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MESSAGE FROM THE CONFERENCE CHAIR ICNSNT 2018

I take great pleasure in writing this message for the 5th International Conference on Nanoscience and Nanotechnology to be held on 13th – 14th December 2018, in Colombo, Sri Lanka. It has been an honor and privilege to serve as the Chair of this conference for five consecutive years. Four editions of this conference were successfully completed. The fourth edition of the conference was embraced by more than 80 participants from various countries with the highest participation from the Sri Lanka Institute of Nanotechnology (SLINTEC). TIIKM has been successful in bringing scientists from various universities and industries to share innovative ideas and new perspectives on a broad spectrum of research areas related to Materials Science and Nanotechnology.

The conference focuses on many areas through the Keynotes Speeches, Invited Talks, and Technical Programs. This year we have carefully selected few research areas such as Synthesis and characterization techniques of nanomaterials, organic and inorganic nanocomposites, nanotechnology for energy and environment and value addition to mineral resources. The conference is organized by the professional local organizing committee at TIIKM. There will be a significant participation by researchers from local universities and industrial organizations and the potential for collaboration and cross fertilization across borders would be substantial, especially due to the fact that Sri Lanka has already started the nanotechnology programme through a national nanotechnology initiative by setting up Sri Lanka Institute of Nanotechnology (SLINTEC), a world class fifty acre nanotechnology and science park comprising nanotechnology center of excellence equipped with state of the art equipment for nanoscience and nanotechnology.

As the Chair of the conference I am thankful for all the participants of ICNSNT 2018 and wish a pleasant experience with the conference. Extended versions of selected papers from the conference will be published after peer reviewing. I am confident that these experienced local organizers, TIIKM will make the ICNSNT 2018 an unforgettable event for all the participants.

Prof. K.M. Nalin de Silva
Chair, ICNSNT 2018
Senior Professor of Chemistry / University of Colombo
Science Team Leader / Sri Lanka Institute of Nanotechnology.
MESSAGE FROM THE HOSTING PARTNER ICNSNT 2018

It is a great pleasure that our Faculty of Engineering, International Islamic University Malaysia to become the hosting partner for the 5th International Conference on Nanoscience and Nanotechnology 2018 (ICNSNT 2018) in Sri Lanka. Hopefully, ICNSNT 2018 will provide a great opportunity for a common platform to discuss and share new findings, knowledge and experiences.

Malaysia has been facing the impacts and challenges of new technology. One of the new technologies is industry 4.0 in which that the current trend of automation and data exchange can be applied in engineering fields. This includes cyber-physical systems, the internet of things, cloud computing and cognitive computing. It is commonly referred to as the fourth industrial revolution. Having this in mind, the field is heading the communities towards the survival of the humanity to the technology development and skills. Thus, relationships among nations such Malaysian, Sri Lanka and other nations have been improved today owing to the multidisciplinary perspectives and compromising to reach future goals through human harmony. Intellectual scholars, academics and researchers are playing a magnificent role to enhance mutual understanding.

I hope that this conference will become a milestone in the mission to create a valuable platform that enables knowledge-sharing in relation to engineering and sciences. Thereby, I would like to convey my best wishes to all of the participants.

I also hope that the participants, especially the international participants would carry home pleasant memories of Sri Lanka with rich experience of the conference.

Professor Erry T Yulian Adesta,
Dean,
Faculty of Engineering,
International Islamic University Malaysia,
Kuala Lumpur, Malaysia.
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  *Prof. G.R.A. Kumara*
  
- **Particle Accelerators in Nano Science**
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KEYNOTE SPEECHES
NOVEL RESEARCH CONDUCTED IN THE AREA OF NANOTECHNOLOGY

Prof. G.R.A. Kumara

National Institute of Fundamental Studies, Sri Lanka

ABSTRACT

Dye-sensitized solar cells (DSCs) continue to receive attention as a rich field entwining physics and chemistry. Although these devices are plagued with instability and relatively low efficiency, new concepts emerging on way could lead to major breakthroughs. We have been actively involved in examining different innovative versions of DSCs sometimes assembling them into solar cell modules. We have also conducted intensive studies aimed at understanding the mechanisms of operation of these devices. In our past research work we gave primary attention to find ways of improving the photovoltaic performance of dye-sensitized photoelectrochemical cells (DSPECs) and dye-sensitized solid-state cells (DSSCs).

ADSPEC is based on interconnected nanoparticle matrix of TiO$_2$ is well known. However, the liquid electrolyte in this cell presents a number of technical problems such as solvent leakage, evaporation loss, photodegradation of the components in the electrolyte and so on. For the first time, we have found that the problems of the electrolyte could be resolved if a p-type semiconducting material is used as the hole-collector such as CuI, CuSCN. We continued this work and was able to develop the DSSCs to yield the highest recorded efficiency and to improve their long-term stability. The DSSCs usually give lower efficiencies than DSCs. Besides, there are some practical problems in assembling DSSCs. When CuI is deposited from an acetonitrile solution, crystallites formed are larger than the pore size of the TiO$_2$ film. Thus the filling of the pores is difficult. A solution to this problem was also discovered and is the incorporation of a crystal growth inhibitor to the CuI. The best CuI crystal growth inhibitors identified is a molten salt of some thiocyanates. The compounds having above properties first to be identified was 1-methyl-2-ethylimidazolium thiocyanate. With the progress of further investigations, we found that the simple substance triethylammonium thiocyanate can act as an even more effective CuI crystal growth inhibitor. The mechanism of crystal growth inhibition was understood as strong adsorption of thiocyanate ions on the CuI surface.

We have also found that much information and insight into the mechanism of operation and strategies for improving the photovoltaic performance of DSCs could be gained by looking into other composite semiconductor particulate systems. An important observation we made was that the photovoltaic performance of SnO$_2$ is dramatically enhanced when thin layers of certain insulators are coated on the SnO$_2$ crystallite surface. Convincing results were obtained when SnO$_2$ was coated with thin films of ZnO, MgO or CaCO$_3$.

In our past research work we were also engaged conversion of raw graphitic minerals into value-added products such as expanded graphite, graphene oxide and graphene suited for a wide range of applications, notably as counter electrodes in dye-sensitized solar cells. In another related work the utility coconut shells to produce highly porous and highly conducting activated charcoal for super capacitors and counter electrodes of solar cells were established. The counter electrode in DSC has been issue, because of the cost of platinum and imperfect resistance of this metal to corrosion by the electrolyte. DSSCs also entail similar issues some extent as good ohmic contacts are essential. We have succeeded in developing coconut charcoal based counter-electrodes of performance almost equivalent to platinum.
PARTICLE ACCELERATORS IN NANO SCIENCE

Prof. Nilanga Liyanage

University of Virginia, USA

ABSTRACT

Particle accelerators have played a key role in most of the fundamental discoveries made in particle and nuclear physics during the past century. Powerful accelerators continue to push the boundaries of sub-atomic science into higher energies, smaller length scales and finer resolutions. Particle accelerator also offer a wide range of powerful research, characterization and fabrication tools for Nano Science. Today accelerator based intense X-ray light sources are used for nano scale imaging. Accelerator based neutron sources are widely used for material characterization. Accelerated ion beam facilities are used for nano fabrication, material deposition as well as for ion implantation. These are only a few examples of many contributions accelerators make in nano science. In this talk I will discuss particle accelerators, some of the recent particle and nuclear physics experiments at major accelerator facilities and many applications of accelerators in nano science.
NANOSCALE ARCHITECTURES FROM ELECTROHYDRODYNAMIC PROCESSES, AND THEIR APPLICATIONS IN DRUG DELIVERY

Dr. Gareth Williams

University College London, United Kingdom

ABSTRACT

Electrohydrodynamic (EHD) processes exploit electrical energy to generate solid products from a solution, allowing the production of both nanoscale particles and fibres. Typically, a solution of a polymer in a volatile solvent is ejected from a syringe towards a collector, with a high potential difference applied between the two. Because the solidification process is very rapid (< 1s), the random arrangement of molecules in the solution is usually propagated into the solid state, resulting in amorphous solid dispersions which are potentially very powerful in improving the solubility and dissolution characteristics of active pharmaceutical ingredients. The use of pH- or temperature-sensitive polymers to form the EHD products permits stimuli-responsive drug delivery systems to be prepared. Further, it is possible to move beyond processing a single liquid to work with multiple liquids. The macroscale arrangement of needles through which the liquids are dispensed dictates the architecture of the products generated; thus, use of one needle concentrically nested inside another will yield a core/shell structure, while two needles side-by-side give Janus products. Both these architectures are very powerful in targeting the location and controlling the rate of drug delivery. This presentation will present an overview of some recent results in the production of drug delivery systems by EHD approaches, and consider their potential clinical applications.
ORAL PRESENTATIONS
STRUCTURAL AND OPTICAL PROPERTIES OF CuO/ZnO COMPOSITE NANOSTRUCTURES

