Two – Day International Webinar

on

RECENT TRENDS IN NANOMATERIALS & NANOBIOMATERIALS (RTNN)

14th & 15th June, 2020

BOOK OF ABSTRACTS

Organized by

DEPARTMENT OF PHYSICS

NARAJOLE RAJ COLLEGE, NARAJOLE

Paschim Medinipur-721211

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NARAJOLE RAJ COLLEGE
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Message

Dated: 13.06.2020

It gives me immense pleasure to know that the Department of Physics of Narajole Raj College is going to organize a two-day International Webinar on "***Recent Trends in Nanomaterials and Nanobiomaterials (RTNN)***" on June 14th and 15th 2020 under the guidance of IQAC, Narajole Raj College.

As we all know that the current world is incomplete without the revolutionary word **"Nano"**. In spite of their very small size, they have an enormous influence on our everyday life from the preparation of sunscreen lotion to bio-sensing and nanoelectronic devices that makes them exciting and momentous to know about.

In this scenario, I congratulate the Convenor and the members of the organizing committee for arranging this academic venture that focus on *nanomaterials* & *nanobiomaterials* and making it a grand success. I rely on that this Webinar will illuminate the academic activity as well as imagination among the participants.

Dr. Anupam Parua,
Principal,
Narajole Raj College,
Paschim Medinipur,
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Internal Quality Assurance Cell (IQAC)

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I am immensely happy to know that the Dept of Physics, Narajole Raj College, is going to organize a Two-day International Webinar on "***Recent Trends in Nanomaterials and Nanobiomaterials (RTNN)***" on June 14th and 15th, 2020.

In present scenario, nanoscale materials have application in everything from sunscreen lotion to cancer therapy to antibacterial agents--from the mundane to the lifesaving. Therefore, the topic is very much relevant in this fast-changing world of Nanoscience & Biotechnology.

On behalf of, IQAC, Narajole Raj College, I extend my warm greetings to all those who are associated with this academic conference and wish the webinar all success.

Nilanjana Bhattacharyya

Dr. Nilanjana Bhattacharyya
Coordinator, IQAC
Narajole Raj College

Keynote Speaker's Abstracts:

Keynote Speaker: Dr. Subhadip Ghosh

School of Chemical Sciences, National Institute of Science Education and Research (NISER), Jatni, Odisha-752050

Insight to the Photo-physical Processes in Semiconductor Quantum Dots and Carbon Dots

Analyses of photo-physical processes in semiconductor nanoparticles including Förster Resonance Energy Transfer (FRET), Photo-induced Electron Transfer (PET)areoften complicated by a number of factors; like, close emission peak positions of donor and acceptor, presence of fluorescence blinking, and natural excited state decay processes.[1-4] Addressing these concerns mostly from material chemists and biologists, herein we propose an efficient protocol utilizing the bright green emission of fluorescent quantum dots (FQDs). Fluorescence integrity of FQD along with the uniqueness of our analysis methods demonstrates the potential of these FQD particles in their various opto-electrical applications. Molecular distance calculations relying on proposed FRET analysis complement nicely with our spectroscopic results; where FQD

as a photoluminescent marker is electrostatically attached to a compatible fluorescent dye rhodamine-6g (R6g).[1]The beneficial aspect of our state-of-art analysis methods enable many possibilities, including the use of low cytotoxic QD based FRET assays as a next generation molecular ruler for a precise estimation of distances inside a biological system.

