout all domains, where piezo electrics are used as the base materials for sensors and actuators. The present paper explores the different possibilities of using a piezoelectric ceramic sensor as a heart rate indicating system. The designed model is a simple, cost effective and efficient alternative to the conventional heart rate monitoring devices. It is prepared using a piezoelectric sensor, an Arduino Uno microcontroller, a 10KΩ resistor, LCD screen and a few jumper wires. The blood circulation in the radial artery causes slight deformations in the piezoelectric sensor placed under the wrist. These deformations are converted to electrical signals and are passed on to the Arduino microcontroller, where the BPM (Beats Per Minute) of the person is calculated and this BPM is displayed on the LCD screen. The MATLAB software is used to plot the graph of the voltage variations caused by deformations, and the plotted graph resembles the ECG graph obtained by conventional heart rate monitoring devices. If the BPM falls out of the ideal range (60-100), “Abnormal Heart Rate” is displayed on the LCD screen. The values obtained from this model were compared with an oximeter to check for the accuracy and the results proved that the model is quite accurate and could be used as an alternative to conventional heart rate indicating devices. This model can help in early diagnosis of heart conditions such as bradycardia, tachycardia, arrhythmia and atrial fibrillation. Though the model is very cost effective and efficient, due to temperature dependence of piezoelectric materials, this heart rate indicator system cannot be used in very high temperatures. However piezoelectric materials which are temperature independent can be synthesized and used in the model for improving the accuracy of the model over a wide range of temperatures.

Keywords: Piezoelectric Sensor; Arduino Uno Microcontroller; Heart Rate Indicator.

Iron proteome of obligate intracellular pathogen Chlamydia trachomatis

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Abstract

All organisms depend on metal ions for survival since they are betrothed in numerous vital biological processes. The discovery of human infections' metal-binding proteins (MBPs) may offer a guide to understand biological metal utilization and their potential functions in pathogenesis.This study is mainly focused on the analysis of Iron Binding Proteins of *Chlamydia trachomatis*, whichcauses a range of infections in humans, including sexually transmitted infections (STI's) and eye infections and is particularly prevalent among young people.Based on sequence search and three-dimensional structure analysis, a total of 28 iron binding proteins were predicted.Functionally, the anticipated iron-binding proteins were divided into four main categories and among these four major categories gene regulation and transport functional classes were dominant.The potential iron binding proteins of *Chlamydia trachomatis* were detected in the cytoplasm, extracellular membrane, and cytoplasmic compartments, but were mostly found in the cytoplasm. In addition, it was found that out of 28 Fe-binding proteins 14 of the expected proteins were potential bacterial toxins.Four putative Iron binding proteins were able to interact with compounds that were either drugs or drugs-like molecules, suggesting that they may be exploited as broad-spectrum drug targets.These anticipated Chlamydia trachomatis iron binding proteins may be essential for a variety of cellular functions and pathogenicity, making them potential therapeutic targets for the development of iron-based medications to treat the infection.

Keywords: *Chlamydia trachomatis;* Iron binding proteins; Bacterial toxin; Virulent; Drug targets; Potential therapeutic targets.

Role of Deep Learning, Radiomics and Nanotechnology in Cancer Detection

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Abstract
This study examines how deep learning, radiomics and nanotechnology are used to diagnose cancer.Medical imaging, such as computed tomography (CT) and magnetic resonance imaging (MRI), is significant for the detection of cancer. Radiomicsand nanotechnology are the fields of medical imaging analysis that focuses on extracting quantitative features from medical images. Features like texture, shape, morphology and intensity that are associated with various types of cancer can be used to develop various imaging biomarkers. It is a promising tool for cancer detection and diagnosis. Extracted features through radiomicsand nanotechnology are then analyzed using advanced statistical and machine learning techniques. Deep learning is a branch of machine learning that uses artificial neural networks to extract features and classify data. Researchers have reached significant levels of accuracy in identifying different types of cancer by training deep-learning models on large datasets of radiomics data. Large amount of radiomics data can be analyzed using deep learning algorithms to find patterns that might be difficult to find using traditional statistical techniques. We will discuss various machine learning algorithms like artificial neural network (ANNs), support vector machine (SVMs) and decision trees (DTs) which are trained to spot minute variations in medical images that might be cancer-related. Researchers have created highly accurate and dependable ways for identifying cancer by fusing deep learning with radiomics and nanotechnology.Researchers have created highly reliable and accurate ways of identifying cancer by integrating deep learning with radiomics.Deep learning, radiomics and nanotechnology have the potential to revolutionize how cancer is diagnosed and treated. These technologies can help enhance patient outcomes and prevent fatalities by enabling earlier and more precise diagnosis.

Keywords: Drug delivery; Nanomaterials; Deep learning; Artificial intelligence; Neural network.

Toxic effects of heavy effects of heavy metals in water

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Abstract

Heavy metals present in water have been found to have detrimental effects on human health, leading to the development of various severe diseases. Samples from a freshwater source and a water source running through an industrial town are taken to assess the rising quantities of these heavy metals. The first sample was from the industrial town of Kamakshipalya, the 'vrishabavathi'. The other sample was collected from the freshwater lake of Herohalli. To determine if the concentration has increased over time, data from the same water source is compared to data collected in 2009. The industrial workers were also surveyed via questionnaire to learn how this water is affecting them. The questions asked were: - How is this water being used, Why is this water still in use when it is obtained from a contaminated source, How is this water affecting the workers, The steps that were taken by the workers to purify the water themselves, Has there been any external help from the government authorities to improve living conditions of these workers. Some of the major threats, sources of ingestion, toxicity, and treatment for some of the Heavy metals including Lead (Pb), Cadmium (Cd), and Arsenic (As) were determined. The ill effects of neglecting the lake ecosystem have caused urban ecological imbalance, pollution, unhygienic conditions, and floods. The result of the increased population intensified the use of surface water exploitation, due to which inland lakes increasingly are being threatened by sewage disposal Thus, simple preventive measures are included along with a variety of cutting-edge techniques to eliminate hazardous metals from the water like Phytoremediation, Flocculation, Electrodialysis, Precipitation, Microbial Fuel Cell (MFC) and Photocatalysis.

Keywords: Electrodialysis; Flocculation; Ion exchange; Microbial Fuel Cell (MFC); Photocatalysis; Phytoremediation.

Prinsepia Utilis Seed Extract Mediated Green Synthesis of Silver Nanoparticles and their Antibacterial Activities

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Abstract

We explored the application of *Prinsepia utilis* plant mediated silver nanoparticles. In this research work silver nanoparticles are synthesized using *Prinsepia utilis* seed extract acting both capping and reducing agent. The characterization was carried out by XRD (X-Ray diffraction), UV spectroscopy, FTIR spectroscopy, TEM (transmission electron microscopy) and SEM (scanning electron microscopy). The diffraction data showed that the synthesized silver nanoparticles were face centered cubic in nature and were crystalline in nature. UV-Vis spectrometer shows a surface Plasmon resonance peak (SPR) at 432nm confirms the formation of silver nanoparticles. The FTIR studies were carried out to know the functional group present in plant extract and their involvement in the reduction of silver ion. SEM and TEM studies revealed the spherical shape of silver nanoparticles. These synthesized silver nanoparticles being cost effective, eco-friendly and reproducible were utilized for an antimicrobial activity against E-coli bacteria. Studies showed good antibacterial activities, thus opens various fields where these can be utilized as antibacterial agents.

Keywords: Silver; *Prensepia utilis;* Nanoparticles; Antibacterial activity.

Green synthesis of Titanium dioxide Nanoparticles by Utilizing *Marchantia Polymorpha* and their Application in Dye removal

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Abstract

The uniqueness of this research exploration designates the bio-mediated synthesis of Titanium dioxide nanoparticles (TiO_2 NPs) with the use of whole plant extract of *Marchantia polymorpha* (common liverwort) by precipitation method. This execution occurs by using the precursor TTIP (Titaniumtetraisopropoxide) with plant extract as a capping and reducing agents which are functional in the stabilization of shape and size of nanoparticles. The evidences for the formation of TiO_2 nanoparticles were done with the help of various characterization techniques such as UV-Vis spectroscopy, FTIR and XRD. In UV-Vis analysis, the absorption peak appears at 292 nm with the energy band gap 3.49ev confirms the synthesis of TiO_2 NPs. The FTIR (Fourier transform infra-red) analysis was found that the fingerprint area exhibits an absorption band with the Ti-O-Ti and Ti-OH stretching mode at 783.29cm^{-1} supports the formation of Titanium dioxide nanoparticles. The XRD (X-ray diffraction) analysis validates the formation of anatase phase of TiO_2. Anatase phase of TiO_2 is considered as most supportive ones to do various applications like photo degradation and antibacterial activities. The bio-mediated TiO_2 nanoparticles were utilized in the photo catalytic dye degradation application which exhibits appreciable performance against the methylene blue dye in the sunlight in 5 hours.

Keywords: Titanium; *Marchantia polymorpha;* Nanoparticles; Photocatalytic.

The highly effective electrochemical oxidation of substituted benzyl alcohols in a biphasic medium is mediated by bromate on a platinum electrode

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Abstract

This article describes how benzyl alcohol was electro-oxidatively converted to benzaldehyde at a platinum metal electrode in a biphasic media utilizing bromate as the mediator. Based on current density, electrode material, temperature, solvent, inorganic salt mediator, and reaction system pH, electrolysis conditions were tuned. By adjusting the electrolysis parameters coupled with a straightforward reaction setup, the current experiment was able to produce outstanding yields of benzaldehyde (97%) at the optimal reaction conditions. One mole of benzyl alcohol was converted to benzaldehyde using 5 F of electrical current. The yield (97%) and current efficiency (97%) of two-phase electrolysis are both quite high. Several substituted benzyl alcohols were subjected to the optimum conditions, and encouraging yields were achieved. The oxidation of benzyl alcohol has been theorized to be a feasible mechanism.To the best of our knowledge, our work is the first to describe how substituted benzyl alcohol derivatives are oxidized in a biphasic system. In the current study, a number of primary and secondary alcohols were converted to the matching aldehydes or ketones by using the mediator bromate.

Keywords: Electrooxidation; Sodium bromate; Substituted benzyl alcohols; Platinum electrode; Biphasic medium.

Blend of low cost electrode material for energy storage device under DC glow discharge plasma exposed ESAC

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Abstract

The waste biomass in the form of eucalyptus globulus seeds activated carbon, which is employed as the electrode material and is environmentally acceptable, provides the good specific capacitance in the current work which is used for the energy storage application. A sample carbonization and physical activation procedure was used to create the activated carbon from the eucalyptus seeds. As prepared activated carbon was exposed to a DC glow discharge plasma, which modifies the surface of the material without altering its core characteristics. The investigation of the activated carbon was done utilizing structural, morphological, and electrochemical techniques both pure and plasma treated. The increasing intensity of the X-ray diffraction indicates the carbon's amorphous and disorderly character. More oxygen-containing functional groups are present, according to an FTIR analysis. The FESEM/EDAX investigation has demonstrated the appearance of less and more graphitic porosity with random orientation. Moreover, the electrochemical investigations were examined utilizing Electrochemical Impedance Spectroscopy (EIS) and Galvanostatic charge-discharge (GCD) which has a specific capacitance of 150F/g for a 1.5mA/g current density. The results revealed that the activated carbon made from Eucalyptus seeds after plasma treatment has good surface characteristics, improved specific capacitance, and is a low-cost electrode material for energy storage application fabrication.