A. Agarwal\(^1\) and S. Srivastava\(^2\)

\(^1\)Department of Physics, Motilal Nehru National Institute of Technology, India
\(^2\)Department of Physics, United College of Engineering & Research, India

ABSTRACT

The fabrication and characterization of CuO/ZnO bioxide nanostructures at low temperature by inexpensive sol-gel method has been done. In the synthesis of CuO/ZnO bioxide nanostructures, aqueous solutions of 25 ml of CuCl\(_2\).H\(_2\)O (0.8524 gm) and 75 ml Zn Cl\(_2\) solution (2.044 gm) were mixed. The same process was followed for ZnO:CuO (90:10). The XRD spectra confirm the formation of ZnO/CuO nanocomposite. The results reveal that ZnO peaks are more evident and two phases (CuO and ZnO) co-exist. All diffraction peaks are in good agreement with the standard patterns of hexagonal wurtzite ZnO and monoclinic CuO. No peak of other phases and impurities were detected confirming the single phase of CuO nanoparticles. The XRD patterns of samples containing 10 at% and 25 at% CuO coupled with ZnO indicates the formation of composite ZnO/CuO. The segregation of any other phase was not detected. The average crystallite size was found to be 26 nm. EDAX analysis of samples confirms the presence of Zn in Cu nanoparticles. TEM results for ZnO show rod like structure while for 10 at% CuO the shape is spherical and for 25 at% CuO the morphology is mixed. The UV-Vis spectroscopy exhibits absorbance at about 376nm for bare ZnO particles, whereas for ZnO/CuO nanoparticles it is at 417nm which exhibit red shift. Furthermore, a broad absorption was seen around 580–800 nm. The bandgap of ZnO/CuO composite is found to be 2.86 eV. The PL spectra indicate the formation of ZnO/CuO bioxide leading to significant changes in PL peak positions.

Keywords: CuO/ZnO, bioxide, nanostructures, sol-gel, XRD
CARBON QUANTUM DOTS DECORATED MAGNESIUM OXIDE NANOPARTICLES AS A PHOTOCATALYST AND ANTIBACTERIAL AGENT


Sri Lanka Institute of Nanotechnology, Nanotechnology and Science Park, Homagama, Sri Lanka

ABSTRACT

Synthesis of carbon quantum dots (CQDs) decorated inorganic nanoparticles has become an interesting research area in recent years as these materials show various properties to use in broad range of applications. Herein, CQDs were adsorbed on surfaces of MgO nanoparticles (Abbreviated as CQDM) to develop a new type of sunlight active photocatalyst and an antibacterial agent. In the synthesis method, CQDs were synthesized by calcining 1 M ammonium citrate solution (5 mL) at 180 °C for 3 h. The obtained brown colour residue was dissolved in 10 mL of absolute ethanol. Pre-synthesized MgO nanoparticles were added into the CQD solution and sonicated for 5 minutes to adsorb CQDs on to MgO nanoparticles. The final product was characterized using scanning electron microscopy (SEM), transmission electron microscopy (TEM), Fourier transformed infrared spectroscopy (FTIR), X-ray diffraction (XRD) and Raman spectroscopy. Characterization results showed that spherical CQDs have well-adsorbed on MgO surfaces. The photocatalytic activity of synthesized material was studied by dispersing 0.01 g of the material in 10 ppm methylene blue (MB) (10 mL) of solutions followed by sunlight irradiation time intervals. The final concentration of each MB solution was measured using UV-vis spectrophotometer. Based on results, 95% of MB has been degraded by the material within 150 min of sunlight irradiation which confirms that the material is an efficient photocatalyst under sunlight. The synthesized CQDM product showed antibacterial activity against Staphylococcus aureus, Staphylococcus epidermidis, Escherichia coli, Bacillus. Therefore the synthesized material has potential applications in environmental pollution control and in development of various antimicrobial products.

Keywords: Carbon quantum dots, magnesium oxide nanoparticles, photocatalysis, antimicrobial activity
REPLICATION OF THE SURFACE WETTABILITY OF PLANT LEAVES WITH DIFFERENT SURFACE MORPHOLOGIES USING SOFT LITHOGRAPHY


Department of Physics, University of Sri Jayewardenepura, Sri Lanka

ABSTRACT

Naturally occurring surfaces such as those found in most aquatic plants display interesting surface wetting properties such as superhydrophobicity, superoleophobicity and directional wettability. These phenomena arise from the micro/nano structures present on these surfaces complimented by their surface chemistry. The replication of such surface structures are highly pursued due to their potential in applications such as self-cleaning (Lotus effect), microfluidic devices and antifouling surfaces. Soft lithography is a technique that has been used to replicate micro/nano structures with varying degrees of success. Nevertheless, in the context of natural surfaces the technique has been mostly limited to the replication of the lotus leaf structure. Therefore, a systematic investigation could be fruitful since it has the potential to be scaled up to replicate different surface structures as well as large-area patterning. In this study, the feasibility of soft lithography technique on natural leaf surfaces were investigated using five plant species with different surface morphologies. The negatives of these primary molds were replicated using polydimethylsiloxane (PDMS) and the final positive replica, was successfully replicated from PDMS while using hydroxypropyl methylcellulose (HPMC) as an anti-stick layer. The structures were characterized based on SEM images and contact angle measurements. Additionally, the effect of HPMC and degassing were also investigated. The technique can easily be extended to broader applications in other areas that require micro/nanostructured surfaces such as anti-reflection coatings, chemical sensors and anti-microbial surfaces.

Keywords: Micro-structures, soft-lithography, PDMS molding, lotus effect, surface fabrication, biomimicry
OXIDATION PROTECTION OF CARBON FIBER BY Zr₃(PO₄)₄/YPO₄ – B₂O₃ COMPOSITE NANO COATINGS

K. Purasinhala¹, S.P. Ratnayake¹, Y.M.R. De Silva², P.G. Mantilaka¹, G.A.J. Amaratunga¹,³ and K.M.N. De Silva¹,⁴

¹Sri Lanka Institute of Nanotechnology, Homagama, Sri Lanka
²Department of Chemistry, University of Sri Jayewardenepura, Sri Lanka
³Electrical Engineering Division, Department of Engineering, University of Cambridge, UK
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ABSTRACT

Efficient utilization of carbon fiber reinforced composite material at high temperatures have been hindered due to the poor thermal resistance of standard carbon fiber. Although, carbon fiber can withstand temperatures up to 2200 °C under inert conditions, they are known to be readily oxidized at temperatures as low as 500 °C. ZrO₂ based surface coatings have been shown to significantly improve the oxidation behavior of carbon fiber by acting as an oxygen barrier between the fiber and the environment. Although thermal performance of ZrO₂ based material have been studied extensively, Zr₃(PO₄)₄ and its composites have hardly been studied. In this research initiative, a novel Zr₃(PO₄)₄ based, YPO₄ and B₂O₃-included coating system was developed which could enhance the oxidation resistance of coated carbon fiber passed 900 °C. Carbon fiber was desized and oxidized for a better surface functionality. ZrOCl₂ was used as the Zr source. P and Y were provided in the form of H₃PO₃ and Y(NO₃)₃ respectively. Coatings were formed by adding 0.1 M H₃PO₃ drop wise to a ZrOCl₂ solution prepared in ethanol/water under vigorous stirring. In addition to single coatings, multiple coatings were applied on carbon fiber for a comparative analysis. Coated fibers were cured for 1 hour in air and calcined at 800 °C for 2 hours. Coatings and calcined nanocomposites were examined for morphology, composition and crystallography by SEM, EDX and XRD while coated fibers were thermally characterized via TGA. As per obtained results, Zr₃(PO₄)₄/YPO₄ - B₂O₃ composite nanoparticles exhibited a size of ~50nm and the single fiber coating exhibited a thickness of ~60nm. EDX mapping detected presence of Zr and P on the surface with C in the bulk cross section. The best thermal performance was exhibited by a twin coating of B₂O₃ on top of Zr₃(PO₄)₄/YPO₄ which arrested fiber oxidation at temperatures above 900 °C. Owing to the commendable thermal performance, the coating system holds potential for use in carbon fiber composites with high-temperature applications.