Reference:

1. Model-free estimation of energy-transfer timescales in a closely emitting CdSe/ZnS quantum dot and rhodamine 6G FRET couple; Kiran Bharadwaj, Somnath Koley, Subhra Jana, **Subhadip Ghosh**, **Chem. Asian. J.** (2018)*13*,3296-3303.
2. Study of diffusion assisted bimolecular electron transfer reactions: CdSe/ZnS core shell quantum dot acts as an efficient electron donor as well as acceptor; Somnath Koley, Manas Ranjan Panda, **Subhadip Ghosh**, **J. Phys. Chem. C** (2016), 120, 13456-13465.
3. Diffusion Assisted Bimolecular Electron Injection to CdS Quantum Dots: Existence of Different Regimes in Time Dependent Sink Term of Collins–Kimball Model; Aparna Bhowmik, Harveen Kaur, Somnath Koley, Subhra Jana, **Subhadip Ghosh**; **J. Phys. Chem. C** (2016), 120, 5308–5314.
4. Ground State Heterogeneity along with Fluorescent Byproducts Cause the Excitation-Dependent Fluorescence and Time-Dependent Spectral Migration in Citric Acid Derived Carbon Dots; Krishna Mishra, Somnath Koley, **Subhadip Ghosh**;. **J. Phys. Chem. Lett.** (2019), DOI: 10.1021/acs.jpclett.8b03803.

Invited Speakers' Abstracts:

Invited Speaker: Dr. Ravi Kiran Saripalli

Tulane University, United States of America

Manipulation of Light through interaction with Nanomaterials

A fundamental property of light is its ability to rotate while propagating through a medium. The commonly observed form of such rotation is the polarization rotation, or spin angular momentum (SAM). SAM is associated with the polarization of the light beam which is a consequence of the vectorial nature of the electromagnetic field. Only about two decades ago, Allen et al. [Phys. Rev. A 45, 8185–8189 (1992)] recognized that light has another form of angular momentum originating from its helical wavefront structure, known as orbital angular momentum (OAM). Optical beams carrying OAM, commonly termed vortex beams, have azimuthal phase pattern leading to phase singularity and doughnut shaped intensity profile. Spin-Orbit interaction (SOI) of light is an important phenomenon where these otherwise independent angular momenta (SAM and OAM) can be made to interact, hence allowing the

manipulation of the spatial profile of the light beam while tuning its polarization. This talk focuses on recent developments on light-matter interactions with Nanomaterials - termed as metasurfaces, that facilitate SOI of light.

SOI of light has been observed previously by either high-numerical aperture (NA) focusing of circularly polarized light or through the propagation of circularly polarized light in inhomogeneous and anisotropic media. Proper designing of anisotropic and inhomogeneous structures in metasurfaces facilitates considerable enhancement of the SOI effects, however requiring complex and precise nano-structuring facilities. Also, metasurfaces would render ineffective for very small wavelengths and also have very limited bandwidth of operation. Recently, A. Ciattoni et. al. [Phys. Rev. Lett. 118, 104301 (2017)] have developed a theory proposing an intriguingly simple geometry for the efficient vortex generation through SOI in homogeneous and isotropic Epsilon-Near-Zero (ENZ) thin films without high NA focusing. In this talk, I focus on our work where using a femtosecond laser source with a wavelength in the ENZ wavelength regime of the film, we have experimentally verified the SOI and thus vortex generation in ENZ films.

Invited Speaker: Dr. Uday Narayan Maiti

Department of Physics, IIT Guwahati, Guwahati-781039

Two dimensional atomic layers: Graphene and beyond

Two dimensional (2D) crystals had long been considered as non-existent materials, but still taught in the classroom for easy understanding of physics beyond simplest one dimensional (1D) model. But surprise discovery of graphene in 2004, an atomic thin layer of carbon, has changed this perception and have immediately started to revolutionize the field of nanotechnology. Ultrahigh specific surface area, record electron mobility, unprecedented strength and easy tunability of electronic properties are the few unique properties which find their applications in electronic industry, energy storage and conversion, memory devices, water cleaning, cell imaging, aviation industry and many more. Following the discovery of graphene, recently several analogous 2D materials have also been discovered; single layer of molybdenum disulphide, boron nitride, Titanium aluminium carbide (MXene), Silicene, and germanene are being few notable examples. This second round wave of discovery of 2D materials has led to new

inventions and devices. In my presentation, I am going to discuss this new world of 2D materials and it will be delivered at a level considering college students as the primary audience.