Magnifying the GCD behaviour of $FePO_4$ composite with Low temperature Plasma exposed Bamboo charcoal enforced in energy storage devices

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Abstract

Materials based on phosphate have been suggested as suitable electrode components for energy storage devices and also indicated that the phosphate framework can help to keep active sites stable. The physical and chemical properties of Fe-based phosphates make them promising cathode compounds for energy storage systems. In this work, the additive carbonousmaterial as a bamboo charcoal which was prepared and activated using the pyrolysis process (BCC). The irradiation of DC glow discharge plasma improved the surface attributes such as wettability, adhesion, and conductivity. Here, the hydrothermal technique was used to synthesize $FePO_4$nano particles. The dielectricbehaviour was analysed at room temperature for pure $FePO_4$ and composite of $FePO_4$/Plasma treated BCC. The GCD behaviour of pure $FePO_4$ and composite of $FePO_4$/Plasma treated BCC was analysed with aqueous electrolytes at different current densities.In perspective, the dielectric constant and specific capacitance of the $FePO_4$/plasma treated BCC material seems to be very strong.

Keywords: Bamboo charcoal (BCC); $FePO_4$ nano particles; DC glow discharge plasma; Surface modification; GCD, Dielectric properties.

Transition metal based materials for aluminium batteries

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Abstract

With the marvellous advancement of battery as an efficient energy storage and conversion device, the world is witnessing a paradigm shift of the energy sector towards clean energy from conventional fossil fuel-based systems. The insurgence of lithium-ion batteries revolutionized this transition making the lithium ion-based batteries a household name.But in the present-day scenario, despite the widespread popularity of the lithium-based energy systems, the longevity of the lithium-ion system is encumbered by its availability and supply chain.Considering the abundancy, low flammability and its three electron per cation redox electrochemistry leading to its high theoretical capacity, aluminium is gaining popularity in the present-day battery research.The aluminium battery research primarily focuses on positive aluminium hosting electrode materials and the electrolyte system.But the research attempts in developing proper electrode materials have encountered various complications like inadequate cycle life with capacity fading after several cycles, lower cell discharge voltage, dissolution of the host materialsetc. Herein, the opportunities and challenges of transition metal based electrode materials for aluminium ion batteries will be discussed.

Keywords: Energy storage; Aluminium; Capacity; Performance.

Neem oil coated Zinc Oxide nanoparticle and its biopesticidal activity onCallosobruchus maculatus

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Abstract

Pathogens, insects, and other pest species inflict considerable damage to worldwide agricultural products, both during production and storage. The pulses are the main source of protein and, unfortunately, are largely infested by the insect *Callosobruchus maculatus*. To address this issue, many synthetic pesticides are widely employed both in the field and in commercial storage facilities. Despite the many positive impacts of synthetic pesticides, their long-term persistence and harmful residues are hazardous to humans. To reduce the harmful effect of synthetic pesticides, a plant-based nanoformulation of zinc nanoparticles coated with neem oil was developed. The prepared nano-formulation was then characterised with ultraviolet-visible spectroscopy; the appearance of a characteristic peak at 376 nm confirmed Zn oxide, and Fourier Transform Infrared Spectroscopy confirmed the various functional groups in the nano-formulation. The X-ray diffraction results confirmed the crystalline hexagonal structure of zinc oxide nanoparticles, while on coating, a decrease in crystallinity was observed. The dynamic light scattering confirmed the size in the nano-range, and X-ray photoelectron spectroscopy confirmed the elemental composition of zinc nanoparticles and the coating of neem oil on nanoparticles. The further effect of the prepared nano-formulation on the pulse beetle (Calllobruchus maculatus) in chickpea was investigated under different parameters. The different concentrations of the prepared formulation on the pulse beetle (Callosobruchus maculatus) in chickpea were studied in terms of different entomological parameters, viz., number of eggs, adult mortality, seed damage, and seed weight loss. The percent mortality was recorded on the 1^{st}, 2^{nd}, 5^{th}, 8th, and 14^{th} days after treatment.

Keywords: Calllobruchus maculates; Nano-formulation; Neem oil; Zn nanoparticle.

Temperature dependent Dielectric, Impedance Spectroscopy andhopping Mechanism in $NiFe_2O_4$ modified $Pb_{0.75}Nd_{0.25}TiO_3$ based Multiferroic Composites

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Abstract

Magneto-electric multiferroics are the current research topic due to its extensive use in different fields. Their significance in a variety of industrial domains, including storage devices, sensing applications, used as energy storage, and energy harvesters, is due to the co-occurrence of both ferroelectric and magnetic ordering. The simultaneous occurrence of these instructions is essential since they conflict with one another. Magneto-electric coupling describes the connection between the ferroelectric and magnetic orderings in multiferroics, which show both orderings.

Multiferroic Composite ceramics of $_{(1-x)}$ $(Pb_{0.75}Nd_{0.25}TiO_3)$- $_{x}(NiFe_2O_4)$ where x = 0.50 & 0.60 successfully synthesized using conventional mechanical mixing approach has been already been reported by Akshay Kumar et al. (Material Today Proceedings-In Press) for multiferroic and Magneto-Dielectric properties. Temperature-dependent electrical behavior of composites of $NiFe_2O_4$ & Nd^{3+} modified $PbTiO_3$ multiferroic composites have been studied yet. In this paper, we studied effect of temperature on dielectric behavior $_{(1-x)}$ $(Pb_{0.75}Nd_{0.25}TiO_3)$- $_{x}(NiFe_2O_4)$ where x = 0.50 & 0.60 multiferroic composites. The effect of stoichiometric proportion of $NiFe_2O_4$ in $_{(1-x)}$ $(Pb_{0.75}Nd_{0.25}TiO_3)$- $_{x}(NiFe_2O_4)$ where x = 0.50 & 0.60 on conduction behavior has also be studied in this paper.

Keywords: Multiferroics; Composites material; Magneto-dielectrics; Dielectrics; Impedance.

Spatial Self-Phase Modulation in Pyrromethene 567 for Optical Applications

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Abstract

When a continuous wave laser with an adequate amount of energy passed through a cell that contained pyrromethene 567 (PM 567), a phenomenon known as spatial self-phase modulation (SSPM) was observed. SSPM patterns appear in the far field as a result of the phase shift inducedby the temperature-dependent refractive index distribution. The nonlinear refractive index of the pyrromethene 567 samples was calculated from these patterns. SSPM in a mixed structure of PM 567 having different nonlinear optical responses is utilized for nonreciprocal nonlinear excitations. The work demonstrates the prospective use of PM 567 for obtaining spatially asymmetric light propagation based on SSPM.

Keywords: SSPM; PM 567; Nonreciprocal excitation.

GO@PEI@Starchnanocomposite for methylene blue adsorption from water

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Abstract

Synthetic dye effluents and their discharge into various water resources are one of the major environmental issues in recent times. To address this problem, biodegradable polymer-based adsorbents have great potential under different environmental conditions. In this context, the composite of Graphene-oxide modified with polyethylenimine and starch was developed to remove cationic methylene blue dye utilizing an adsorption process. The preparation of graphene oxide, polyethylenimine and GO@PEI@Starch is first observed by Ultraviolet-Visible spectroscopy. Fourier Transform-Infrared spectroscopy is used to confirm the synthesis of Graphene oxide, PEI-GO and various functional group interactions in the composite. The dynamic light scattering confirmed particle size in the nano range. Zeta potential confirmed the surface charge property of the prepared composite material. The X-ray diffraction shows the crystalline structure of Graphene oxide and the decrease in crystallinity after modification with polymer polyethylenimine. X-ray photoelectron spectroscopy is used to confirm the elemental composition in the developed nanocomposite. The dye adsorption study at different pH was done and the best results at basic pH were observed. The effect of various parameters such as dye concentration and adsorbent concentration was also studied. Thus GO@PEI@Starch may be a promising adsorbent for methylene blue removal in wastewater pollution treatment.

Keywords: Graphene oxide; Dye adsorption; Biodegradable polymer.

Phytotoxicity Assessment of PEI-Coated Copper Oxide Nanoparticles in Agricultural Plants

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Abstract

Copper oxide nanoparticles have gained significant attention in nanotechnology and have brought numerous possibilities for their utilization in various sectors, including agriculture. While CuO NPs offer numerous benefits in different fields, their potential toxicity toward agricultural plants has become a serious concern. In this study, copper oxide nanoparticles were modified with a biocompatible polymer polyethyleneimine to check the induced changes in their toxicity towards plants. The PEI-coated CuO NPs were synthesized using a chemical reduction method. Various characterization techniques successfully confirmed the presence of coating. The resulted nanocomposite showed a hydrodynamic size of 160.5 nm and the coating was successfully confirmed in the FTIR, XRD and XPS results. The effects of polyethyleneimine (PEI)-coated CuO NPs and uncoated copper oxide nanoparticles (CuO NPs) on different agricultural plants were compared. A series of controlled experiments were conducted to assess the impact of nanoparticles on the growth and physiological parameters of plants. The selected plant's seeds were treated with different concentrations of NPs to check for germination index. Results showed that at lower concentrations, the nanoparticles had no significant effect on the germination of seeds. However, a significant decrease in sprouting was observed at a higher concentration. Although bare and coated NPs show adverse effects, the impact was more pronounced in bare CuO NPs.Thus, this study demonstrates the influence of surface modifications of CuO nanoparticles on toxicity, and these findings will help to understand nanoparticle-plant interactions. Also, it becomes crucial to research how nanoparticles are disposed of and transported due to their rapid use in industries, and thus this investigation will assist in the safe utilization of nanotechnology in agriculture.

Keywords: Polyethyleneimine; Copper oxide; Toxicity; Agricultural plants; Chemical reduction method; Nanotechnology.

Tunable emission of polymer optical fibre random laser by resonance energy transfer

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Abstract

Here we demonstrate tunable light emission from a polymer optical fibre random laser containing a donor-acceptor mixture by resonance energy transfer between a donor-acceptor dye mixture. The random lasing emission from the polymer optical fibre samples containing the gain materials and scattering centers by pumping with Nd.YAG laser (532nm). It was found that the random laser emission of the acceptor molecule gets shifted to the shorter wavelength in the presence of donor molecules with an appreciable reduction in the lasing threshold. Also, by properly selecting the concentrations of both donor and acceptor molecules, a dual-colour random laser emission was obtained with a single excitation.

Keywords: Polymer optical fibres; Random lasers; Dual-colour emission; Resonance energy transfer.

Orally activecapecitabine-loaded biopolymeric microsphere inhibiting the proliferation of human colon cancer: in vitro and in vivo evaluation

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Abstract

Capecitabine-loaded gum odina and sodium alginate-based microspheres were formulated and tested for their potential activity against colon cancer. Physicochemical characterizations such as size, surface morphology, entrapment efficiency, drug loading, drug release kinetics pattern, FTIR, XRD, DSC, TGA, antioxidant study, and in vitro biodegradation study were conducted. A cytotoxicity study against HT29 using different assays was performed. In-vivo studies in Swiss albino mice were carried out to determinethe pharmacokinetic study and distribution pattern of microspheres.Lastly, the stability of the microspheres was evaluated. The microsphere was spherical with a mean diameter of 568.33 ± 45.76 µm and drug entrapment efficiency of 45.91 ± 2.94%. In vitro dissolution study of the microsphere exhibited negligible release in 0.1 N HCl (pH 1.2) and followed by 100% release in phosphate buffer (pH 7.4) within 24 hours. In vitro, cytotoxicity assay (MTT) of formulation F_6 on HT29 human colon cancer cell line indicated inhibition of the proliferation of tumor cells over a longer time. The accelerated stability study exhibited negligible changes in the physicochemical properties of the storage microsphere. An oral acute toxicity study did not cause any toxic signs, or symptoms in the rat model up to 14 days of the observation period. Evaluation of pharmacokinetic activity, biodistribution study,biomarker test, and anticancer activity in mice models showed that optimized formulations have higher efficacy compared to free capecitabine. In conclusion, capecitabine-loaded natural polymers based on formulated micro spheres exhibited drug targeting exclusively to the colonic site, without its premature release.

Keywords: Gum odina; Capecitabine; Acute toxicity study; Stability study; Anticolon cancer.