Keywords: Carbon fiber, oxidation protection coating
COMPARISON OF PROPERTIES IRON DOPED ZnO NANOPARTICLES
FABRICATED BY MICROWAVE METHOD AND PRECIPITATION METHOD

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ABSTRACT

Background: Iron doped ZnO nanoparticles are widely studied for various biological applications such as drug delivery in cancer treatment. Methods of fabricating large quantities of Iron doped ZnO nano particles in a short period of time is an important consideration in various technological applications. Purpose: The main goal of this study is to compare the structural, optical, magnetic and electrical properties of Fe-ZnO prepared by microwave method and precipitation method.

Methodology: We used Zinc acetate dehydrate and iron nitrate nonhydrate along with sodium hydroxide and PVP (polyvinylpyrrolidone) as precursor chemicals for microwave and precipitation method. The precursor solution was heated for 3 hrs. at 300°C for the precipitation method and heated for 5 minutes in a microwave at 600 W power level for 5 minutes using the microwave method. Solution prepared by both methods were further heated at 300 C for 2 hours and powder of nano particles are obtained. We used structural, optical, magnetic and electrical properties of Fe-ZnO prepared by microwave method and precipitation method to study properties of nano particles prepared by the two methods.

Results: It was also possible to obtain Fe-ZnO nanoparticles of size up to 10 nm with the help of pvp and ethanol in a microwave. Fe-ZnO prepared by microwave method produced particles with electrical, optical, structural and electrical properties comparable to particles prepared by the precipitation method. Conclusion: It was observed that preparation of nanoparticles from microwave method is quicker and cost-effective compared to precipitation method in fabricating Fe-ZnO with tunable properties.
PLASMA MODIFIED TEXTILE TREATED WITH PLANT MEDIATED SILVER NANOPARTICLES FOR BIOMEDICAL APPLICATIONS

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ABSTRACT

The synthesis, characterisation and application of biologically synthesized nanomaterials has emerged as a pioneering area in the field of nanotechnology. Biosynthesis of metal nanoparticles using plant derivatives has drawn significant attention in healthcare and hygiene textiles. *Tridax Procumbens*, a procumbent herb commonly used in Indian traditional medicine is known to posses several potential therapeutic properties. Leaf extract of *Tridax Procumbens* was used for green synthesis of silver nanoparticles. The synthesized nanoparticles characterized by UV spectrum were confirmed at 420nm and was evaluated for antimicrobial activity against various clinical pathogens. The nanoparticles were further confirmed by FTIR, EDAX, XRD, PSA, SEM, SAED and TEM. The biocompatibility of silver nanoparticles to fibroblast cell line (L929) was confirmed by MTT assay with 109.35µg IC₅₀ value. The biogenic silver nanoparticles of *Tridax Procumbens* were applied onto the oxygen plasma treated and untreated bamboo spunlace nonwoven fabrics by exhaust method. The contact angle and water retention studies revealed a significant difference in the absorption ability of plasma treated fabric. FESEM analysis of the plasma treated fabric showed the presence of large number of AgNPs due to improved adhesion and deposition of evenly dispersed nanoparticles on the cracks and grooves of the etched fibres caused by plasma treatment. The fabricated cloth when tested against selected bacterial pathogens exhibited good anti-microbial property thereby making it suitable for biomedical applications in healthcare textiles.

Keywords: *Tridax procumbens*, silver nanoparticles, oxygen plasma, bamboo spunlace nonwoven, antimicrobial
PREPARATION OF PROTEIN BASED FLUORESCENCE DYE FROM WOOL KERATIN PROTEIN

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ABSTRACT

Carbon based fluorescence dyes prepared from biological sources have attracted considerable attention in various research areas due to their excellent qualities in aqueous solubility, functionalizability, low toxicity and biocompatibility. Wool fibers consist of scales (outer layer) and fibrils (inner layer) whose carbon, nitrogen, hydrogen and sulphur contents vary due to their constituents. Carbon dots enhance their fluorescent properties when they are doped with nitrogen and sulphur atoms. Wool keratin which is a carbonous material abundant with nitrogen and sulphur, can be easily used to synthesize N and S containing fluorescence dyes. Synthesis of fluorescent dyes from wool keratin was performed using the hydrothermal carbonization method, where wool keratin yarns were digested at a high temperature (180°C) and high pressure (1000 kPa). Prepared fluorescence dye was characterized using UV-Vis & fluorescence spectrophotometer. The wool keratin fluorescence dye showed fluorescence at 350 nm upon excitation at 320 nm. The calculated quantum yield of the synthesized wool keratin fluorescent dye is 48.6% (Quinine sulphate was used as the reference). These keratin proteins based fluorescence dye can be used in optoelectronic devices, catalysts, biological labeling, and biosensors.

Keywords: Keratin wool fibers, fluorescence, quantum yield, fluorescence dye
THERMAL RESPONSIVE SMART YARN INTEGRATED WEARABLE TEXTILES

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ABSTRACT

A thermal responsive smart yarn was fabricated using a Nylon mono filament material. This yarn is capable of changing its dimension gradually according to the change of external environment temperature. The yarn respond to a wide temperature range of 34 °C - 47 °C. For this flexible wearable yarn to have gradual dimensional change in a wide temperature range the polymer composition, molecular arrangement in the monofilament need to be optimized in the yarn spinning process. Morphology of the already prepared (commercially available) nylon monofilament yarn was optimized and Tubular, spiral and zig-zag architectures were assed for the thermal responsiveness in this study. It was observed spiral yarn morphology with higher spiral frequency have better responsiveness over a wide temperature range. The dimensional change of the thermal responsive yarn in relation to the temperature is reversible with minimal hysteresis. This allow the material to maintain its durability in thermal responsiveness for multiple number of heating and cooling cycles. Material’s thermal responsive for different temperature was also characterized using Dynamic Mechanical Analyzer. Amorphous and Crystalline microstructure of the Nylon filament was analyzed using XRD. Yarn morphologies were analyzed using scanning electron microscope. The outer surface of a fabric was integrated intermittently with the TR yarn using textile weaving process. The TRY integrated on the fabric, subjecting to high temperature get expanded in its dimension and return to its initial dimension in the absence of the high temperature. The shape and shape recovery of the prepared fabric was analyzed. Thermal responsiveness of the textile material was in 34 °C - 47 °C temperature range. Responsive time of the textile material was < 5 ± 2 min and depends on the surface temperature of the yarn. Therefore this technology has allowed to fabricate a smart fabric that respond to external environment temperature which can be used for body heat regulation.

Keywords: Nylon yarn, mono filament, morphology, thermal, smart, temperature
ELECTROLESS SILVER PLATING ON PREMETALLIZED POLYAMIDE FIBERS FOR SMART TEXTILE APPLICATIONS

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ABSTRACT

At present innovations in textile field conductive yarns gained a greater attraction by demonstrating potential applications such as connecting and embroidering circuits, conductive electrodes by weaving and knitting conductive yarns. This research aimed on achieving conductivity by producing a metallic layer on the yarn using electroless plating of the yarn using unique strategy. For that, silver/ammonia complex was reduced on the pre metalized yarn to introduce nanosilver on or within the polymeric backbone of nylon 6. Then particles were grown to a silver layer by reducing the rest of silver iron complex in the solution by formaldehyde. Conductivity of the yarns were measured by changing the silver concentration. Yarn samples for each silver concentration were characterized using instruments such as Scanning electron microscope, Fourier transform infrared spectroscopy, UV visible spectroscopy, X-ray diffraction analysis, Thermal gravimetric analysis. The yarn sample, before reducing by formaldehyde wasn’t conductive, but conductivity has been increased with increasing the silver concentration after reducing the samples by formaldehyde. Yarn showed 70, 8.3, 4.8, 2.8 Ω/cm conductive values for corresponding 0%(w/v), 2.5%(w/v), 5%(w/v), 10%(w/v) silver concentrations. This introduced electroplating is novel way to preparing conductive fabrics for smart textile applications such as stretchable wearable electronic devices which has more than 50% stretchability.

Keywords: Conductive, electroless plating, silver, yarn
SYNTHESIS AND CHARACTERIZATION OF SEQUENCE-DEFINED POLY
(PHOSPHODIESTER)S

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ABSTRACT

The control of monomer sequence in synthetic polymers is a key goal of modern organic materials chemistry. The ability to control the sequence of building blocks in polymer leads to precise, well-managed synthetic macromolecules with unique and ordered chemical and physical properties. Synthetic macromolecules have entered almost every aspect of modern life, but the use of sequence (as is so potent in biology) has not yet been integrated. However, in the last few years, it has been demonstrated that sequenced-defined bio-oligomers such as oligonucleotides or oligopeptides can find applications in the fields of data storage, biomedicine, drug delivery and nanofabrication because of their versatile physical and chemical properties.