Invited Speaker: Dr. Kallol Roy

Centre for Advanced 2D Materials, National University of Singapore, Singapore 117546

Photons, plasmons and nanometer-size gaps

Physical parameters, which define the properties of a material, can change dramatically when the geometrical dimensions of the material are sized to nanometer scale. Thus, nanomaterials offer control on various physical phenomena. In this presentation we shall highlight confinement of light within nano-gaps (~2nm-100nm) formed by metal-dielectric and metal-dielectric-metal interfaces. Such nano-gaps help altering effective index or optical density of states of the system and allow controlling various physical phenomena such as optical-energy confinement beyond diffraction limit, optical-scattering, plasmonic resonance, inelastic electron tunneling-assisted light or plasmon emission etc. Few specific device geometries will be presented to relate the said phenomena. Applications involving strong photonic and plasmonic interactions at nanoscale, will be discussed.

Invited Speaker: Dr. Sudipto Kumar Pal

Postdoctoral Researcher, Department of Innovation Engineering, University of Salento, Lecce, Italy

Nanomaterials in Environmental remediation, self-cleaning and antimicrobial surfaces-from laboratory concept to practical applications

Nanomaterials and nanotechnology carries a significant impact, and serves as a revolutionary and beneficial technology across various industrial domains, including, medicine, transportation, agriculture, energy, materials & manufacturing, consumer products, and households. The present contribution gives an overview and direct application of nanomaterials in environmental remediation as well as antimicrobial surfaces. In the area of environmental remediation, nanomaterials offer the potential for the efficient removal of pollutants and biological contaminants, both outdoor and indoor. Photocatalysis is an effective and environment friendly way to combat with the pollutants. Different application of nanostructured TiO_2 photo-catalyst will be discussed, which is widely used in many fields including environmental

decontamination, sterilization, household and personal products. Another interesting application of nanomaterials is the development of antimicrobial materials. Silver and copper nanomaterials on different surfaces show extremely high antimicrobial activities that leads them to use in different biotechnological fields. Some of the recent trends with these materials will be discussed.

Invited Speaker:HaradhanKolya

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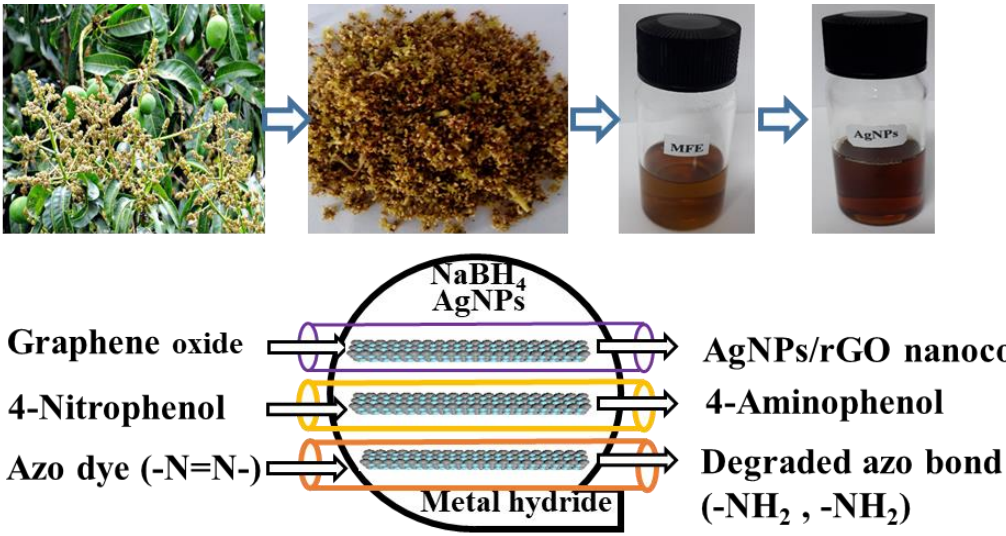
Metal nanostructures for wastewater purification