Functionalization of Dopamine with Amino sugar for Advanced Applications

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Abstract

Drug delivery has advanced significantly in the last few decades. The main obstacle for every medication delivery is biocompatibility and acceptance since synthetic materials interact considerably differently with human body cells than biological ones do. The prime challenge in drug loading is to find compatibility between the polymer and the drug and to deliver the drug to its specific site for better and improved results than the techniques that were used earlier. Polymeric nanoparticles' potential as drug delivery systems has undergone substantial research in the pharmaceutical and medical areas because of their controlled and sustained-release capabilities, sub-cellular size, and biocompatibility with tissue and cells. polydopamine-modified nanoparticles have diverse drug loading strategies because of their exceptional adhesiveness, outstanding biocompatibility, low synthesis needs, high photothermal conversion capacity, and liability to deterioration, which have been sought after as drug carriers. Here, we report a strategy to modify the polydopamine nanoparticles with high loading efficiency. In this work, we functionalise the polydopamine nanoparticles with the glucosamine amino sugar in order to load an antibiotic drug on it. An easy and manageable procedure was used to prepare polydopamine-conjugated glucosamine nanoparticles. The functionalization has been characterized by various techniques (UV, FTIR, and XPS). The XPS and FTIR results have confirmed the conjugation of an amino sugar functional groups with the polydopamine reactive groups. The nanoparticles were then further loaded with an antibiotic drug and their drug loading study was evaluated using an UV spectroscopy which showed a significant loading efficiency within 48 hours. Further, we aim to study the loading capacity at different pH conditions as well as their drug release profile will be investigated.

Keywords: Polydopamine; Antibiotic; Drug loading efficiency; Glucosamine; Drug delivery; Nanoparticles.

Synthesis and Characterization of Spinel Zinc Ferrite Nanoparticles for Photocatalytic Applications

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Abstract

Spinel zinc ferrite nanoparticles have gained considerable attention in recent years as promising photocatalytic materials. This abstract provides a concise overview of the synthesis, characterization, and potential applications of spinel zinc ferrite nanoparticles in the field of photocatalysis. The synthesis of spinel zinc ferrite nanoparticles involves various synthetic approaches, including co-precipitation, that are employed to precisely control the particle size, composition, and crystalline structure and enhance the photocatalytic performance of the nanoparticles. Characterization techniques such as X-ray diffraction (XRD), scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDX), and UV-Vis spectroscopy are employed to evaluate the structural, morphological, optical, and surface properties of spinel zinc ferrite nanoparticles. XRD analysis confirms the formation of a well-defined spinel crystal structure with the desired composition and high crystallinity. SEM images provide detailed insights into the nanoparticle size, shape, and distribution, enabling a thorough understanding of their morphological characteristics. EDX analysis ensures the elemental composition of the nanoparticles, while UV-Vis spectroscopy determines their absorption characteristics and bandgap energy, which are crucial parameters for photocatalytic applications. The unique properties of spinel zinc ferrite nanoparticles make them highly promising for photocatalytic applications. With their narrow bandgap energy and efficient charge separation abilities, these nanoparticles demonstrate excellent photocatalytic performance in the degradation of various organic pollutants, highlighting their potential for environmental remediation. Furthermore, the inherent stability, low cost, and facile synthesis process of spinel zinc ferrite nanoparticles make them attractive for large-scale industrial applications. In conclusion, the synthesis and characterization of spinel zinc ferrite nanoparticles for photocatalytic applications offer exciting prospects for sustainable environmental remediation. The photocatalytic results show that the spinel zinc ferrite sample can degrade (CR) dye solution up to 70% and methylene green dye solution up to 33% after 5hr under simple visible light irradiation.

Keywords: Spinel zinc ferrite nanoparticles; Photocatalysis; Synthesis; Characterization; Environmental remediation.

PDA-coated Iron Oxide Nanocomposite Stability in Biological FluidsunderDifferent Physiological Conditions

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Abstract

Nanoparticles in biomedical applications must be stable at various physiological temperatures and pH. Here we have studied the behavior of biological fluids withPolydopamine-coated iron oxide nanoparticles (PDA@Fe_3O_4) for their use in biomedical applications. This study investigates the stability of PDA@Fe_3O_4 nanocompositein different biological fluids. The co-precipitation method was used to prepare the iron oxide nanoparticles and then modified with polydopamine (PDA).Various techniques, including UV-spectroscopy, FT-IR, DLS, TGA, XRD, and XPS, confirmed the formation of the PDA@Fe_3O_4 composite.The UV-spectroscopy technique has been used to demonstrate the stability of composite based on observing the variation over time. The composite's stability was examined over sevendays at different temperatures and pH. Results demonstrated that the stability of the composite material was influenced by the durationof exposure, temperature, and pH conditions. PDA@Fe_3O_4 composite shows stability in both plasma and human serumat all temperatures, but the composite exhibited high stability in low-temperature conditionscompared toroom temperature and physiological temperature. The overall stability of nanocomposite in plasma at three different temperatures was more than inhuman serum. Findings from this study contribute to understanding PDA@Fe_3O_4 composite stability in biological fluids because nanoparticles show unpredictable behavior in the biological environment. Transferring NPs in complex biological environments may result in aggregation and formation of protein layers on nanoparticle surfaces. These changes affect the Np's functionality and behavior in the biological medium. Such insights from this study are crucial for knowing the composite's potential suitability for biomedical applications, including targeted drug delivery systems and diagnostic imaging.

Keywords: Polydopamine; Iron oxide nanoparticles; Plasma; Human serum.

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Verifying the compliance of a General -Purpose Microcontroller with the IEEE (JTAG) 1149.1 Standard

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Abstract

Boundary scan testing is a widely used technique in the semiconductor industry for testing and debugging integrated circuits. The objective of this article is to describe the design (components) of a general-purpose microcontroller and explaining the process to check the compliance of design with the IEEE 1149.1 Standard, which is the basic standard to describe the interconnections and placement of the components in a design for its better testing. The implementation process involves identifying the key digital components that need to be included in the boundary scan chain & analyzing the microcontroller's architecture. The article discusses the challenges encountered during the implementation and verification process and proposes solutions or work arounds. The compliance is successfully proved for a sample design of a general-purpose microcontroller. Overall, this showcases the importance and benefits of implementing a design of a general purpose microcontroller in compliance with IEEE 1149.1 Standard.

Keywords: Boundary scan testing; IEEE 1149.1; Compliance; Microcontroller; Scan chain.

Structural, Magnetic and Dielectric Properties of Fe2O3 modified CuO Composite

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Abstract

P-type nano-crystalline semiconductors have drawn a lot of interest in recent year because of their potential uses in numerous industrial applications in field of microelectronic industry. CuO is a transition metal oxide-based semiconductor with a small band gap (1.2-1.5 ev), has received particular attention. CuO is unique and beneficial for a wide range of applications, including photochemical cells, gas sensors, biosensors, solar cells, and nano-catalyst devices. Recent studies have shown that CuO provides significant potential in the realm of microelectronics because of its extraordinarily high dielectric constant. It has been reported in literature that synthesis methods impact on particle size and dielectric behavior of CuO. These are so many synthesis methods to synthesize CuO reported in literature such as sol-gel and sono-chemical method, thermal decomposition method and precipitation method. According to Zhu et.'s investigation into the structural characterization of CuO nano- particles created by microwave irradiating copper (II) acetate and sodium hydroxide as starting material, the particles have a regular form , a limited size distribution, and a high degree of purity. Kim et al. investigated the structural, optical, and electrical characteristics of CuO nano-particles with a monoclinic structure [1]. In this paper, we report impact of Fe2O3 on structural, Magnetic and Dielectric properties of $_{1-x}CuO_xFe_2O_3$ composites where x = 0.05, 0.10, 0.15 and 0.20. Composites of CuO and Fe_2O_3 in above mentioned stoichiometric proportion have been synthesized using mechanical mixing method. The polyvinyl alcohol (PVA) as binder was mixed in powder of CuO-Fe_2O_3 composites. The PVA mixed powder pressed into circular disc for sintering at different temperature to study effect of temperature on various physical properties. X-ray diffraction peaks reveals presence of both structural phases of CuO and Fe_2O_3. The FESEM micrographs shows grain growth of sintered composites whereas Energy Dispersive X-ray spectroscopy confirms presence of elements as per stoichiometric proportion. The saturated magnetic hysteresis reveals presence of magnetic ordering whereas room temperature dielectric data shows effect of Fe_2O_3 on dielectric properties of CuO.

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Controlled release of Ofloxacin through Polydopamine modified ninhydrin nanocomposite

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Abstract

The drug encapsulation with biodegradable polymeric material has grown dramatically in recent years.The encapsulation of medicine within a polymeric matrix improves stability, reduces toxicity, and allows the drug to be released in a targeted and controlled manner. . The Polydopamine (PDA) has a great impact as a novel drug delivery system since of its biodegradability, biocompatibility, hydrophilicity, low cytotoxicity effects, thermal stability, robust adhesion properties. For this purpose, polydopamine nanoparticle was developed and modified with ninhydrin. The wet adhesion property of PDA along with ninhydrin which helps to track the drug carrier.This modification allows for targeted and specific delivery of the drug, thereby enhancing therapeutic efficacy.The developed nano-composite was characterized with ultraviolet-visible (UV-Vis) spectroscopy and Fourier Transform Infrared (FTIR) Spectroscopy which confirmed the presence of various functional groups. Further zeta potential study also confirmed surface charge properties and XPS confirmed the elemental composition of prepared nanoparticles. Thenloading of antibiotic drug ofloxacin at different parameters was investigated. In the future, the ninhydrin-modified polydopamine system holds potential for applications in cancer therapy and other medical fields. Its target specificity and non-toxic effects make it a promising candidate for targeted drug delivery, which can enhance the effectiveness of treatment while minimizing side effects. Further research will be conducted to investigate the release profile of the loaded drug and explore its potential in various medical applications.

Keywords: Polydopamine; Ninhydrin, Ofloxacin, Drug encapsulation; Antibiotic.

Vibrational Spectroscopic Properties of Activated Charcoal embedded Polyaniline Nanocomposites

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Abstract

Activated charcoal (AC) embedded polyaniline-based nanocomposites were synthesized using the chemical oxidative polymerization synthesis route in their emeraldine salt form.For the growth of nanocomposites, the four concentrations of activated charcoal i.e.,2, 4, 6 and 8 wt.% were added in the polyaniline (PANI) matrix. The growth of desired samples and vibrational spectroscopic properties were examined through the Fourier transform infrared (FTIR) spectroscopy. FTIR spectra of prepared samples contains all the essential fundamental bands of PANI which confirms the growth of desired samples. The band situated around ~1140 cm^{-1} is associated with the delocalization of electron and this band directly linked with the conductivity of the samples. The area under this band increased with the increases in loading concentration of AC in PANI matrix which indicates the enhancement in electrical conductivity. Moreover, another doublet situated at ~1470 and 1560 cm^{-1} is an essential for in the FTIR investigations. The band situated around ~1470 cm^{-1} is associated with the benzenoid rings i.e., the polaronic states (A_P) and band situated around ~ 1560 cm^{-1} is associated with the quinoid rings i.e., bipolaronic states (A_B). If the ratio ofarea under the curves of bipolarons to polarons (A_B/A_P) increases the conductivity of samples also increases. In the present case, this ratio increases from 0.98 to 1.27 with the increase in loading concentration from 0 to 8 wt.% which further indicates the enhancement in electrical conductivity. The higher electrical conductivity of presently prepared samples evident to utilization of prepared samples in various electrical applications.

Keywords: PANI; Activated charcoal; FTIR; Benzenoid; Quinoid.