Nature on planet earth is directed by poly(phosphoester)s (PPEs) in the form of deoxy & ribonucleic acid (DNA & RNA), and, as pyrophosphates, they store up chemical energy in organisms. Taking the organic polymer synthesis to the next level, we are synthesizing sequence-defined poly(phosphodiester)s using a library of non-nucleosidic monomers. We employ diols as monomers, each bearing a unique functionality such as long chain alkyls, aromatic or heteroaromatic rings. We have adapted the automated solid phase phosphoramidite synthesis commonly used for DNA to make our sequence-defined polymers, allowing us to programme and print specific sequences with ease.

Like proteins, these polymers then self-assembly in a sequence-defined fashion to give uniform particles. These nanoparticles were studied using different analytical methods such as DLS, AFM and gel electrophoresis chromatography. Due to their biocompatibility and biodegradability, the PPEs are potentially capable of participating in molecular recognition or directing intracellular drug delivery.

Keywords: Poly(phosphodiesters), sequence-defined, phosphoramidite, self-assembly
SYNTHESIS AND STRUCTURAL CHARACTERIZATION OF MONONUCLEAR ZINC COMPLEX FOR DEPOSITION OF ZNO THIN FILMS BY AACVD

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ABSTRACT

A mono nuclear [Zn (OAc)₂ (dmae)]₂ complex with relatively low decomposition temperature and significantly high solubility in organic solvents was synthesized by a simple chemical technique and analysed by its melting point, elemental analysis, FTIR, ¹H NMR, single crystal x-ray crystallography and thermogravimetric analysis. Aerosol-assisted chemical vapour deposition technique was used to deposit a high quality thin film with good adhesion properties at relatively low temperature of 400 °C. The SEM of the films shows clearly distinct nanoballs of uniform composition. PXRD measurements have indicated the deposition of a crystalline phase of ZnO exhibits a tetragonal system with space group P4/nmm. The UV band gap of ZnO thin film was calculated a value of 2.6 eV suitable for Photoelectrochemical applications.

Keywords: Mononuclear complex, AACVD, ZnO, XRD, band gap
SYNTHESIS OF CALCIUM CARBONATE MICROCAPSULES AS NOVEL SELF-HEALING CONTAINERS

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ABSTRACT

Epoxy (EPX) encapsulated calcium carbonate (CC) inorganic microcapsules were synthesized using a facile method and used for self-healing application. Healing agent loaded microcapsules were incorporated into epoxy matrix to prepare a capsule based self-healing composite system. These inorganic, formaldehyde free non-toxic, CC microcapsules were characterized using Light microscope (LMC), Field emission scanning electron microscope (FE-SEM), Fourier transform infrared spectroscopy (FTIR), and Thermogravimetric analysis (TGA). Results showed that epoxy resin (araldite 506) was successfully encapsulated within the CC inorganic microcapsules in a form of a spherical shape container with a diameter ranging from 2 - 4 μm and the average shell thickness ranged from 600 – 900 nm. The encapsulation efficacy or loading capacity (LC) of these vacuum epoxy loaded microcapsules (ST-CC) were estimated using TGA analysis and the LC deemed to be 28%. The FTIR analysis confirmed the epoxy encapsulation within the microcapsules. There were no new peaks or peak shifts observed in the FTIR spectra and that implies there is no chemical reaction in-between CC and epoxy resin polymer, which is a governing factor in the releasing mechanism. For the first time, synthesis of inorganic mineral, formaldehyde free and non-toxic calcium carbonate microcapsules were prepared for the application of self-healing systems which showed remarkable healing ability in epoxy composites coatings.

Keywords: Inorganic calcium carbonate microcapsules, self-healing containers
SOIL ACTINOMYCETES MEDIATED PRODUCTION OF ZINC OXIDE NANOPARTICLES

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ABSTRACT

Nanoparticles are the wide class of materials that include particulate substances, which have any one dimension less than 100 nm. The synthesis of nanoparticles are employed by various methods. In biosynthesis of nanoparticles, microbes play a major role because of cost efficiency and requirement of low maintainance, which gives better characterization. Nanoparticles are of different shape and of different colours. In the present study, zinc oxide was produced from the actinomycetes isolated from the rhizosphere of the soil in India. Zinc oxide is hexagonal in shape and of permanent white colour. Zinc oxide nanoparticles (ZnO Np) are mostly used in the field of medical applications like ointment and dental appliances. Actinomycetes are excellent biopotential resource, more commonly available in soil. These are gram positive bacteria but appear like a fungus with powdery mass. The present actinomycetes belongs to Streptomyces sp. and was utilized as the source for the production of zinc oxide. The synthesize ZnO Np was characterized using UV-Vis which exhibited its resonance between 350-400nm. The efficiency of biological mediated zinc oxide nanoparticles were evaluated in Vigna radiata as fertilizer which enhanced shoot length, chlorophyll, carotenoid, biomass @ 10ppm of ZnO Nps.

Keywords: Zinc oxide, actinomycetes, biosynthesis, agriculture, Vigna radiata
ENHANCEMENT OF ULTIMATE TENSILE STRENGTH OF NATURAL RUBBER COMPOSITES VIA TITANIUM CARBIDE NANO PARTICLES

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ABSTRACT

Tensile properties of natural rubber (NR) composites were enhanced by incorporating nano Titanium carbide (TiC) novel ceramic filler particles. The natural rubber TiC nano composite was prepared by solution mixing and later the other additives and curatives were mixed by melt mixing using internal mixture. In preparation of TiC master batch, initially, TiC nano powder was dispersed with the aid of a surfactant dispersion agent and followed by adding NR latex solution. Hereafter, the nano TiC and NR latex (TiC/NR) mixture was homogenized using overhead stir and quickly coagulated using Formic acid in aluminum plates and thin sheets were prepared by two roll milling. The prepared sheets were dried at 60°C for 48 hours prior to melt mixing. Following the same experimental procedure, 0.5, 1.0, 2.5 and 5.0 of TiC parts per hundred of rubber (phr) batches were prepared and control batch was prepared without any TiC nano materials. For comparison purpose, 1.0 and 5.0 phr carbon black (CB-N 330) and NR latex batches (CB/NR) were prepared and tensile strength was compared with TiC/NR composites. Maximum tensile strength was achieved in TiC/NR-1.0 as 31.12 MPa and it was enhanced by 92%, 73% and 63% compared to control sample (TiC/NR-0, 16.22 MPa), CB/NR-1.0 and CB/NR-5.0, respectively. The Prepared rubber composites were further analyzed and characterized using Thermogravimetry analysis (TGA), Dynamic mechanical analyzer (DMA), Fourier-transform infrared (FTIR) spectroscopy, X ray diffractometer (XRD), Hardness meter (Shore A) and Scanning electron microscope (SEM). According to the characterizations, those were evident to the significant improvement of tensile strength of TiC/NR composites.

Keywords: Natural rubber nanocomposites, high strength, Titanium Carbide, carbon black
AN OVERVIEW OF USE OF BIODEGRADABLE AND NON-BIODEGRADABLE NANO PARTICLES IN DIFFERENT INDUSTRIES

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ABSTRACT

Application of bio degradable and non-bio degradable Nano Particles (NPs) has been influential in production, depending on their ability to decompose. Utilization of NPs is emerging among industries beyond traditional hazards and risk assessment models. Drug delivery and cancer diseases identification in medicine, fish feed production and nutrient enrichment in aquaculture development, fertilizer and pesticide innovation to improve yield in agriculture, bacterial identification and food quality monitoring in food processing, use of NPs for air pollution and environmental remediation, NPs use in molecular and crop biotechnology, forestry applications, activated material use in water purification, haircare products and moisturizers in cosmetics, bacterial action improvement in microbiology, electronic appliances development, Nano-engineered infrastructure development in transportation and renewable energy synthesis and alternating fuel modifications via NPs are major implications of NPs. In Sri Lanka, Sri Lanka Institute of Nanotechnology (SLINTEC) performs studies of NPs in water treatment, agriculture, textile and health care. The need of information for effective regulatory policy instruments formulation has been realized by society to meet the growing demand for sustainable good production and services. Available information of Nano particles risks and guidelines to environmental, occupational health and safety practices has been highlighted globally. In conclusion, as applications of NPs is a sustainable filed, existing knowledge gaps should be immediately addressed while ensuring human and environmental health and safety via effective monitoring programs.