Supply of pure water is a big challenge in most of the developing and third-world countries. There are many strategies for wastewater purification. Nowadays, metal nanostructures have been the focus of active research and development in the world. Different studies have shown that metal nanostructures can detect and remove various contaminants in water effectively and have therefore been successfully applied in water and wastewater purification. Here, different precious metal nanostructures such as AuNPs, AgNPs, Ag-AuNPs and AgNPs-rGO nanocomposite are discussed in detail. In addition, future

applications of metal nanostructures are being discussed in wastewater purification.

Graphical Abstract



Paper Presenters' Abstracts:

Electrical and Opto-electronic Properties of Chemically Synthesized Zinc Oxide Nanoparticles

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We have deployed a chemical method for growing ZnO nanoparticles. XRD data suggests the formation of crystalline ZnO nanoparticles (NPs) of high crystallinity with crystallite 16 nm. Frequency dependent dielectric and electrical response suggests that the relaxation behaviour of ZnO NPs is non-Debye type. This leads to the generation of additional constant phase element (CPE) along with the ac equivalent parallel RC network. Dominance of the grain boundary effect was also observed from the Nyquist plot. The synthesized ZnO NPs has dc electrical conductivity of 4.9×10^{-8} Ω-cm. The UV-visible absorption spectroscopy revealed high transparency of the material in the visible region of wavelength. Analysis of the UV-visible spectroscopic data with Tauc equation the band gap was calculated to be 3.52 eV. The synthesized ZnO NPs exhibit strong photoluminescence peaked at 582 nm owing to the presence of interstitial oxygen in the ZnO nanocrystals.

Keywords: Nanoparticles, Nyquist Plot; Non-Debye relaxation, Absorption, Photoluminescence.

Structural and Textural Characteristics of Nanoporous Aluminophosphate and its Catalytic Application

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The objective of this effort is to synthesize the nanoporous molecular sieves by simple method using alkylamine as template. The obtained synthesized material was characterized by various spectroscopic techniques. The Infrared spectrum was taken for confirming the tetrahedral frame work of $AlPO_4$. Crystalline nature of the material was confirmed by wide angle and low angle XRD method. Thermal stability of the material were analyzed by thermo gravimetric method. Nitrogen adsorption was used to determine the specific surface area, pore volume, pore diameter of the material. The surface morphology of the material was confirmed by Scanning Electron Micrograph. The catalytic activity of the material is studied by transesterification reaction for the production of biodiesel. Transesterification is affected by factors like reaction time, temperature, oil to alcohol ratio and concentration of catalyst. The reaction parameters were optimized and a maximum yield of biodiesel has been achieved.

Key words: molecular sieve, nanoporous, transesterification, template

Positron Annihilation studies on Cu doped ZnO nanoparticles

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During recent past nanoparticles of the otherwise nonmagnetic inorganic materials exhibit room temperature ferromagnetism. Presence of cation or anion type defects at the surface of the particles makes the nanomaterial either ferromagnetic or diamagnetic. Thus, it is expected that ferromagnetism is confined to the surface of the nanoparticles while the core remains diamagnetic. Many research papers has been published to show that atomic defects or substitution of other elements in very low amounts in semiconductors introduced different functional properties like magnetic, electric, optical etc. The nature of defect responsible for magnetism strongly depends on specific material. Thus identification of defects in these materials draws several attraction. Positron annihilation technique is a non-destructive technique to identify the defects inside a material. In these study we have prepared Cu doped ZnO nanoparticles and try to identify the defects by Positron annihilation technique.