Multilayer ZnO/MgO Deposited Thin Films forUV Detectors Applications

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Abstract

ZnO and MgO multilayer thin films were prepared using the sol-gel spin coating technique. Alternating layers of zinc oxide (ZnO) and magnesium oxide (MgO) form multiple layers of structures which provide potential applications for UV detectors applications. These multilayer thin films use the special characteristics of ZnO and MgO, such as ZnO's wide band gap and MgO's tunable energy levels, to effectively absorb UV radiation and provide optimal charge separation. The solution was prepared using methanol solvent, and starting precursors magnesium acetate tetrahydrate and zinc acetate dihydrate were utilized. The deposited films were examined for their structural, morphological, and optical characteristics using a Powder X-ray diffractometer (PXRD), scanning electron microscope (SEM), Energy dispersive X-ray analysis (EDAX), and UV-VIS spectrophotometer. The solution was deposited on glass substrates, and Mg-doped ZnO films were grown and post-annealed at 400°C. The UV absorption coefficients measurements demonstrate the wide optical band gap of Mg-doped ZnO films has been found to be in the range of 4.8 to 5.4 eV which is applicable for UV detector applications like active layers, photodiodes, and waveguides.

Keywords: Sol-Gel; Spin Coating; UV Detector; Wide Band Gap.

CTAB and $[MoO4]^{2-}$based MOIFs: As adsorbent for methylene blue dye

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Abstract

Inorganic-organic hybrid (IOH) compounds are being widely used in the design of multifunctional materials owing to their rich properties and flexible assembly. Here, we report metal organic ionic frameworks (MOIFs)/ IOH for the adsorption of methylene blue (MB) organic pollutant, synthesized via simple ion-exchange mechanism in water using cetyltrimethylammonium bromide and ammonium molybdate These were characterized through powder XRD, and FTIR techniques. MOIFs have shown the adsorption of toxic pollutants investigated through thermal kinetics and activation parameters which inferred about the interaction between adsorbate and adsorbent as characteristics for the adsorption system. More than 90% adsorption of MB was noted for three adsorbent cycles.

Study of dynamic activity and image parameters obtained from laser-based imaging of solutions containing gold metal nanoparticles of different morphologies

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Abstract
It is important to develop a cost-effective way to distinguish between nano particles of different size and morphologies during synthesis. This paper discusses the use of laser speckle image processing to compare four different gold nano particles. A coherent laser beam passing through an optically rough medium results in speckle patterns on the plane of observation. This pattern is formed due to the scattering of the beam by the dynamic particles present in the medium. Gold nano particles of different morphologies (Nano sphere 20nm and 100 nm, nano rod 20nm, nano urchin 100 nm) aresuspended in deionized water as solvent at the same concentration (591 mg/mL). The samples are illuminated by a low power laser. The back-scattered light is captured by a camera lens setup. The scattered intensity, entropy and inertia moment values representing the dynamic activity of the solution are obtained for the four samples. The dynamic activity is maximum for gold nano sphere (100nm) followed by gold nano urchin, gold nano rod and least for gold nano sphere (20nm). The experiment is repeated with imaging lasers of wavelengths 632.8 nm (Helium-Neon) and 532 nm DPSS laser. Concurring results were obtained.

Keywords: Nano-metrology; Nano-morphology; Laser speckle imaging.

Spectroscopic investigation of newly synthesized 2-(6-hydroxy-3-oxo-5-((2,4,6-trichlorophenyl)diazenyl)-3,9,9a,10-tetrahydroanthracen-9-yl)benzoic acid molecule

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Abstract

In this report the spectroscopic property of the 2-(6-hydroxy-3-oxo-5-((2,4,6-trichlorophenyl)diazenyl)-3,9,9a,10-tetrahydroanthracen-9-yl)benzoic acid molecule was studied. The molecule belongs to the well-known fluorescein family. The titled molecule was synthesized used standard protocol, fluorescein, ethanol, and aniline chemicals are used as starting materials and the spectroscopic property such as the Nuclear magnetic resonance, Fourier transform infrared spectroscopy techniques were performed in order to confirm the structural behavior. From the proton NMR studies we can infer that the molecule exhibited the 9 proton signals for the final compound. We have observed 04 peaks in the frequency range 4000 to 3000 cm^{-1} exhibits O-H stretching vibrations due to the presence of alcohol group at and C-H bending groups due to the presence of aldehyde group at 1500 to 1000 cm^{-1}, and N-H stretching group at 3000-3500 cm^{-1} due to the aniline group in the molecule. From the results obtained we can infer that the synthesized molecule is stable and the bond angles and bond lengths were stable in the molecule.

Keywords: Organic; NMR; FTIR.

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Synthesis, physical and optical characteristics of TeO_2-B_2O_3-Bi_2O_3-$SrCl_2$ glasses

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Abstract

An exploration was undertaken to examine the physical and optical traits of a quaternary glass system utilizing tellurium dioxide as its primary component. The glasses were prepared with $60TeO_2$-$15B_2O_3$-$(25-x)Bi_2O_3$-$xSrCl_2$ molar compositions, where x varied from 5,10,15, and 20 mol%. The utilization of X-ray diffraction interpretation verified the amorphous nature of the glasses. Several physical properties were measured, encompassing density (ρ), molar volume (Vm), and oxygen packing density (OPD). It was observed that the density decreased (from 5.301 to 3.542 g/cm^3) as the heavier molar mass of bismuth (III) oxide was replaced with the lighter molar mass of strontium chloride. Consequently, the glass matrix became less dense. The molar volume increased (from 40.129 to 51.612 cm^3/mol) with higher strontium chloride content. The addition of strontium chloride decreased the oxygen packing density (from 56.069 to 34.875), reducing the number of oxygen atoms in the glass sample. The optical properties were analyzed through the Ultraviolet Absorption spectrum. The cut-off wavelength (λ_c) decreased (from 442 to 359 nm) as the strontium chloride content increased. With increased strontium chloride content, the prepared glasses show cased indirect transitions in their energy band gaps. Additionally, the values of the indirect band gap energy (E_{opt}) experienced an increment from 2.02 to 2.95 eV. The Urbach energy (ΔE), which characterizes the disorder in the glass structure, decreased (from 0.288 to 0.270 eV) with increasing strontium chloride concentration, indicating a lower defect concentration. The molar refractivity values ranged from 26.82 to 31.79, reflecting the polarizabilities of the constituent ions. The glasses demonstrated a metallization criterion within the range of 0.332 to 0.384, indicating their promising suitability for applications in the realm of non-linear optical devices.

Surface modification of electrospun PVA/Gelatin nanofibers at atmospheric pressure using dielectric barrier discharge plasma to study the mechanical properties

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Abstract

Atmospheric dielectric barrier discharge is a promising technique for surface modification of biomaterials due to the ability to manipulate the chemical and physical properties of material surfaces at ambient temperature without altering the bulk properties of the materials. The purpose of this work is to prepare electrospun PVA/ Gelatin nanofiber mats followed by A-DBD plasma treatment and observed the change in mechanical properties nanofibers and plasma-induced surface properties. Plasma treatment of electrospun PVA/Cs nanofibers is carried out with reactive (oxygen, O2) gases at atmospheric pressure.

The mats were obtained by electrospinning, and it consists of Gelatin with 12% polyvinyl alcohol (PVA), prepared at an optimal ratio (v/v, Gelatin/PVA). A-DBD plasma treatment of the Gelatin/PVA mats are carried out with oxygen at atmospheric pressure. Studies on the surface characteristics of the mats were carried out to check any changes on the mats, before and after the plasma treatment. The changes are analyzed by water contact angle measurement showing change in surface roughness after plasma treatment, Tensile Strength and Young's modulus was measured to evaluate the physical properties of the mats. X-ray diffraction is used to determine change in the crystallinity of the mats before and after the plasma treatment is done. The results suggest that the A-DBD plasma treated electrospun PVA/ Gelatin nanofiber mats can have potential in biomedical field.

Keywords: Poly (vinyl alcohol); Gelatin; Nanofiber; Plasma surface modification; Dielectric barrier discharge.

Characterization of *Calamus tenuis* (Jati Bet) Cane Fibers as a Potential Reinforcement for Polymer Composites

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Abstract

This study explores and evaluates the physical, structural, chemical, thermal, mechanical, and morphological characteristics of *Calamus tenuis* cane fibers to find the place of these fibers as reinforcements in polymer composites. Through chemical analysis, it is confirmed that these fibers contain approximately 37.43 ± 1.40% cellulose, 31.06 ± 1.03% hemicellulose, and 28.42 ± 0.81% lignin. The presence of these constituents is further validated using Fourier Transformed Infrared Spectroscopic (FTIR) analysis. In order to assess the crystalline structure of the fibers, X-Ray diffraction (XRD) analysis is employed. The results of this analysis indicate a crystallinity index of 37.38 ± 0.27% and a crystallite size of 2.73 ± 0.12 nm for the *Calamus tenuis* cane fibers. These findings provide valuable insights into the arrangement and organization of cellulose chains within the fibers. The results of Thermogravimetric analysis (TGA) demonstrate that these fibers exhibit thermal stability up to a temperature of 210 ± 5°C, suggesting their suitability for applications involving elevated temperatures. Tensile properties of the *Calamus tenuis* canes are estimated using Weibull distribution analysis. This analysis reveals a tensile strength of 37.5 ± 2 MPa, Young's modulus of 1.05 ± 0.08 GPa, and an elongation at break of 18.94 ± 4.26%. Furthermore, the morphology of the fibers is examined using Scanning Electron Microscopy (SEM) micrographs and Atomic Force Microscopy (AFM) analysis. The obtained images confirm the roughness of the fibers' outer surface. This roughness indicates the potential for enhanced adhesion between the fibers and the polymer matrix during composite fabrication.

Keywords: *Calamus tenuis* cane fibers; Chemical analysis; Thermal analysis; Mechanical properties; Morphological properties.

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Physical and optical properties of copper-modified bismo-borovanadate semiconducting glasses

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Abstract

The melt-quench technique was utilized to synthesize copper-modified bismuth borovanadate (50-x) V_2O_5-40 B_2O_3-10 Bi_2O_3-xCuO, where x=5, 10, 15, 20 & 25 mol% glasses. X-ray diffraction technique was used to ascertain the amorphous nature of synthesized samples. The characteristics of processed samples were evaluated by employing a density measurement kit and UV-Visible spectroscopy. An analysis was conducted to examine the changes in physical parameters, including density (ρg), molar volume (Vm), Crystalline volume (Vc), and Oxygen packing density (OPD) in relation to increasing concentrations of copper oxide in as prepared glass samples. In addition, other physical parameters such as interionic distance (Ri), Cu^{2+} ions concentration (N), polaron radius (Rp), and copper yield field (F) were determined. Density (ρg), Cu^{2+} ions concentration (N), and copper yield field (F) were showing increasing trends while molar volume (Vm), Crystalline volume (Vc), interionic distance (Ri), and polaron radius (Rp) all decreased with rise in CuO content. Optical band gap computed from UV-Visible spectroscopy showed an increasing trend with copper oxide concentrations. Further, calculations were conducted on additional parameters, including optical refractive index (n), optical basicity (ʌth), electron polarizability (αe), and metallization criterion (Mc). The glasses analyzed in this study demonstrated a significant refractive index range of 3.069- 3.217, metallization criterion range of 0.242-0.262 and optical basicity range of 1.514-1.541. These findings suggest that the synthesized glasses exhibit favorable characteristics, making them promising candidates for optoelectronic devices.

Lignocellulose from wood waste: Extraction & characterization

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Abstract
The need to both avoid waste production and find new renewable resources has led to new research based on the possibility. Herein, we report an extraction and characterization of lignocellulose from Medium density fiberboard (MDF) waste. MDF is a good source of lignocellulosic referring to its main constituent biopolymers: cellulose, hemicellulose and lignin. The study revealed that a facile in situ lignin regeneration strategy to synthesize a high-performance lignocellulosic resources. The porous matrix of MDF is deconstructed in this process to yield a homogeneous cellulose-lignin slurry entanglement and hydrogen bonding between the regenerated lignin and cellulose microfibrils. The extracted lignocellulosic from MDF was characterized by using FTIR. This in situ lignin regeneration technique, which uses simply green and recyclable chemicals, provides a viable path towards generating lignocellulosic materials. We used biodegradable and recyclable deep eutectic solvent (DES) a family of green solvents with properties of both ionic liquids and organic solvents to deconstruct the loose and porous structure of the MDF powder. The basic concept is to utilize the waste from furniture industry and convert it into useful material for made of Bioplastics by a simple process.