Keywords: NP, biodegradable, non-biodegradable, applications, environmental, risk
SYNTHESIS OF ELECTROSPUN HYDROXYAPATITE ZINC OXIDE NANORODS
AND THEIR PHOTOCATALYTIC ACTIVITY ON METHYLENE BLUE
DEGRADATION

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ABSTRACT

Hydroxyapatite (Ca₁₀(PO₄)₆(OH)₂) (HAp) is the major inorganic material in vertebrate hard tissues. Synthetic HA nanoparticles that mimic the natural HA, are widely used in biomedical applications and are also used in other applications such as water purification, catalytic applications and chromatography. HA nanoparticles can easily be used to synthesize nanocomposites in order to incorporate the important properties. In this study, HA-ZnO nanocomposite is synthesized to incorporate the photocatalytic activity to the composites for water purification applications. In the synthesis process, first, HA-Zn(OH)₂ nanocomposites were synthesized by simple chemical precipitation (HAp : ZnO ratio =1 : 1). Then one portion of washed sample is electrospun with polyvinyl alcohol (PVA) (Polymer ratio of 1: 3) and later sintered at 500 °C for 2 h. Other portion of synthesized sample was sintered at 500 °C for 2 h to compare with electrospun samples. Synthesized samples were characterized using different characterization techniques such as Scanning Electron Microscope (SEM), Energy Dispersive X-ray (EDX), Transmission Electron Microscope (TEM) and Fourier Transform Infrared Spectrometer (FT-IR). Electrospun samples produce the hexagonal rod like morphology whereas prepared samples convert to the spherical shape with sintering. Methylene blue degradation is determined by UV-Visible spectrometer. Results show that after electrospinning with the polymer is able to form hexagonal nanorods. Also methylene blue degradation rate is higher in sintered electrospun sample than that of sintered and non-sintered sample. Therefore the HA-ZnO rods prepared by electrospinning have a great potential to be used as a photocatalyst effectively.

Keywords: Hydroxyapatite, zinc oxide, nanorods, electrospinning
HYDROXYAPATITE BASED NANOCOMPOSITES WITH BIOPOLYMERS AND GRANULAR ACTIVATE CARBON TO REMOVE DIFFERENT TYPES OF CONTAMINANTS FROM WATER

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ABSTRACT

In this study hydroxyapatite (HAP) nanoparticles, nanocomposites of HAP with four biopolymers (chitosan, carboxymethylcellulose, alginate, and gelatin were synthesized using simple wet chemical precipitation methods and those composites were named as HAP-CTS, HAP-CMC, HAP-ALG and HAP-GEL. In addition to that granular activated carbon was incorporated with HAP biopolymer nanocomposites were also synthesized and they were named as HAP-CTS-GAC, HAP-CMC-GAC, HAP-ALG-GAC and HAP-GEL-GAC. All the synthesized products were characterized using and Fourier transform Infra-red spectroscopy (FTIR) and scanning electron microscopy (SEM). Separate batch adsorption studies were carried out to study their effectiveness in immobilizing Pb²⁺, Cd²⁺, fluoride and arsenate as these toxic contaminants are considered as causative agents for chronic kidney disease with unknown etiology (CKDu) in Sri Lanka. In addition, the ability of these nanocomposites to remove organic pollutant from water also investigated using congo red, an organic dye which is used in the textile industry. For all the tested contaminants HAP-Biopolymer nanocomposites showed improved adsorption properties than that of HAP-Biopolymer nanocomposites incorporated with GAC. For Pb²⁺ and Cd²⁺ HAP-GEL was found as the best composite with 99% and 79% removal at 0.5 and 5 minutes respectively. HAP-CTS was identified as the best adsorbent for fluoride with more than 50% removal of fluoride with in the first 15 minutes and 94% and 100% removal of arsenate and congo red within 5 minutes at room temperature and drinking water pH.

Keywords: Hydroxyapatite, nanocomposites, biopolymers, granular activated carbon (GAC)
MICRO Sized GRAPHITE Based CONDUCTIVE INK FOR CAPACITIVE BASED E-PAPER DEVICES

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ABSTRACT

Screen printable conductive ink based on graphite micro platelets was explored for applications in smart paper and textile electronics devices. The print conductivity of the obtained prints were found to be a function of the thickness and the width of the applied print which could be easily tuned between 50 – 1000 Ω/cm. The prepared ink was characterized with various spectroscopic and imaging tools to better understand the charge transfer and binding mechanism. The developed ink was fully compatible with capacitive sensing platform. Therefore, capacitive based switch, linear regulator, proximity sensor and a memory device was fabricated. To suit practical applicability, signal processing circuitry and backend data processing algorithms were optimized. Through the tuning of the circuitry it was possible to increase the sensitivity of the devices to detect physical touch or proximity to the human body. Along with the optimized circuitry, prototypes were demonstrated to illustrate their use in real world applications. These printed capacitive based devices will pave way to interesting paper devices that may have applications in wearable and printed circuits.

Keywords: Conductive ink, graphite micro platelets, capacitive touch sensing, smart paper
FABRICATION AND CHARACTERIZATION OF POLY (VINYL ALCOHOL) BASED FAST RespondING AND HIGH SENSITIVE HUMIDITY SENSOR

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ABSTRACT

Fast responding and high sensitive humidity sensor was fabricated using a polymer layer as the sensing material. 5% (Poly(vinyl alcohol)) PVA- solution was mixed with HI acid and was stirred at room temperature for proper mixing. The synthesized polymer mixture was deposited on top of the designed PCB and then was spin-coated at 800 rpm in order to obtain a thin nanoscale layer as the homogeneous sensing layer. Then polymer coated PCB was heat treated at 80 °C for 3 h to form conjugated double bonds in the PVA film. Development of conjugates were analysed using FTIR and electrical characterizations of the sensor were performed using an impedance spectrometer for the measurements of impedance, sensitivity and the response rates of the sensor. The resistance and impedance of the sensor was measured between 7% relative humidity (RH) and 92%RH. The maximum change in resistance was from 18.6 kΩ to 4.7 MΩ and from 10.2 kΩ to 4.5 MΩ for impedance. The sensing element was attached at a Weinstein Bridge for a real time humidity measurements and the voltage readings were converted into corresponding %RH. The results show promising response with 2% reading error. The response and recovery times of the sensor were measured to be 232.1 s and 57 s respectively in between 50% RH and 90%RH showing excellent performance of the sensor toward increasing and decreasing humidity levels. The results indicate the sensor is capable of measuring high humidity levels at greater efficiency with higher sensitivity and fast respond rates Cost effective high humid sensing can be recognized as the most effective potential application for this sensor.

Keywords: Humidity sensor, impedance spectroscopy, PVA /HI , higher humidity, fast response
A BACTERIAL BIOSENSOR, STRUGGLE IN THE LABORATORY TO ENTER TO THE MARKET; A POTENTIAL CANDIDATE IN NANO-PHOTONICS APPLICATIONS

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ABSTRACT

Extreme industrialization via unethical human practices has led to serious environmental issues such as heavy metal contaminations in water reservoirs and bioaccumulation along food chains. The demand for novel on-sight heavy metal detection systems/devices is increasing to ensure that public has access to pure drinking water. In this study we have developed a genetically engineered, heavy metal sensitive bacterial strain that is capable of emitting fluorescence as a specific signal when incubated with contaminated heavy metals. The \textit{cadR} gene sequence retrieved from \textit{Pseudomonas} genome database and the gene sequence corresponding to enhanced Green Florescent Protein (eGFP) were linked together to bio-informatically design the DNA cassette of heavy metal sensing. It was chemically synthesized at GenScript, USA. Subsequently, the DNA cassette was cloned into pJET1.2 vector and transformed into \textit{Escherichia coli} (E.coli) BL21 cells. Transformants were PCR confirmed and subjected into fluorescent microscopic heavy metal sensitive assays. The minimum detection values for Cd\textsuperscript{2+}, Zn\textsuperscript{2+} and pb\textsuperscript{2+} were 0.01 ppm, 0.5 ppm and 0.5 ppm respectively, with linear correlations when corrected total cell fluorescent (CTCF) value plotted against metal concentrations. Result of the current study indicates that heavy metal sensing, genetically modified microbial strain that we have produced is a potential candidate in nano-photonics based heavy metal detection applications since \textit{E.coli} BL21 is suitable to be grown in a microfluidic environment printed on a Lab-on-a chip and it is possible to couple it with either a micro scale or Nano scale fluorescent detection technique.