Reference:

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Temperature dependence Impedance spectroscopy of $SrCo_3$ modified $0.7BaTiO_3$-$0.3ZnFe_2O_4$ ceramic materials

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Complex impedance spectroscopy (CIS) of $0.7Ba_{0.9}Sr_{0.1}TiO_3$ $0.3ZnFe_2O_4$ multiferroic ceramic materials were prepared by high temperature solid state reaction (mixed oxide) method. The rhombohedral crystal structure of the material is confirmed by room temperature X-ray diffraction (XRD) study. Scanning electron microscope images revealed the formation of well crystalline grains separated by grain boundaries. These micrographs reveal the growing of likely hexagonal grain which is distributed on the surface of the samples with wide range of average grain size from 300 nm ~ 600 nm. The Nyquist plot (Z' vs Z'') exhibits semicircle in the complex plane indicating the presence of both bulk and grain boundary effect at high temperature. The bulk resistance of the material decreases with rise in temperature which implies the NTCR (Negative temperature coefficient of resistance) behaviour of the material like that of a semiconductor.

Silver Nanoparticles: Its Synthetic approaches, Properties and Applications

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Nanoparticles (NPs) are tiny materials having size ranges from 1 to 100 nm. They can be classified into different classes based on their shape and size dependent properties. The different groups include fullerenes, metal NPs, ceramic NPs, and polymeric NPs. Silver nanoparticles (AgNPs) are unique among these nanoparticles (NPs). They are synthesized by physical, chemical and biological approaches. AgNPs possess unique physical and chemical properties due to their high surface area and nanoscale size. Their optical properties are dependent on size, which imparts different colours due to absorption in the visible region. Their reactivity, toughness and other significant properties are also dependent on their unique size, shape and structure. Due to these characteristics, they are suitable candidates for various commercial and domestic applications, which include catalysis, imaging, medical applications, energy-based research, and environmental applications. In this review, we have focused on mainly synthetic approaches and different applications of silver nanoparticles.

Keywords: Silver Nanoparticles, Surface area, applications

Determination of Soil Suitability Based on Different Techniques

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In this paper discussed the different techniques for detecting the moisture of soil. Various techniques were used but found few drawbacks such as large measurement setup, time consuming as well as expensive. The microwave techniques are analyzed, which is low cost as well as compact size. Various microwave sensors have been designed to give a real-time, simple, sensitive, small size and low cost for soil moisture measurement. In this paper discussed the various techniques and compared, it is concluded that oven drying technique is better to others in terms of time efficiency, accuracy and low cost.

Keywords: Microstip patch antenna, Moisture Content, Soil, Printed circuit board (PCB), Vector network analyzer (VNA)

Metal Nanoparticles-Protein Interface: CoronaFormation and Interaction Analysis

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Recently, metal nanoparticles have shown its potential importance in the field of nanoelectronics to diagnosis and therapy, particularly drug delivery, gene therapy, biosensor as well as bio imaging. There are many successful applications of nanomaterials in biomedical domain, including the detection of bacteria, Alzheimer disease, detection of cancer cells, protein fibrillation and so on. Among the several nanoparticles, the gold (Au) and silver (Ag) nanoparticles have been using widely in environment, food, cosmetics industry, as well as drug delivery. The ultra-small size metal nanoparticles (1–50 nm) exhibits larger surface area compared to its volume. This relatively large surface area increases their free energy and reactivity, which in many instances also increases toxicity. The toxicity can limit the use of metal nanoparticles in their biology applications unless the nano-bio interface is fully understood. Thus, the fundamental question related its safety issue to health science which remains numerous challenges. Proteins from *"Nanoparticle-Protein Corona"*, when they came in contact to nanoparticles [1-2]. It causes the unfolding of protein, which is intimately related to loss of

activity of protein molecules along with several protein-mediated diseases. In this article, we have focused on the several aspects of interaction of proteins with metal nanoparticles and their corona formation. The dynamics of corona formation, change of hydrodynamic size of the corona and unfolding of protein molecules along with their deformation of secondary structures upon interaction with metal nanoparticles are also discussed.