Keywords: MDF Waste; Lignocellulose; In situ regeneration; Green solvent; FTIR.

Extraction of mango seed starch and its characterization – A sustainable alternative to plastic packaging industry

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Abstract

Reducing environmental pollution and obtaining benefits based on utilization of waste materials are drivers for the implementation of greentechnologies. Starch is a versatile candidate witha wide range of application potential. Mango seeds are the by- product of mango industry and that their starch content makes them a probable source of valuable raw material. The present study is concerned with the isolation of starch from mango seed. The extracted starch from mango seed was characterized via FTIR, SEM and XRD. The characteristic peaks of starch at 1082.7cm^{-1} and 761 cm^{-1} corresponds to C-C stretching vibrations and C-O-C ring vibrations respectivelyof the polysaccharide molecules. The extracted starch was also subjected to scanning electron microscope analysis. Lastly the isolated starchwas also analyzed by X-ray Diffraction that reflects its amorphous pattern. This study provides new insights into the potential of mango seeds as a source of promising material, and the findings could have important implications for the plastic packaging industries.

Keywords: Starch; Mango seed; Packaging; Polysaccharide.

Comparative assessment of structural, magnetic and impedance properties of $xLaMnO_3$-(1-x)$BiFeO_3$ solid solutions

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Abstract

The material $BiFeO_3$ (BFO) is extensively researched due to its composition without lead, high ordering temperature, remarkable polarization, and useful electric and magnetic switching mechanism for data storage devices. On the other hand, the super-exchange ordered system of $LaMnO_3$ (LMO) is well-suited for fuel cells. This study examines the structural, magnetic, and impedance properties of a solid solution composed of phase-separated BFO and LMO. The solid solutions $xLaMnO_3$-(1-x)$BiFeO_3$, where x = 0.05, 0.10, and 0.20, were prepared using solid state reaction method. X-ray diffraction (XRD) technique, Vibrating Sample Magnetometer (VSM), and Impedance analysis were used to investigate the changes in structural parameters, magnetic ordering, and electric properties, respectively.

Keywords: $BiFeO_3$; $LaMnO_3$; XRD; VSM; Impedance.

A Study on the effect on its mechanical properties of areca fiber reinforced recycled LDPE composite

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Abstract

Areca fibers possess superior properties like being light weight, strong and having a high strength-to-weight ratio. Further, areca fibers are biodegradable, non-toxic and eco-friendly and have low maintenance cost. The areca husk is a hard fibrous material covering the endosperm and constitutes about 60–80% of the total weight and volume of the areca fruit. The husk fiber is composed of 55.82% cellulose, 34.28% hemicelluloses, 6.82% lignin 1.80% moisture content and 1.28% ash content. In general, the hydrophilic nature of natural fibers and polymer matrix results in incompatibility between the fibers and matrix and further leads to poor interfacial bonding between the fibers and matrix. This, in turn, causes inferior properties to the natural fiber reinforced polymer composites. Further, there is improvement on mechanical characteristic (tensile strength and impact strength) of surface modified natural fiber reinforced polymer composites. The main objective to develop the recycled LDPE composite with Areca fibre which increase the Mechanical properties of the composite and give the maximum strength.

Keywords: Areca fibers; Recycled LDPE; Mechanical properties.

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Environmental and biomedical applications of Copper doped Zinc oxide nanoparticles synthesized using galactomannan as bio-template

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Abstract

Green methods for the synthesis of nanoparticles and nanocomposites have gained a prominent place in the field of material sciences, as it reduces the hazards associated with chemical procedures. The current study involves biopolymer assisted synthesis of Copper (Cu) doped Zinc Oxide (ZnO) nanoparticles (NPs) and their applications as a photo-catalyst for degradation of azo compounds and anticancer agent against lung cancer and ovarian cancer cell lines. Here, the polysaccharide Galactomannan was used as the bio-template for nanoparticles synthesis via solution combustion method. The nanomaterial was characterized through X-ray Diffraction (XRD), Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM) with Energy Dispersive X-ray Analysis (EDX), and Fourier Transfer Infrared Spectroscopy (FTIR). The Cu doped ZnO NPs showed enhanced photocatalytic property with 97.60% degradation of methylene blue, a model azo dye. The NPs also caused cell death and prevented cell migration in ovarian and lung cancer cell lines in cytotoxicity and wound healing studies. The percentage cell death was 45 and 42 at a concentration of 31 µg/ml in lung cancer and ovarian cancer cell lines, respectively using 4% Cu doped ZnO nanoparticles. Wound healing experiments lung cancer cell lines demonstrated that nanocomposite have strongly reduced cell migration at dose low as 61 µg/ml.

Keywords: Green approach; Galactomannan; Biotemplate; Cu doped ZnO; Photocatalysis; Anticancer agent.

Extraction of Orange Essential Oil in Coconut Oil and its Possible Applications

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Abstract

This study depicts the extraction of the essential oil of orange in coconut oil, followed by GC-MS analysis of the prepared sample. Essential oil extraction and processing have captured a lot of curiosity because of the potential applications in a number of sectors, especially aromatherapy and cosmetics. The extraction method employed is solvent extraction, with coconut oil as the solvent. Due to its distinct fatty acid content and moisturizing qualities, coconut oil makes an ideal carrier oil. The resulting coconut oil-infused orange essential oil has a variety of therapeutic properties. Orange essential oil can be extracted from coconut oil and has a number of uses in aromatherapy and massage therapy. Because there is such a significant amount of orange peel trash globally, we can strive to reduce it by extracting the peels and using the waste in a useful way.

Keywords: Extraction; Orange peel; GC-MS; Aromatherapy; Therapeutic.

Sustainable Utilization of Bone China Ceramic as Fine Aggregates in Geopolymer Concrete

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Abstract

Recycling solid waste presents a financially feasible solution for protecting the environment, conserving natural resources, and reducing the consumption of raw materials. This study focuses on assessing the effects of Bone-china ceramic on the properties and performance of geopolymer concrete, which is known for its eco-friendly characteristics. Previous research has investigated the utilization of Bone-china waste (BCC) in concrete due to its pozzolanic properties. The primary objective of this research is to evaluate the workability, compressive strength, split tensile strength, and flexural strength of fresh and hardened concrete by incorporating BCC in geopolymer concrete. The replacement of natural fine aggregate (sand) with BCW was carried out at varying percentages: 0%, 20%, 40%, 60%, 80%, and 100%. Experimental findings demonstrated that each percentage of BCC replacement achieved the desired characteristic strength. Notably, the mix containing up to 60% BCC showed potential for structural applications. Furthermore, incorporating bone-china ceramic as a fine aggregate (up to 60%) in structural concrete resulted in significant strength improvements. Additionally, an empirical regression-based model was formulated to evaluate the strength of Geopolymer concrete (GPC) at different bone-china ceramic percentages.

Keywords: Bone-china waste fines; Geopolymer concrete; Regression; Sustainable development; Waste management.

Photocatalytic degradation of textile dye with titanium (IV) doped tungsten oxide nanoparticles

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Abstract

Water pollution from textile industries is a major concern with respect to the availability of clean drinking water. The Removal of textile (organic) dyes through photocatalytic degradation with pure WO_3 and titanium (IV)doped tungsten oxide [Ti (IV)-WO_3)] nanoparticles were studied under visible light. The WO_3 and Ti (IV)-WO_3nanoparticles were synthesized via microwave-assisted method at microwave power of 180 W for the duration of 10 minutes. The as synthesised WO_3 and Ti(IV)-WO_3nanoparticleswere characterized for their structural, microstructural, and spectroscopic properties by using powder X-ray diffraction (XRD), UV–Visible (UV-Vis) spectroscopy, Fourier-transform infrared spectroscopy (FT-IR), Scanning electron microscopy (SEM) and High-resolution transmission electron microscopy (HR-TEM).The X-ray diffractograms confirmed the formation of highly pure WO_3 and Ti (IV)-WO_3nanoparticles. The average crystallite size of WO_3 and Ti (IV)-WO_3nanoparticles were calculated as 53.37 nm and 35.24 nm respectively using Debye Scherrer formula. The bandgap of Ti (IV)-$WO_3$was found to be decreased to 2.5 eV from 3.2 eV (WO_3) respectively. It can be deduced that Ti (IV)-WO_3can be utilized as efficient visible light (λ>420 nm) driven photocatalyst as the bandgap was < 3eV. The agglomerated spherical nanoparticles were seen for WO_3 and Ti (IV)-WO_3nanoparticles in the SEM and HR-TEM images.The photocatalytic activity of textile dye was studied by UV-Vis spectrophotometer under visible light. The photocatalytic organic dye degradation was investigated by employingUV–Visible spectro photometer under visible light.The enhanced photocatalytic activity of titanium (IV)doped tungsten oxide was observed.It makes titanium (IV) doped tungsten oxide nanoparticles apotential nanomaterial for water purification.

Keywords: Photocatalytic degradation; Organic dyes; Microwave assisted method, Photocatalytic activity.

Investigations of structural and Luminescence spectroscopic Characteristics of Eu^{3+} doped and un-doped Ca_2CeO_4 nanophosphors for lighting applications

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Abstract

In this study Europium (Eu^{3+}) doped calcium cerate (Ca_2CeO_4) nanophosphors are synthesised by low temperature initiated solution combustion technique using citric acid as fuel. In particular influence of dopant concentration (xEu^{3+}) on emission characteristics of $Ca_{2-x}CeO_4$ (x = 0.01 to 0.11) are studied in detail. The as-synthesised powders are calcinated to 1000 °C in order to increase the crystallinity. The samples are characterized by various analytical and spectroscopic techniques such powder X-ray diffraction (XRD), field emission scanning electron microscopy (FESEM), Fourier transform infrared spectroscopy (FTIR), transmission electron microscopy (TEM) and photoluminescence spectroscopy (PL). Phase purity and morphology of the samples are studied by PXRD and SEM. From XRD it was evident that $Ca_{2-x}CeO_4$ (x = 0.01 to 0.11) stabilises in orthorhombic structure and SEM micrographs shows porous agglomerated particles. Accurate particle size determination was done by Transmission electron microscopy (TEM) and the image reveals that the average sizes of the particles are in the range of 60-80 nm. Photoluminescence (PL) studies showed dominant orange–red emission due to f-f transitions at 611 nm and 630 nm with assigned transition between 5D0→ 7F2 and 5D0→ 7F3 . The emission spectra were recorded at excitation wavelengths of 395 nm and 460 nm. The emission spectra recorded at the observed excitation wavelength and the dopant (Eu^{3+}) influences are discussed in detail.

Keywords: Energy transfer; Photoluminescence; SEM; XRD; WLED.

Categorization of Oxide Glasses along with its Uses and Advancement in its journey: A Review Paper

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Abstract

Glass is an inorganic solid material that is usually transparent, hard, brittle, and have high structural disorder i.e., these belongs to amorphous solids. It is one of the most antique materials originated by human beings. Among several materials the research on glasses has been very active because of their controllable physical properties, easy mass production at low cost, excellent homogeneity in a variety of shapes and sizes and their tremendous applications in field of optics and electronics etc. The most recent development in this field is glass ceramic materials which leads enormous applications in future. In this paper we will became familiar with different classes of glass and their applications and different glass theories, although this empirical hypothesis describes the glass formation in some co-related manner, but a uniform approach capable of satisfying all the above explanations is yet to be developed.

Keywords: Ceramic materials; Oxide glasses; Transition temperature.