Keywords: Bacteria, biosensors, heavy metals, environmental pollution
SPIN COHERENCE OF TWO-DIMENSIONAL ELECTRON GASES CONFINED IN MULTILAYERED STRUCTURES

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ABSTRACT

In the last few decades, the field of semiconductor spintronics has attracted large interest for possible applications in electronic devices. Observation of long spin coherence time ($T_2^*$) is one of the key requirements for practical applications to store and manipulate spin information without loss. It has been widely studied in different dimensionally semiconductor nanostructures like quantum wells (QWs), quantum dots (QDs) and layered structures. The doping level has a major role in attaining or limiting the spin coherence time with $T_2^*$ changing from tens of picoseconds up to nanoseconds due to the Dyakonov-Perel mechanism.

In present work, we report on the generation of spin dynamics in GaAs quantum wells containing a dense two-dimensional electron gas (2DEG). We investigated the spin coherence in double and triple QWs because such structures are suitable for long spin coherence time. The DQW sample studied here consists of a 45 nm wide quantum well with high-density $n_s = 9.2 \times 10^{11}$ cm$^{-2}$ and electron mobility $\mu = 1.9 \times 10^6$ cm$^2$/Vs assembling a bilayer system. The triple QW sample consists of a 22-nm-thick GaAs central well and two 10-nm-thick lateral wells each separated by 2 nm-thick Al$_0$Ga$_{0.7}$As barrier.

The mechanism for generation of spin coherence in 2DEG was studied experimentally by means of pump-probe techniques: time-resolved Kerr rotation (TRKR) and resonant spin amplification (RSA). Spin polarization was generated by a focused laser beam, which is circularly polarized by the photoelastic modulator. The probe beam was linearly polarized and its change induced by the spin dynamics was detected with a bridge using coupled photodiodes. The samples were placed in a magnetic field applied in the Voigt configuration, perpendicular to the optical axis. TRKR measurements were performed as a function of experimental parameters in multilayers system. A g-factor of 0.453 and 0.452 for the double and triple QWs samples were observed, respectively. RSA was employed to detect the spin coherence time exceeding the laser repetition period. Long-lived spin coherence with dephasing time $T_2^* > 4$ ns has been found at $T = 5$ K in DQW sample. And $T_2^*$ exceeding 14 ns was observed in the TQW sample at $T = 8$ K. The results are among the longest $T_2^*$ reported for samples of similar doping level.
CELLULOSE BASED POLYMERIC SYSTEMS FOR STATE-OF-THE-ART DRUG DELIVERY


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ABSTRACT

Nowadays, polymer-based drug delivery systems represent frontier areas in nanoscience attracting both industry and academia. Polymers like cellulose, alginate and chitosan have been used in biomedicine due to biocompatibility, ready availability and low immunogenicity. Polymer-drug systems also show higher drug encapsulation, enhanced circulation, reduce off-target effects, improves drug kinetics and stability. Fabrication of a drug delivery system using bacterial nanocellulose (BNC) hydrogel and a model protein drug bovine serum albumin (BSA) is systematically investigated. Freeze dried bacterial nanocellulose hydrogel (fd-BNC) synthesized by Gluconacetobacter species used as the drug delivery matrix. Varying concentrations of 2, 5, 10, 20 (mg/ml) BSA in phosphate buffer used to identify the pattern of adsorption and releasing from a preswollen fd-BNC hydrogel at predetermined time points under shaking conditions of room temperature. Absorbance of UV at 278 nm indicated mean loaded BSA amounts as 1.65, 3.02, 7.04, 13.52 (mg) in 2-20 (mg/ml) BSA after 48 hours. Percentage of loading was 16.48 - 135.18% with 96 ± 0.94% uptake capacity. Loading stabilized after initial 8 hours and controlled mainly by diffusion whereas no saturation effects observed. Release profile indicated a ‘burst release’ during initial 8 hours followed by a controlled release. The mean drug release amounts were 1.12, 2.89, 5.59 and 10.37 (mg) in 2-20 (mg/ml) BSA. Ritger-Peppas power law suggested a Non-Fickian (anomalous) drug transport mechanism. The study demarcates the significance of biopolymer BNC as a suitable carrier for active protein drugs like BSA and further studies for a non-toxic and non-biodegradable drug delivery system.

Key words: Anomalous diffusion, Bovine serum albumin, Bacterial nanocellulose, Drug delivery, Power law model
SYNTHESIS AND CHARACTERIZATION OF ANTIGEN-FUNCTIONALIZED NANOPARTICLES FOR IMMUNODIAGNOSIS OF ANTI-LEPTOSPIRAL ANTIBODIES USING UV-VISIBLE SPECTROSCOPY

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ABSTRACT

Due to exceptional optical and chemical properties, protein-functionalized nanoparticles are used in immunodiagnostics. Protein-nanoparticle interaction is identified by surface plasmon resonance of nanoparticles in UV-visible region. The objective of this study was to determine the stability of antigen-functionalized silver nanoparticles at optimum environmental conditions for the identification of antibodies against leptospirosis, which is an emerging, infectious, zoonosis in many developing countries, including in Sri Lanka. Silver nanoparticles of 80 nm were incubated with different concentrations of rLigA (recombinant leptospiral immunoglobulin-like protein A) antigen at different temperatures and pH levels. rLigA-functionalized nanoparticles were characterized by UV-visible spectroscopy, Fourier Transform Infra-red (FT-IR) spectroscopy, Dynamic Light Scattering (DLS) and Scanning Electron Microscopy (SEM). 1.5 µg ml\textsuperscript{-1} was selected experimentally as the optimum concentration of rLigA for the functionalization of spherical silver nanoparticles at 25 °C and pH of 7.0. Concentrations that were higher and lower than that showed lower absorption values in UV-visible spectroscopy. FT-IR spectra verified that nanoparticle-rLigA interaction was taken place through electrostatic interactions with carboxylate groups of the protein. SEM and DLS confirmed the monodispersity of functionalized nanoparticles. These nanoparticles showed a significant reduction and red shift in UV-visible absorption upon the addition of human sera containing IgG (Immunoglobulin-G) anti-leptospiral antibodies due to agglutination. No significant difference in absorption was observed when the nanoparticles were tested with human sera without IgG. This preliminary study is a successful initiation step for biosensing of anti-leptospiral IgG antibodies in human sera at 25 °C and pH of 7.0, using UV-visible spectroscopy.

Keywords: Functionalization, immunodiagnostics, leptospirosis, surface plasmon resonance, UV-visible spectroscopy
SUPER ANTIBACTERIAL PROPERTIES OF TITANATE SPECIES IN DARK CONDITIONS

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ABSTRACT

Although antibiotic resistance is naturally occurring, it’s accelerated by misuse of medicines. This leads to malfunction of potent antimicrobial agents against bacterial strains; resulting longer hospital stays, increased cost of medicine and mortality. Therefore newel chemicals exhibiting antimicrobial properties such as nanoparticles of titania (TiO₂), zinc oxide, copper oxide and silver were extensively studied. Due to having photocatalytic activity resulting reactive oxygen species (ROS) such as hydroxyl, oxo and peroxo; titania achieved higher merits in terms of killing bacteria. The greater difficulty of applying titanium species for this objective is, it shows antimicrobial properties in the presence of UV irradiation and it cannot be achieved clinically. In this research the possibility of performing light independent antibacterial activity was studied. Meta titanic acid (H₂TiO₃) and potassium titanate (K₂TiO₃) were used as antimicrobial chemicals compared to nanotitania, against gram positive bacterial strain Staphylococcus aureus, and gram negative bacterial strains Escherichia coli, Pseudomonas aeruginosa. The synthesized H₂TiO₃ was characterized using X – ray diffraction (XRD), Thermo Gravimetric analysis (TGA), Scanning Electron microscopy (SEM) and FT-IR. Antimicrobial properties were studied in terms of inhibition zone diameters by disc diffusion method using Gentamycin as positive control. Nine concentrations from each antimicrobial test compounds were used for the experiment. Triplicated results were analyzed statistically using computational software. As results obtained from the experiments, both H₂TiO₃ and K₂TiO₃ showed excellent antimicrobial properties in facile conditions superior to that of Gentamycin.

Keywords: Antibiotic resistance, positive control, reactive oxygen species, disc diffusion method
ELECTROSPUN NANOFIBERS LOADED WITH ZnO AS ANTIBACTERIAL WOUND DRESSING MATERIALS

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ABSTRACT

Polyvinylpyrrolidone (PVP)/ethyl cellulose (EC) fibrous mats were prepared by electrospinning technique. Similarly, ZnO nanoparticles (size ~40 nm) incorporated PVP/EC/ZnO fiber mats were also electrospun at 25 °C. PVP/EC electrospinning was carried out using ZnO with different concentrations to prepare PVP/EC/ZnO composite nanofibers. The prepared composite nanofibers were characterized using FT-IR and SEM studies. The antibacterial activity of the ZnO nanoparticle-filled PVP/EC fiber mats was assessed by observing their activity using the disc diffusion method, against both Gram-negative (Escherichia coli) and Gram-positive (Staphylococcus aureus) bacteria and found that PVP/EC/ZnO mats show antibacterial activity due to the presence of ZnO. These results suggest that PVP/EC fiber mats fabricated with ZnO have the ability to prevent bacterial proliferation at implantation sites and thus have good potential to be used for wound dressing applications.