References

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Role of *swift heavy ion irradiation* in materials science in consequence with Thermal Spike Model

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Irradiation of materials, by high energy ions (known as swift heavy ions or SHI), results a rapid increase in lattice temperature (~10^4 K) and highly excited lattice atoms in dominant inelastic collisions. Atomic displacements and structural transformations of such a lattice brings out interesting modifications provide new advanced materials. Thermal spike model is an established mechanism to explain the ion-matter interaction phenomenon. The interaction of the ion with material is the deciding factor in the ion beam-induced material modifications such as latent track formation in insulators, semiconductors and metallic glasses, nanoparticle elongation in metal and semiconductor, ion beam mixing in the metal/Si interface, defect production and annealing of defects in semiconductors, plastic deformation, structural modifications of nuclear materials in a reactor undergo due to radiation damage. With the emergence of nanotechnology ion irradiation also provides controlled ways to create or modify nanostructures including nanowires, nanorods, etc.

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Silver Nanocluster assisted Metal ion Sensing

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Metal nanoclusters now a days have attracted special attention due to their biocompatibility and optical appearance. Among them Silver nanoclusters (AgNC) is of special interestowing to its versatile property from optical to biological applications. In this work we have showed tiny sized polyetheleneimine capped AgNC (PEI-AgNC) (size ~2.4 nm) can distinguish cobalt ion (Co^{2+}) among a series of metal ions. Cobalt ions has important biological role due to its presence in vitamin B12 (cobalamin). On the other hand excess Co^{2+} may cause rhinitis, allergic dermatitis, asthma. A plausible meachanism has also been demonstrated here which explains that in presence of Co^{2+} PEI can no longer stabilize AgNC, which leads to aggregation.

Imparting Natural Compounds and Nanomaterials Based Potential Inhibitors of Advanced Glycoxidation

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Non-enzymatic attachment of reducing sugar to amino acids of proteins usually via lysine and arginine residues is commonly known as glycation. The process undergoes several reactions including Mailard, Schiff base and Amadori rearrangement. Under hyperglycaemic condition, the oxidative cleavage of those adducts leads to advanced glycation products which are characterized by the cohort of complex, heterogenous and toxic intermediates. Many of them are prone to crosslink with the protein itself or with other proteins resulting in further complication in diabetic mellitus. By virtue of its abundance in plasma, serum albumins are amenable to non-enzymatic glycoxidation under elevated sugar concentration and alteration of pH. Both diabetic condition and aging escalate the process of advanced glycoxidation to a serious health condition.To prevent the process of such complication, many inhibitor based drug molecules are commonly employed. Past few years, considerable attention has been imparted towardsdevelopment of inhibitors from natural phytochemicals, natural products and green nanoparticles (NPs) possessing antiglycative properties. To inhibit the formation of glycoxidation products, the most common molecular strategy is based on the ability to quench reactive carbonyl species (RCS) as glycation precursors. There are ample of carbonyl quenchers such as aminoguanidine, metformin, hydralazine, edaravone, ALT-946, TM2002 which act as potential inhibitor of advanced glycoxidation. In addition,

metal chelators are often found to be effective to neutralise RCS. In vitro antiglycation potential of AuNPs and AgNPs in conjugation with collagen or β—galactosidase has recently been found to be useful tool to counteract aberrant glycoxidation process.