Study of Structural and Luminescence Spectroscopic characteristic in Dy^{3+} doped Zn_2SiO_4 phosphor for LED applications

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Abstract

In this work, we have reported synthesizedZn_2SiO_4 phosphor doped with different concentrations of the Dy^{3+} ion using solution combustion method.We have been usedoxalyldihydrazide(ODH) as fuel. The prepared samples were characterized using Powder X-ray Diffraction (PXRD method), Transmission electron microscopy (TEM), Field Emission Scanning Electron Microscopy (FESEM), Fourier Transform Infrared Spectroscopy (FTIR) and Photoluminescence (PL) spectroscopy. PXRD analysis confirms that Zn_2SiO_4 forms hexagonal phase at 1100 °C without any impurities. FESEM shows that morphological features of the samples.The excitationcharacteristic spectra were recorded at 570 nm emission. The photoluminescence emission spectra of Dy^{3+}doped Zn_2SiO_4 phosphor were recorded upon excitation at 350nm.From theseresults we can expect that the prepared phosphors can be considered as potential candidates for applications in UV/NUV excited white LED’s.

Keywords: Zn_2SiO_4; Nanophosphor; Photoluminescence.

Phytochemical screening of *Vitex Negundo*leaf extracts and its role in green synthesis and anti microbial properties of silver nanoparticle

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Abstract

The rise in drug resistance shown by human pathogenic bacteria become a clinical crisis from all over the world. In order to control the situation, it is essential to develop alternative drugs for the treatment of infectious diseases. Recent advancement in the field of green synthesis has enabled the development of alternative drugs. The work described in this paper details the phytochemical screening and biological investigation on Vitex negundo leaf extracts, which is already used in treatment of several diseases. Phytochemical screening of the aqueous extract of Vitex negundo leaves reveals the presence of phytochemical constituents like carbohydrates, alkaloids, tannins, saponins, and flavonoids. The antibacterial activity of water, acetone and alcohol extracts were tested against human pathogenic bacteria such as Staphylococcus aureus, Escherichia-coli and Klebciella pneumonia by adopting a disc diffusion method. Compared to other extracts, water extract of vitex negundo shows the greatest inhibitory action against Staphylococcus aureus. Biologically synthesized silver nanoparticles also exhibit greater inhibitory action against Staphylococcus aureus. The results suggested that the leaf extract of Vitex negundo and the silver particle prepared from the leaf extract indeed possessed significant antimicrobial activity against all the bacteria tested but in both cases the effect was greater towards S aureus.

Design of Electronic-ink based IoT Message Board

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Abstract
Information Displayshas madeprogressto enable oneto even readthis article.LiquidCrystal Displays and Organic Light Emitting Displays, in use today can be replaced byreflective displays like electronic ink. Unlike emissive displays, electronic ink displays havevery less power consumption as well reduce eye strain while reading. It does not have in-builtbacklight and power is needed to only change the contents of the screen. In order to realize areal-time applicationusing thedisplay, anIoT modelwasdeveloped.Thepurpose of thesame was to develop an IoT message board which could display the text that was inputthrough a Google Sheet. The electronic ink display was connected to the Raspberry Pi 3B Computer which enabled to compile and run the Python code used in this regard. The GoogleSheet data was fetched and sent to be printed on the display. Without considering the time lag, the data was successfully displayed on the electronic ink. The bi-stability property means thatthe contents of the screen will be retained even when the power source is removed. This waswell observed in our model as well. It imitates paper features. It is used in price tags in retailstores, signboards and e-readers. While it started as monochrome displays, it has expanded tocolour displays. Automobiles whose external color can be modified using this technology is arecent advancement. It has potential to be a sustainable alternative to existing Information Displays.

Keywords: Reflective display; Electronic ink; Bi-stability; IoT message board.

Tuning the defect density in zinc oxide nanoparticles using cobalt doping

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Abstract

This work focuses on the low-temperature synthesis of cobalt-doped zinc oxide nanoparticles using a simple solution process and the as-prepared cobalt-doped Zinc Oxide nanoparticles (ZCO Nps) with doping concentrations (0.01M, 0.03M, and 0.05M) are coated on a stainless-steel form used as photoanodes for electrochemical measurements in an electrochemical work station. The Mott – Schottky analysis was performed for cobalt-doped samples to obtain information about the flat-band potential of a semiconductor, and its donor concentration N_D for an n-type semiconductor photoanode or acceptor concentration N_A for a P-typesemiconductor photoanode. Using this method, it is possible to find out the conductivity (P-type or N-type) of the samples, after doping. The results are further confirmed with Photoluminescence spectroscopy and Raman spectroscopy.

Keywords: Cobalt-doped Zinc Oxide Nps; Mott-Schottky Analysis; Donor density; Flat band potential.

Review on Bottom-up and Top-down Nanofabrication techniques

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Abstract

Advancements in various fields, including electronics, photonics, and biomedical applications, are made possible by the production and manipulation of nanoscale structures, which is made possible by nanofabrication techniques. Nanofabrication today is done using two different techniques: bottom-up and top-down. The ideas, benefits, and applications of bottom-up and top-down nanofabrication techniques are examined in this review of the literature. The review starts out with a description of bottom-up nanofabrication methods, which entail assembling and synthesizing nanoscale structures out of smaller constituent parts. The ability to create complex nanostructures with exact control over composition, morphology, and size is highlighted by the exploration of a number of techniques, including self-assembly, atomic-layer deposition, and sol-gel. Bottom-up approaches, benefits and drawbacks, including those related to scalability and reproducibility, are examined along with their uses in nanoelectronics, nanophotonics, and nanomedicine. The article then goes into top-down nanofabrication methods, which entail modifying bigger structures to produce characteristics at the nanoscale. Among the popular methods covered in this area are different lithography techniques, and molding. Their operating principles, resolution capacities, and fabrication constraints are briefly discussed by the review. The top-down and bottom-up techniques are contrasted in order to show their relative advantages and disadvantages. It is also investigated how bottom-up and top-down strategies might work together to form hybrid nanofabrication methods that take advantage of the best aspects of both approaches. Concluding with discussion of nano fabrication's present tendencies and potential in the future. It is underlined how improvements in nanofabrication methods could spur innovations in fields including nanoelectronics, energy storage, and biosensing.

Synthesis and Characterization of PVA-KOH Based Polymer Gel Electrolyte for solid state supercapacitor application

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Abstract

Supercapacitor are considered as the most promising electrochemical energy storage device. Practically supercapacitor needs to be highly safe and good in electrochemical performance. To date, mainly liquid electrolytes are employed for supercapacitor. Replacing them with gel polymer electrolytes will improve the safety, as it can solve the electrolyte leakage and corrosion. In present work, simple and cost-effective solution casting method has been carried out for the synthesis of large scale. Uniform gel electrolyte membranes with uniform pore size and high ionic conductivity for a quasi-solid-state supercapacitor. In this work, we have investigated effect of KOH and KI addition in PVA on ionic conductivity of gel electrolytes and activated carbons electrodes.The surface analysis of the membranes was studied by using XRD, FTIR, SEM, Optical images and EDS characterization tools. XRD pattern reveals amorphous gel formation. Optical images and SEM micrographs reveals very small pores and uniform matrix of PVA with alkali (KOH-KI) electrolytes. The elements and type of bonding present in gel electrolytes are confirmed by FTIR and EDS spectra. Further, these membranes are used for electrochemical investigation using electrochemical cell consisting of carbon electrodes and gel membrane as a separator with Metrohm Potentiostat instrument. Symmetric supercapacitor was designed using carbon-based electrodes and gel electrolyte membrane as a separator. The gel electrolyte membrane was capable to transfer ions in between electrode.

Keywords: Gel Polymer; Ionic Conductivity; Membrane; Supercapacitor; Electrochemical.

In situ analysis of Rayleigh instability in ultrathin gold nanowires

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Abstract

One-dimensional metal nanostructures are important research subjects in nanotechnology. Nanowires, which has the cross sectional dimension in nanometer range and one dimension unconfined, provide a better platform for investigating the dependence of electronic transport, optical and mechanical properties on size confinement and dimensionality. Metal nanowires represents nature's ultimate limit of conductors in one dimension and can be reduced to single atom thickness. Based on this, ultrathin metal nanowires are considered essential building blocks that can be used to construct nanoelectronic devices for applications in sensors, photonics, and waveguides. In this work, we have attempted to produce and understand the synthesis of ultrathin gold (Au) nanowires with diameter of ≈ 2 nm and micrometer level lengths. The nanowires could be synthesized employing a chemical process using the organic molecule oleylamine (OAm), Triisopropylsilane (TIPS) and AuCl as a metal precursor. UV- visible spectroscopy is employed for studying the optical absorption properties. Field emission scanning electron microscopy (FESEM), transition electron microscopy (TEM) as well as atomic force microscopy (AFM) is employed for studying the morphological properties of the nanowires. It is found that, the size and morphology of the ultrathin gold nanowires are readily controlled by changing the amount of precursor added. Correlating with observations from analysis of high-resolution transmission electron microscopy, we have studied how temperature affects the stability of nanowires and Rayleigh instability. Effect of presence of surfactant molecules on the surface of nanowires is also discussed.

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Fabrication of NiO Nanostructures as a Cathode Materials for High Performance Asymmetrical Supercapacitors

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Abstract

Asymmetric supercapacitors based on aqueous electrolytes have great attention in recent years due to their high ionic conductivity, high energy and power densities. Herein, we report the carbon-based anode that store electrical energy at the interface between the carbonaceous electrode surface and the adsorbed electrolyte layer and NiO cathode materials that provides battery type storage. In experimental part, carbon-based anode materials and nickel oxide (NiO) are prepared by Modified Hammers method and Hydrothermal synthesis method respectively. The simple, cost effective one pot hydrothermally synthesis followed by annealing produces highly reproducible and uniform sized particles. To investigate the morphological, structural and compositional properties of the synthesized materials the Scanning Electron Microscopy (SEM), X-Ray Diffraction (XRD) and Energy Dispersive Spectroscopy (EDS) were studied.

In the end, these carbon-based anodes and NiO cathode electrodes of all samples were prepared and were investigated to obtain suitable properties followed by measurement on three electrodes electrochemical set up using MetrohmAutolabpotentiostat instrument. In this part, the cyclic voltammetry (CV), Galvanostatic charge-discharge (GCD) and Electrochemical Impedance Spectroscopy (EIS) were used to estimate the charge-discharge cycles, specific capacitance and interfacial charge transfer analysis. Here the optimum combination of carbon anode and NiO flower like structures of cathode shows very good storage capacity and stability in alkali electrolyte.

Keywords: Supercapacitor; Electrochemical; Hydrothermal; Capacitance.

Crystal structure refinement of $SmCuO_{3-\delta}$ ceramic

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Abstract
We have investigated the effect of temperature on structural and optical properties of SmCu $O_{3-\delta}$ ceramic. The $SmCuO_{3-\delta}$ ceramic has been synthesized using a sol-gel route. Rietveld refinement analysis confirms that $SmCuO_{3-\delta}$ ceramic crystallizes into two phases tetragonal (*I*4/*mmm*) and monoclinic (*C*2/*c*) crystal structures. The increments in volume have been found as synthesis temperature increases. The phase fraction of the tetragonal and monoclinic phases strongly depends on the synthesis temperature. The crystallite size and particle size increase with increasing calcinations temperature.

Keywords: Crystallography; Crystal structure; Auto-Combustion; Perovskite.