Keywords: Polyvinylpyrrolidone (PVP), ethyl cellulose (EC), Zinc oxide, antibacterial activity, wound dressing and electrospinning
INSIGHT OF SILVER CHITIN NANOPARTICLE INTERACTION

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ABSTRACT

Chitin nanofibers (CNFs) were extracted from crabshells using a facile strategy and used to explore the unique interaction between the fibers and silver nanoparticles with various capping agents. Silver nanoparticles, enclosing four main types of capping methods; molecular capping, polymeric capping, surfactant capping and no capping, were synthesized using sodium citrate capping, chitosan capping, sodium dodecyl sulfate (SDS) capping and sodium borohydride respectively. Also, different particle sizes of sodium citrate capped nanoparticles were prepared by changing the reaction conditions. Dynamic light scattering was used to establish the dispersion behavior of the synthesized nanoparticles and CNFs. UV-Vis was used to measure the degree of binding of CNFs on to various silver nanoparticles at specific conditions. CNFs showed more than 80% binding of nanoparticles in all the variants. It was also observed that the type of the capping agent, the concentration of the CNFs and particle size has an influence on the binding behavior. Further characterization were carried out by using SEM, TEM, Particle size analyzer, XRD (X-Ray diffraction analysis), AFM, Surface enhanced Raman spectroscopy(SERS). Insight into the binding behavior of CNFs on to nanoparticles can pave way to novel strategies to remEDIATE water bodies polluted with nanoparticles.

Keywords : Chitin nanofibres, SDS, XRD, AFM, SEM, TEM
PERFORMANCE IMPROVEMENT OF DYE-SENSITIZED SOLAR CELLS BY MgO SURFACE MODIFICATION ON NANOPOROUS TiO$_2$ PHOTOANODE


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ABSTRACT

Dye-sensitized solar cells (DSCs) have been attracted due to its low-cost and high performances. DSC consists with photoanode, dye sensitizer, redox electrolyte and a counter electrode. In this study, nanoporous TiO$_2$ photoanode was prepared by spray pyrolysis deposition on fluorine doped tin oxide (FTO) substrate which empowers the efficient absorption of dye molecules using its large surface area. However, recombination of dye cations and the injected electrons limits the conversion efficiency of DSCs. The extent of recombination mainly depends on nature of TiO$_2$ surface, the structure and the mode of anchoring of the dye molecule to the TiO$_2$ surface. With intention of suppress the electron recombination and improve the power conversion efficiency of DSCs, TiO$_2$ photoanode surface was covered with a thin layer of MgO by immersing TiO$_2$/FTO substrate in a magnesium acetate solution. This ultra-thin MgO layer on TiO$_2$ surface prevents the tunneling of electrons from TiO$_2$ to the electrolyte interface. Scanning electron microscope images indicated the average particle size of TiO$_2$/MgO electrode was smaller than that of TiO$_2$ electrode. Both TiO$_2$ and TiO$_2$/MgO electrodes were soaked in a N719 dye solution overnight. UV-vis absorption spectra showed that dye coated TiO$_2$/MgO electrode had apparently enhanced dye adsorption compare to the dye coated TiO$_2$ electrode. Finally, space between the photoanodes and Pt counter electrode were filled with a liquid electrolyte (I$_1$/I$_3$) and solar cell performance was measured. Power conversion efficiency was increased from 9.8% to 11.0% as a result of blocking effect of MgO surface modification on TiO$_2$ photoanode.

Keywords: Dye-sensitized solar cell, Photoanode, Electron, TiO$_2$, MgO
TUNING OPTICAL PROPERTIES IN NANOCOMPOSITES

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\textbf{ABSTRACT}

Composite nanostructures are combination of different materials and play key role in plasmonics in terms of tuning optical properties. Plasmonic nanostructure have wide range of applications as biological and chemical sensors, photocatalytics, plasmon enhanced spectroscopy (SERS), solar cells and biotechnology. Plasmonics is based on excitation of surface plasmons which are collective oscillations of free electrons. Metallic nanostructures have ability to produce surface plasmon resonance (SPR) which are collective oscillations of conduction electrons of metal at interface with a dielectric medium. Tuning of optical properties in plasmonics can be done with the help of nanocomposites. Local surface plasmon resonance (LSPR) is an optical phenomenon observed in metals especially the noble metals such as Au, Ag in which excitations of conduction electrons are observed when light is incident on nanoparticles. The wavelength ($\lambda_{\text{SPR}}$) at which these resonances occur, strength of resonance and full width at half maximum depends on shape, size, concentration and external matrix of nanoparticles. The tuning of plasmonic resonance in nanocomposites of Au and Ag with different oxides are investigated along with the theoretical simulations to explain the obtained experimental results. According to Mie’s theory extinction cross section which is sum of scattering and absorption cross section is studied for Au and Ag for spherical nanoparticle of size less than incident light in quasi static limit theoretically as well as experimentally. It is shown that $\lambda_{\text{SPR}}$ is independent of particle size but its intensity is directly dependent on size of nanoparticle. Shift in $\lambda_{\text{SPR}}$ is observed by changing background dielectric constant, with a redshift as refractive index of the matrix increases. Good tunability of plasmonic resonance is observed in nanocomposites. It is observed experimentally that LSPR is redshifted as due to 1) Increase in the particle size of nanoparticle 2) Increased dielectric constant of matrix and 3) Increased concentration noble metal nanoparticle in the nanocomposite. This study of nanocomposites can be used as a tool for biodetection or biosensing. Such enhancement and tunability in the plasmonic behavior in Au, Ag based composites of appropriate band gap can be used for enhanced photocatalytic and photoluminescence properties.

Keywords: Nanostructures, SPR, plasmons
PEG AND CHITIN NANOFIBERS COMPOSITE FOR SMART WINDOWS WITH TUNABLE TRANSPARENCY

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\textbf{ABSTRACT}

Chitin is a naturally abundant material that can be easily extracted from natural sources. Chitin was transformed into chitin nanofibers using a unique strategy. Prepared chitin nanofibers were characterized using various spectroscopic and imaging methods which showed that they were completely defibrillated into their fundamental size (2-10 nm). Thus prepared chitin nanofibers were explored for smart window application through preparation of a composite with polyethylene glycol (PEG). PEG is a polymer which is available in different molecular weights and having melting points proportional to the molecular weight. Thus the most suitable PEG (1500 MW) was decided considering the melting point and temperature range of the application. PEG and chitin nanofibers were used in different concentrations to study the influence of PEG and chitin on the properties of the composite. DSC test was carried out to find the melting point of PEG and chitin blends. Melting point of PEG 1500 MW is around 29 0C which is a good switching point for a smart window application. Transmittance properties were studied using UV-Vis spectrophotometry. Further characterizations were done using XRD, DMA and AFM. It is observed that chitin has increased the opacity by 15-20\% compared to the normal PEG sample. The composite can tune the transmittance from 30\% to 90\% over a temperature range of 25 0C to 42 0C. Therefore, this PEG and chitin nanofibers composite can be used in a smart window application with switchable transparency.

Key words: Chitin nanofibers, polyethylene glycol, smart window
RAPID WATER DECONTAMINATION USING HYDROXYAPATITE – CERIA NANOHYBRIDS

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ABSTRACT

The world water stress is increasing rapidly from the time of the industrial revolution due to water getting constantly contaminated with chemicals of different nature. The key intension of this study was to synthesize an efficient biocompatible lead, arsenate and fluoride adsorbent from natural water bodies. For this purpose, hydroxyapatite - ceria (HAP-CeO₂) nanohybrids were successfully synthesized by in situ wet chemical precipitation method using ammonium monohydrogen phosphate, calcium nitrate and cerium sulphate. Synthesized composite was characterized using SEM and FT-IR techniques and the SEM micrograph shows that the shapes are irregular in nature and sizes are ranging from 50 nm to 120 nm. Successful synthesis of the composite was evident from FT-IR analysis which shows peaks corresponding to the both hydroxyapatite and ceria. Prepared hydroxyapatite-ceria composite was used for the removal of lead (II), arsenate and fluoride ions. In this study, it was observed that the composite reached the equilibrium at 30 seconds for Pb (II) and arsenate ions and 2 minutes for fluoride ions. The equilibrium Pb (II), arsenate and fluoride uptake capacities on the composite were 370 mg/g, 15.31 mg/g and 14.83 mg/g respectively. Moreover, the adsorption isothermal profiles of the Pb (II) and arsenate are well fitted with the Langmuir model and that model for fluoride ion adsorption onto HAP-CeO₂ is the freundlich model. These results suggest that the synthesized HAP-CeO₂ nanohybrid hold a great potential for Pb (II), arsenate and fluoride removal from aqueous systems.