Keywords: glycoxidation, hyperglycemia, advanced glycation, phytochemicals, nanoparticles

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Green synthesis of silver nanoparticles using the polysaccharide isolated from the leaves of *Cheilocostusspeciosus* and study of antimicrobial activity and catalytic effect on Congo red

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Nanotechnology is the most interesting areas due to its wide application in chemistry, electronics ecology, and medicine as well chemists, biologists/microbiologists for their commercial demand as in biological fields.[1,2]A green synthesis of silver nanoparticles was synthesized by $AgNO_3$ with polysaccharide, isolated from the leaves of *Cheilocostusspeciosus*. The polysaccharide plays the role for both reducing and stabilizing agent. The synthesized Ag-NPs were characterized by UV–vis spectroscopy. The surface plasmon resonance (SPR) band of UV–vis spectrum around 430 nm confirmed the formation of Ag-NPs.[3] The prepared AgNPs showed antimicrobial activity against some important human pathogenic bacteria such as *E. coli* ATCC 25922, *S. typhimurium* ATCC 14025, *K. pneumoniae* ATCC 70063. This nanoparticles is responsible for the degradation of the bacterial DNA into mononucleotide level and for that reason it shows hyperchromic effect. This Ag-NPs also showed the photocatalytic activity on congo red.

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Recent development in thin film silicon solar cell

Ushasi Dutta

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Solar photo-voltaic (PV) modules is dominated by crystalline-silicon (c-Si) solar cells,occupying nearly 80% of total PV market due to its high conversion efficiency but suffers from high production cost.Thin film amorphous-silicon solar cell for its low cost and ability of large area deposition made it suitable for large scale terrestrial applications. However thin film hydrogenated amorphous-silicon (a-Si:H) solar cell technologies is being commercialized and it occupies nearly 10% of PV market as its conversion efficiency tolls at 10% in PIN solar module which again degrade by 25% in single junction cells, before stabilization sets in. To get most advantageous result of conversion efficiency people are trying to combine amorphous with nano-crystalline/micro-crystalline silicon. Current article focuses on how the significant advancement of thin film solar cells have been made by incorporating nano-crystalline silicon (nc-Si:H) in single and multi-junction solar cells.Recently a high conversion efficiency of 11.1% was attained in microcrystalline silicon solar cells on honeycomb textured substrate [1] and conversion efficiency of 12.69% for a-Si:H/hydrogenated microcrystalline silicon (µc-Si:H) tandem solar cells has been achieved by Matsui et al.[2].On the other side of solar cell spectrum single walled carbon nano-tube (SWCNTs) has been used as an alternative of transparent conductor for hybrid thin film solar cells and the newly fabricated film have been able to achieve 8.8% efficiency (area 1 cm^2).[3]

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Design of Continuous Wave UV induced waveguides in Lithium Niobate

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Single mode CW-UV written waveguide in $LiNbO_3$ is designed by optimization writing parameters. Continuous wave (CW) UV written waveguide was first demonstrated by S. Mailis et al. They showed that it guides TM mode in the visible and infrared light with 0.7-2 dB/cm loss depending on the laser writing parameters. The extra ordinary refractive index profile (TM mode) is nearly Gaussian in nature and its full-width-half-maxima (FWHM) and maximum refractive index change depends on the writing parameters, such as, laser power, wavelength, spot size and scanning speed. However, by using the published model the predicted temperature increment due to absorption of 305 nm writing laser is neglegible to create any optical waveguiding property in the crystal. In this work we incorporated temperature dependent absorption coefficient in the theoretical model and heat flow equation is solved numericallyto determine the temperature profiles during the laser writing process. Finally, the resultant change in concentration of lithium due to thermal diffusion process was obtained by solving diffusion equation numerically also, and converted to refractive index profiles by applying the concentration dependent Sellmeir equation of the material. The computed result explains the waveguide formation process at 305 nm writing wavelength. Then the lateral and depth index profiles are extracted from published near-field distributions of fabricated waveguides. From our theoretical results we have observed that change in activation energy of Li-indiffusion affects the computed refractive index profiles to a large extent, and the computed and measured profiles matches fairly well for 305 nm and 275 nm written waveguides with an

activation energy equal to ~1.3 eV. For both the wavelengths the waveguides are single mode in nature, which tallies with experimental results.

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