In-situ growth of CuO-ZnOnanocompositefor enhancement of the photocatalyticdye degradation

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Abstract

Continuous increase in industries and rapid urbanization has coincided with the emergence of environmental contamination. Metaloxides are very challengingand emerging photocatalytic material because of their flexibility in chemical composition, band gaptuning and structural stability. Therefore, we have shown here the in-situ growth ofCuO-ZnO nanocomposite through co-precipitation technique. Room temperature XRD pattern match well with the monoclinic phase of CuO and hexagonal crystal structure of ZnO. The band gap of the synthesized material have been estimated for CuO, ZnO and CuO-ZnO composite are found to be 1.8 eV, 3.2eV and 2.75 eV respectively. Indigo carmine is categorized as an organicdye (OD) released as effluents after various industrial activities. Further, we have carried out the photo catalytic degradation of Indigo carmine dye solution under the Visible light. Absorption spectra of Indigo carmine dye degradation are recorded at every 30 minutes. The percentage degradation of the Indigo carmine dye is evaluated which confirm the degradation of the pollutant concentration upto 80 %. Therefore, CuO-ZnO might be the promising material for water remediation.

Keywords: XRD; Photocatalysis; Bandgap.

A facile modification of copper mesh for oil-water separation

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Abstract

Oily wastewater has been causing serious environmental pollution hazards for the last few decades. Herein, we have fabricated superhydrophobic/superoleophilic surfaces by modifying etched Cu meshes with different low surface energy materials such as stearic, lauric and terephthalic acid. The presence of the low surface energy materials was confirmed by the FTIR analysis. The stearic acid-modified Cu mesh showed superhydrophobicity with a water contact angle of 151.50, while the surfaces modified with lauric and terephthalic acid showed hydrophobic behavior with a water contact angle of 144.50 and 122.6 0 respectively. The stearic and lauric acid-modified Cu meshes efficiently separated the oil-water mixtures, while the terephthalic acid-modified mesh failed to separate the same. This may be attributed to the lesser carbon atoms present in terephthalic acid compared to stearic and lauric acid. Meanwhile, the stearic and lauric acid-modified Cu surfaces showed excellent reusability. Moreover, the stearic acid-modified surface exhibited superior intrusion pressure compared to the lauric acid-modified surface, which may be attributed to the superhydrophobic behavior of the stearic acid-modified surface. The excellent superhydrophobicity, separation efficiency, recyclability and superior intrusion pressure make the stearic acid-modified Cu mesh an eligible candidate for the practical field of oily water treatment.

Keywords: Superhydrophobicity; Separation efficiency; Surface energy; Reusability.

Microwave assisted synthesis of novel Cu-benzoxazine complex and their biological evaluation

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Abstract

Novel benzoxazine compounds were produced with microwave assistance and employed as ligands for Cu(II) complexes. The synthesized ligands and complexes have been analyzed using analytical methods such as NMR, LCMS, and FT-IR. To study the complexes' crystalline makeup, powder XRD was utilized. The complexes demonstrated effective antibacterial action against a variety of human illnesses caused by various pathogens. To pinpoint the crucial interactions underlying their antibacterial activity, a molecular docking research was run against the ligand complex and proteins.

Synthetic Biology: A Scientific Review of Current Developments and Future Perspectives

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Abstract

The field of synthetic biology combines principles from biology, engineering, and computer science to create novel biological systems with specific functions. It has made significant advances in engineering genetic circuits, creating biosensors and bioproduction platforms, and developing gene editing tools, with potential applications in medicine, agriculture, environmental monitoring, and energy production. The development of CRISPR-Cas9 gene editing technology has revolutionized genetic engineering, enabling scientists to modify genomes faster, more accurately, and at lower costs than previous methods. Synthetic biology faces challenges, including safety and ethical concerns, while continuing to push the boundaries of engineering biological systems. Current developments in synthetic biology include improvements and expansions of gene editing tools, creation of new biosensors and diagnostics, bioproduction, synthetic genomes, and computational tools. The field must balance innovation and responsibility while addressing ethical and safety concerns associated with the creation of novel biological systems.

Keywords: Synthetic biology; Gene Editing; Biosensors; Bioproduction; Biosequirity.

2- Propylimidazole-4,5-dicarboxylic Acid based Cu/ Co/ Ce/ Fe/ Ni complexes: Synthesis, characterization and their catalytic kinetic study

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Abstract

2- Propylimidazole-4,5-dicarboxylic Acid (1H Imidazole) used as ligands for the synthesis of their Cu, Co, Ce, Fe and Ni complexes. The ligands and their respective complexes were characterized using ^{1}H NMR, FTIR, and LCMS analytical tools. Powder XRD was used for crystalline nature of complexes. Their thermal gravimetric analysis (TGA) revealed their thermal stability up to $650^{0}C$. The ligands have been tested for their catalytical activity using *p*-nitro phenol where they have shown good reducing activity. More than 90% catalytical conversion of p-nitro phenol (PNP) to p-aminophenol has been obtained.

Keywords: Olmesartan Medoxomil; Metal, Anti-microbial; Antioxidant; XRPD.

Review on photo catalytic materials in water splitting: For hydrogen production

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Abstract

The unlimited light energy from sun provide us an opportunity to convert the solar energy from sun into the another form of energy that is chemical energy which is considered as a god and safe method to create a renewable and viable source of energy. The production of hydrogen by the using the method of water splitting process over various kinds of photocatalysts which are made up of different kinds of semiconductor is noticed as a simple, safe cheap or we can say cost-effective approach for the production of hydrogen in large amount for uses in future when the current sources will ends. Since the very first time when the Honda–Fujishima discover or we can say try to do this kind of synthesis ,then a successful progress is done in this field of energy. During this time period a huge number of different kinds of photocatalytic materials are being discovered till the date and also many more like them are under observation and this field has gaining more and more attention by researchers day by day. In this present review article, we are going to study about, what is water splitting, its mechanism, and we also summarize the present available knowledge about the water-splitting method and the water splitting systems that are going to be based on different kind of photo catalysts. In the end we also going to discused about the various challenges that may come in the mechanism of this process and its role in our future.

Keywords: Photocells; Photoreacters; Titanium oxide; PVE; Catalyst.

Influence of aluminium oxide nano particle on the performance and emission of diesel engine fuelled with distilled tyre pyrolysis oil

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Abstract

Diesel engines are widely employed in all industries, causing significant pollution, global warming, respiratory illnesses, and other dangers. Nearly an equal number of tyres are permanently removed from vehicles and classified as waste every year. The use of nano additives has been found to be successful in lowering emissions and enhancing the performance of diesel engines. The aim of this present study is to analyse the effect of nanoparticle Aluminium oxide (Al_2O_3) on engine performance and emissions of a diesel engine fuelled with distilled tyre pyrolysis oil (DTPO). The nanoparticle is mixed in various concentrations (100, 200, 300 ppm) with DTPO. The blends prepared are DTPO10%, and Diesel 90% called B10D90. The performance (BTE, BSFC), and emissions (NO, HC, CO, CO_2, and Smoke) were investigated in the four-stroke, single-cylinder, water-cooled diesel engine without any modification. From these results, the experimental result shows that nano additives is effective in increasing the Performance and reducing the NO emission of distilled tyre pyrolysis oil fueled diesel engine.

Keywords: Distilled tyre pyrolysis oil; Al_2O_3 Nanoparticle; Vacuum Distillation; Performance; Emission.

Role of doping transition metal on the Structural and Magnetic properties of antiferroelectric $NaNbO_3$

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Abstract

Environmentally friendly antiferroelectric ceramics for electrostatic energy storage has been drawn attention in recent era due to the wide application in high power and/or pulsed power electronic systems. However, achieving both ultrahigh recoverable energy storage density and high efficiency has been a challenge, limiting their use in miniaturized, lightweight, and easily integrated electronic devices. In this framework, a novel ceramic material called $NaNbO_3$ has been introduced. This material combines the advantageous properties of antiferroelectric and relaxors, resulting in a stabilized antiferroelectric phase and enhanced dielectric relaxor behaviour. In this paper the solid-state approach for the synthesis of NaNbO3 materials, both pure and doped with transition metals (Fe and Cu) at varying concentrations (pure, 0.05, 0.075 and 0.1), followed by heat treatment (calcination) at 1150 °C for 6 hours. X-ray diffraction (XRD), scanning electron microscopy (SEM and EDS), Fourier transform-infrared (FT-IR), and vibrating sample measurement were used to investigate the effects of transition metal doping in $NaNbO_3$ compounds on the structural and magnetic properties as well as their dependence on dopant concentration. The pure orthorhombic structure that was linked to the bonds detected by FTIR spectroscopy is shown by XRD. EDS demonstrates the appropriate concentration of all the elements in prepared samples whereas SEM demonstrated the presence of well-defined grains.

Keywords: Antiferroelectric ceramics; XRD; FTIR; UV-Vis.

Fabrication and design of neutral density filter based on alloy in visible range

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Abstract

A neutral density filter in visible range designed by using Essential Macleod software and fabricated on glass substrate using co-evaporation of Nickel and Chromium by thermal vacuum coating unit. The Co-evaporation of Nickel/Chromium (80:20) bears uniform stoichiometry ratio confirms in EDAX of thin films. X-ray diffraction profile indicates that Nichrome thin film of 11nm thickness has amorphous nature but 82 nm has crystalline nature. A smaller crystallite size of ~3.986 nm results peak broadening and lattice strain for thin film having least value of 0.019488 indicating no peak shifting.The Atomic Force Microscopy analysis reveals that with increase in film thickness surface roughness found decreases from 6.034 to 2.895.The decrease in roughness prevents from scattering losses in the ND filter.These thin films also have neutral absorption and transmittance in visible region (400-700 nm) measured by UV-Vis-NIR Spectrophotometer. The OD value for 11 nm thickness is 0.5. An OD value of 0.5 indicates a moderate level of light attenuation, which reduces the light intensity reaching the sensor by approximately >68%. This can be useful in color sorting applications with relatively bright lighting conditions, where reducing the light intensity can help prevent overexposure and improve color detection accuracy. Variation in Optical density is ΔOD=0.08. Also, for 82 nm thickness film OD is 2.7. It means that only about 0.2% of the incident light is transmitted through the material, and approximately 99.8% of the light is absorbed or blocked. These filters with an OD of 2.7 are used in applications where a substantial reduction in light intensity is required, such as in laser safety goggles, high-power light sources, or situations where the camera or sensor needs to operate with minimal light to prevent overexposure or glare. Variation in Optical density is ΔOD=0.44.

Keywords: NDF; Optical coating; Absorption; Color Sorting; Thin Films.

Enhanced mechanical properties of functionalized MWCNTs/TPU nanocomposite films

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Abstract

The concept of creating both structural and functional nanocomposites with improved performance is currently under development in a wide variety of metallic, ceramic and polymeric matrices although the emphasis till date has been on polymeric systems. PU is one of the most versatile polymers today. It is widely used in coatings, self-healing materials, adhesives, thermoplastic elastomers and composites. In this present study, as synthesized, and surface modified multi-walled nanotubes (MWCNTs) reinforced thermoplastic polyurethane (TPU) nanocomposites has been prepared via solution mixing and evaporation techniques. Surface modification of MWCNTs was done for the better interaction and interfacial bonding between MWCNTs with TPU matrix. Carboxylic (-COOH) as well as sulphonate (-SO_3H) groups were introduced at the MWCNT surface using chemical treatments. –SO_3H group was introduced first time on MWCNT surface due to better hydrogen bonding with TPU as compared to –COOH group. The surface modified MWCNTs/TPU nanocomposites shows better improvement in the tensile strength and elastic modulus as compared to as grown MWCNTs due to proper interaction and interfacial bonding with TPU chains which participates in efficient load transfer. The high mechanical performance along with low-cost, ease of fabrication and stretchability opens new opportunities for the fabrication of high performance polymer nanocomposites based devices.