Keywords: Adsorption, ceria, hydroxyapatite, adsorption isotherm
THERMALLY STABILIZED NANOMAGNETITE AND NANOTITANIA DOPED POLYACRYLONITRILE NANOFIBERS FOR SIMULTANEOUS REMOVAL OF As(V) AND Cd(II) IN WATER

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ABSTRACT

The fabrication of nanomagnetite and nanotitania doped polyacrylonitrile (MTPAN) composite fibers is explored by an electrospinning process. A uniform bead-free fiber production process is developed by optimizing electrospinning conditions: polymer concentration, applied electric voltage, feed rate and the distance between needle tip to the collector. The composite fibers were characterized using scanning electron microscopy (SEM), X-ray diffraction (XRD) and Fourier transformed infrared (FT-IR) spectroscopy. The pyrolysis temperature conditions of MTPAN fibers were determined by thermogravimetric analysis (TGA), as a prerequisite to produce metal oxide nanoparticles decorated carbon fibers via this route. Thermally stabilized MTPAN fibers were assessed for their As(V) and Cd(II) ion removal capacity. The isotherm studies were carried out in batch experiments. As(V) adsorption data could be best explained by the Freundlich isotherms whereas that of Cd(II) was well matched with Langmuir isotherms. The results indicate that the incorporation of nanomagnetite and nanotitania enhance the removal of both As(V) and Cd(II). However MTPAN fiber shows a greater affinity to Cd(II) than to As(V). The studies on the effects of pH on adsorption capacity showed that the adsorption of both As(V) and Cd(II) on to MTPAN fibers are electrostatically driven. The studies to evaluate the effect of the presence of co-ions demonstrated that the presence of high concentrations of Ca²⁺ and Mg²⁺ suppress the As(V) and Cd(II) adsorption while that effect from Ca²⁺ being prominent. This study suggests the potential use of MTPAN like nanofiber structures in the microfiltration techniques used for the heavy metal removal in water purification.

Keywords: Adsorption, nanofibers, polyacrylonitrile, electrospinning
POSTER PRESENTATIONS
INTERPENTRATIVE PEG/CHITOSAN POLYMER THIN FILMS FOR SMART TEXTILE APPLICATIONS: STUDY SHAPE MEMORY RESPONSIVENESS FOR MOISTURE

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ABSTRACT

In smart textiles several methodologies have been adopted to evaporate out the accumulated moisture using fabric engineering methods. These include improving wicking property (fabric made out of the fiber having crescent cross section), grafting of phase changing materials, channeling of moisture from the human body to the fabric surface using alternative hydrophobic, hydrophilic areas etc. In another applications the concept of shape memory polymers has been used in engineering of specific materials to effectively manage the body heat through textiles. In this study shape memory polymer thin films were prepared using PEG/chitosan as an interpenetrative network system. This polymer network is capable to absorb moisture and change its dimensions. Five different PEG/chitosan films were prepared with PEG/chitosan concentrations of 0%(w/v), 5%(w/v), 10%(w/v), 20%(w/v), 40%(w/v). The area percentage increasing due to moisture absorption, was measured. It has increased 2.24%, 2.75%, 3%, 3.24%, and 3.49% for corresponding PEG/chitosan concentrations. The best possible PEG/chitosan composition was selected by considering the responsiveness and strength of the film before and after moisture absorption. Moreover, expansion of the fabric attached with the SM composite film was observed and it showed good controllability over the dimensional changes and improvement of air permeation by increasing the pore size of the fabric. It can be suggest that chitosan/PEG films attached textile composite has allowed to make a channel for moisture evaporation and heat dissipation from the body to evaporate the moisture for returning to its initial position results cooling the body.

Keywords: Moisture, chitosan, PEG, textile, shape memory polymers
PEPTIDE DIRECTED SELF-ASSEMBLY OF ORGANIC SEMICONDUCTORS FOR BIOCOMPATIBLE ELECTRONICS

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ABSTRACT

Peptide sequences resembling protein-protein interfaces often exhibit impressive self-assembly behaviour. In particular, self-assembling peptides have the potential to be an elegant method for the preparation of nanostructures with well-defined molecular organisation. Attachment of self-assembling peptides to semiconducting dyes provide an additional possibility for control of molecular organisation not normally present in these materials. This increased control may enable the production of electronically-tuned organic semiconductors suitable for use in miniaturized, inexpensive, low-power electronic components and devices. This project aims to design a new family of bioelectronic materials featuring the semiconducting molecule diketopyrrolopyrrole (DPP) coupled to a naturally self-assembling peptide, derived from the protein-protein interface of diaminopimelate decarboxylase. Further modification of the peptide sequence will be explored to improve the self-assembly properties. The properties of these hybrid materials will be examined after modification and compared with previously synthesised molecules. Eventually, we aim to test these hybrid materials in organic electronic devices.

Keywords: Nanostructures, Self-assembling peptide, bioelectronics materials.

References:


MULTIPERIODIC SPIN PRECESSIONS OF THE OPTICALLY-INDUCED SPIN POLARIZATION IN Al$_x$Ga$_{1-x}$ As/AlAs SINGLE QUANTUM WELL

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ABSTRACT

Recently, the dynamics of spin polarization has attracted a great deal of interest for possible applications in electronic devices. The tuning of the electron g-factor and spin coherence time (T2*) is one of the key ingredients, for practical applications to store and manipulate spin information without loss. It has been widely studied in different dimensionally semiconductor nanostructures ranging from the bulk to quantum wells (QWs), quantum dots (QDs), quantum wires and layered structures.

In the present work, we employed the reflective probing of linear birefringence to explore the dependence of electron spin dynamics, in a high mobility dense two-dimensional electron gas, on the applied magnetic field, excitation power, and sample temperature using the time-resolved Kerr rotation (TRKR). Owing to the complex layered structure, the dynamics of spin polarization in the studied sample enclosed information about the spin signal corresponding to the different populations of electrons. Fit to the data revealed multi-periodic spin precession, with distinct g-factors that modulate the decay of the TRKR envelope. Additionally, the spin precession in our structure was seen to be thermally robust, persisting up to high temperature. The dynamics of optically-induced spins was monitored as a function of different experimental parameters.

Keywords: Spin coherence, Spin dephasing time, Quantum well, g-factor

Fig: Decomposition of the TRKR signal recorded at $B = 1$ T, $\lambda = 731$ nm and $T = 5$ K. The bottom curve is the measured signal and the top traces are the components obtained from decomposition.
VIRTUAL PRESENTATION
BIMETALLIC Co-Ru NANOPARTICLES SUPPORTED ON POLYACRYLONITRILE- DERIVED CARBON AS EFFECTIVE ETHANOL STEAM REFORMING CATALYST

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ABSTRACT

One-step method of preparation of bimetallic Co-Ru nanoparticles supported on polyacrylonitrile-derived carbon was proposed. IR pyrolysis of the precursor based on joint solution of polyacrylonitrile and metal compounds leads to the simultaneous formation carbon support and metal nanoparticles reduced due to the release of hydrogen during decomposition of backbone polymer chain. Furthermore, IR radiation shortens fabrication time significantly. It was shown that the presence of cobalt and ruthenium in the system provides the creation of alloy Co-Ru nanoparticles. In addition, cobalt provides a formation of structured carbon shells around bimetallic nanoparticles. The metal-carbon nanocomposites with 5% metal loading were prepared and characterized. The nanocomposites were tested as catalysts for the hydrogen production through ethanol steam reforming. It was revealed that a stage of hydrogen pre-treatment does not affect on the nanocomposite catalytic properties. The high yield of hydrogen was recorded, whereas the by-product yield was relatively low. Applying IR-PAN/Co-Ru(5%) provides the hydrogen yield up to 4.5 mol H₂/mol EtOH.

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Keywords: Metal-carbon nanocomposite, polyacrylonitrile, IR radiation, bimetallic nanoparticles, ethanol steam reforming, Co-Ru catalyst
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