Effect of Potassium carbonate chemical derived activated carbon on Lithium-ion battery anode performance

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Abstract

In this work, effect of Potassium Carbonate (K_2CO_3) chemical derived Calotropis gigantean biomass stem activated carbon on Lithium-ion battery anode performance was studied. Activated carbon was produced by chemical activation method where raw stem powders were mixed with the chemical K_2CO_3 in the ratio of 1:1 (chemical: raw stem) and carbonized at 400^{o}C, 600^{o}C, 750^{o}C, 900^{o}C in normal atmospheric conditions. Scanning Electron Microscopy (SEM) analysis was done to confirm the presence of pores and Energy Dispersive spectroscopy (EDS) analysis was done to confirm the elements present in the activated carbon product. Nitrogen adsorption and desorption isotherm was studied by BET surface area analysis to calculate BET surface area and pore volume of the activated carbon. Further, Lithium-ion battery anode was fabricated using the activated carbon products for electrochemical characterizations. Galvanostatic charge discharge cycle and cyclic performance of anode in CR2032 type coin cell confirmed the possibility of use of Potassium carbonate chemical derived activated carbon as anode in Lithium-ion batteries.

Keyword: Calotropis gigantea; Potassium carbonate; Activated carbon; Anode; Battery.

Electrochemical Activities of Ni-Ti Super-elastic in artificial blood plasma with Trigonella foenum graecum seeds

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Abstract

An investigationof the electrochemical behaviour of Ni-Ti super-elastic implant alloy when exposed to artificial blood plasma (ABP) in the presence of 0.1 and 0.5 ppm of Trigonella foenum graecum (TFG) seeds for 1, 10, 20, and 30 days. Studies on AC impedance and polarisation haveshown that a protective coating forms on the metal surface while inhibiting corrosion. The protective film has formed on the Ni-Ti implant alloy surface, the linear polarization resistance increased (LPR), and the corrosion current value (I_{corr}) decreased.The charge transfer resistant value (R_{ct}) and impedance value increase, and the double-layer capacitance value decrease.The protective layers morphology and the elemental composition were analyzed by SEM/EDAX.The property of the protective film on the Ni-Ti super-elastic alloy has been examined by atomic force microscope.The X-ray diffraction analysis has confirmed the nature of the apatite. The corrosion inhibition efficiency of Ni-Ti Super-elastic alloy in ABP in the presence of TFG seeds at various concentrations for different times was improved.

Keywords: Alloy; Nickel-titanium; AFM; Protective film; Inhibition efficiency; Tafel plots; Bode plots.

Microstructure investigation and FTIR spectroscopy of Calcuim Copper Titanate cermaics

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Abstract

The present investigation involved the production of ceramics composed of $CaCu_3Ti_4O_{12}$ through the utilization of Solid State Reaction (SSR) technique. Pure CCTO was calcined for 10 hours at 1000 °C and then fused for 3 hours at 1050 °C in a muffle furnace. X-ray diffraction analysis was employed to examine the crystallinity of the sample and confirm the presence of a singular phase in the synthesized samples. The structural integrity of the sample was further validated through Rietveld refinement, utilizing Full proof software for accurate results. The lattice parameters (a = b= c = 7.3825 Å) and angles ($\alpha = \beta = \gamma = 90^{\circ}$) indicate the presence of a cubic crystal structure with the space group Im3. The verification of the establishment of a cubic crystal lattice was carried out by generating a crystal lattice using VESTA Software.Varied estimating techniques, such as the Debye-Scherer method, the Williamson-Hall method, and the Rietveld refinement method, often provide varying findings because of the different parameter choices for peak broadening. The FESEM study predicted the an inhomogeneous structure in prepared ceramic materialsand an average grain size of 30 µm was revealed by analyzing the SEM images using ImageJ software. The EDS examination substantiated the presence of Ca, Cu, Ti, and O, which is indicative of the products' high level of purity and accurate stoichiometric representation. According to the FTIR spectra, the modes that were detected at 606, 525, and 463 cm^{-1} were respectively ascribed to the vibrational modes of Ca-O, Cu-O, and Ti-O-Ti.

Keywords: Rietveld Refinement; FESEM; FTIR spectroscopy; Perovskite Ceramics.

Synthesis and investigation of crystal structure of NBT-based Aurivillius type ceramics

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Abstract

With the purpose of fabricating ceramic, for potential applications at higher temperature aurivillius Sodium Bismuith Titanate (NBT) was synthesized via solid state method. Pure NBT was calcined at 950˚C for 5 hrs and sintered at 1050˚C for 3h in muffle furnace. X-ray diffraction analysis confirmed that synthesized sample have single phase, which was further confirmed by reitveld refinement done using fullproof software. Four layer crystal structure formation was confirmed by generating crystal structure using VESTA Software, which shows four pervoskite layers imbedded between $(Bi_2O_2)^{2+}$ layers both sides. Lattice parameters (a = 0.38, b = 0.38 and c = 4.069 nm and $\alpha = \beta = \gamma = 90^\circ$) confirmed the formation of tetragonal crystal structure with space group I4/mmm. Scanning electron microscopy (SEM) was used to study the surface morphology of the prepared sample. SEM images reveals formation of plate like grains with anisotropic grain growth.Average grain size of 2.306μm was calculated from SEM image using ImageJ Software. Elemental analysis was done using Energy dispersive spectroscopy (EDS) attached along with the SEM. Raman spectroscopy was used to study the different modes of vibrations, which were observed at 112, 267, 349,551,885 cm^{-1}. Modes observed above 200 cm^{-1} attributed to internal vibrations of TiO_6 and modes around 885 cm^{-1} might arised due to vibration of Bi-O bonds. On the basis of different modes observed, nature of synthesized sample was discussed.

Keywords: Reitveld Refinement; Scanning electron microscopy; Raman Spectroscopy; Aurivillious Pervoskite.

Synthesis of Optically Stimulated Luminescent (OSL) Materials: Recent Advances for Dosimetry Applications

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Abstract

Optimally stimulated luminescent materials have received a lot of attention because of their potential applications in a variety of fields, including radiation dosimetry, medical imaging, and environmental monitoring. The creation of materials with improved optically stimulated luminescent qualities, such as higher sensitivity, luminescent efficiency, linear response, and stability, has been made possible by the development of various synthesis pathways and processes. Sol-gel, co-precipitation, chemical vapor deposition, microwave – assisted synthesis and hydrothermal synthesis have all been used to create diverse kinds of OSL materials, such as halides, aluminates, sulfides, etc. Understanding the structure and characteristics of these materials has been aided by the application of cutting-edge characterization techniques like X-ray diffraction, scanning electron microscopy, transmission electron microscopy, and energy-dispersive X-ray spectroscopy. The synthesis of OSL materials has enormous potential for personal radiation and environment monitoring, and continuing studies in this area continue to propel developments in the sector. We will discuss numerous optically stimulated luminescent material synthesis techniques in this paper.

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Novel modification of Activated Charcoal sheet with N-Methylpolypyrrole and Silver Nanoparticles for removal of Hexavalent Chromium in water treatment processes

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Abstract

The novel NPPY-AgNP's@AC CPN were synthesized and used for batch mode reductive adsorption of hexavalent Chromium (Cr^{+6}) ions in water treatment processes. The Activated Charcoal (AC) sheet was firstly encapsulated with silver nanoparticles (AgNP's) by in-situ reduction method and capped with N-methylpolypyrrole (NPPY) to obtain NPPY-AgNP's@AC conducting polymer nanocomposites. The obtained CPN were characterized by HR-FESEM, XRD, FTIR, and EDS. The CPN materials showed excellent Cr^{+6} ions adsorption efficiency (Ad%) of 97.8% with adsorption capacity (*qe*) of 340 mg/g. The impact of various parameters like pH, adsorbent dose, initial Cr^{+6} ions concentration, temperature, and contact time on Ad% and *qe* were evaluated. The recycling experiments of NPPY-AgNP's@AC CPN revealed their enhanced reuse performance and could be utilised for five consecutive cycles without suffering much reductions in their initial efficacy. The novel PPY-AgNP's@AC CPN seems to be highly efficient materials for Cr^{+6} ions removal from effluent water.

Optoelectronic properties of Chemically synthesized CdSe/ZnSe quasi type-II core-shell quantum dots

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Abstract

In this work, CdSe/ZnSe core-shell nanostructures have been synthesised through chemical bath deposition method. The structural and optical properties of the synthesised core and core-shell have been thoroughly studied with the help of XRD and electron microscopy which reveals that the nanostructures possess spherical shape and cubic polycrystalline nature with three prominent diffraction planes (111), (220) and (311). The crystallite sizes of CdSe and CdSe/ZnSe estimated from XRD are 5nm and 7.85nm respectively. The UV-Vis data of the core and core-shell nanostructures show blue shift in their absorption edges. The bandgap of the samples are calculated as 2.01eV and 1.96eV for CdSe and CdSe/Znse respectively. The PL spectra reveals a broad near bandgap emission at around 532nm with a broad impurity emission ranging from 610nm to 700nm. The PL intensity of the nanocrystallite samples are 19 and 6 a.u. for CdSe and CdSe/ZnSe respectively. This decrease in intensity in case shell is an indication of the formation of quasi type-II nature of core-shell quantum dots. The I-V characteristics of the samples have been studied and found to follow a linear nature in gap type geometry. The current increases in case of core shell than the core sample which is also a prime property of quasi type II core shell. The underlying mechanism of current conduction in the nanoparticle samples are thorouly studies in this work.

Keywords: Chemical synthesis; Core-shell; Quasi-type II; Bandgap; Conduction mechanism.

Transition metal Doped $BaTiO_3$ Ceramics: Structural, optical and Magnetic Properties for Sensor based Applications

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Abstract

Barium titanate ($BaTiO_3$) is a highly researched perovskite material renowned for its exceptional properties, such as the ability to undergo substitution in both the barium and titanium sites, its high dielectric constant, and overall stability. These characteristics make it a capable material for a extensive variety of applications. Our research centred on examining $BaTiO_3$'s microstructural, optical, and magnetic properties by substituting copper (Cu) and iron (Fe). In present research, we utilized the solid-state reaction method to synthesize ceramic compounds with compositions of Ba0.9(Cu0.05Fe0.05)TiO_3 and Ba0.8(Cu0.1Fe0.1)TiO_3. The resulting compounds exhibited a tetragonal crystal structure, and the size of the crystallites was determined to be approximately 18-20 nm. By employing Fourier transform infrared spectroscopy measurements, we observed that the incorporation of copper and iron influenced the octahedral vibrations within the compound. These vibrational changes shed light on the structural modifications induced by the Cu and Fe doping. The M-H loop displayed the soft ferrimagnetic characteristics as presence of transition metal dopant at Barium site. However, doping with Cu and Fe can enhance the performance of $BaTiO_3$ and expand its potential applications. Particularly, this research opens up possibilities for utilizing $BaTiO_3$ in sensor-based devices, taking advantage of its modified structural, optical, and magnetic properties.

Keywords: Barium titanate Ceramic; Structural, optical, magnetic properties; Sensor devices.

Prospective features of Fiber Optic Communication and its futuristic applications

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Abstract

Fiber optic communication is indeed a promising trend of the future with its numerous applications and advantages. The use of fiber optics allows for the transmission of data over long distances with minimal loss in signal quality. This makes it ideal for both individual and military applications. One of the key benefits of fiber optics communication is its high speed of data transmission. Unlike traditional copper wire cables, fiber optics can transmit data at speeds that are almost at the speed of light. This makes it ideal for high bandwidth applications such as video conferencing, online gaming, and streaming. Another significant advantage of fiber optics is its reliability. Fiber optic cables are less susceptible to damage from environmental factors such as moisture, temperature changes, and electromagnetic interference. They are also less prone to signal interference from nearby cables, making them ideal for use in densely populated areas. Moreover, fiber optic cables are lightweight and flexible, making them easy to install and maintain. They also have a longer lifespan than copper cables and require less maintenance, resulting in cost savings over the long term. To optimize the use of fiber optics communication, it is recommended to use high-quality fiber optic cables and equipment. Regular maintenance and testing of the cables and equipment can help to identify and resolve any issues before they escalate. Fiber optics communication is a reliable, high-speed, and efficient means of transmitting data. In this review we emphasize on high-quality equipment and regular maintenance, the benefits of fiber optics in a wide range of applications.

Keywords: Fiber Optics; Transmission of data; Communication purposes; Applications.