INTERNATIONAL CONFERENCE ON RECENT TRENDS IN PHOTONICS

NPS 2022

Feb 27-March 1, 2022

Organised by:
International School of Photonics
Cochin Universtity of Science and Technology
Cochin,Kerala - 682022

BOOK OF ABSTRACTS

COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY

YEARS CELEBRATING KNOWLEDGE

International Conference on Recent Trends in Photonics

NPS - 2022

27 February - 01 March 2022

International School of Photonics

Cochin University of Science and Technology

Cochin - 682022, Kerala, India

Book of Abstracts

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International Conference on Recent Trends in Photonics (NPS - 2022)

27 February - 01 March 2022

International School of Photonics
Cochin University of Science and Technology, Cochin, Kerala, India

Program Schedule

Time(IST)	Program	Speaker	Session Chair
Day 1: 27 February 2022			
09:00	**Inauguration**		
10:00	**Plenary Talk**	Dr. V M Murukeshan. Center for Optical and Laser Engineering (COLE), NTU Singapore.	Prof. Pramod Gopinath
11:00 - 11:15	Break		
11.15 - 13:00	**Oral presentations**	(NPS-2022-04, 21, 24, 39, 42, 46, 48, 56) In the listed order.	Dr. Saji K J
13:00 - 14:00	Break		
14:00	**Keynote Talk**	Prof. Franz Kaertner. University of Hamburg, Germany.	Prof. A. Mujeeb
15:00	**Plenary Talk**	Dr. Pablo Albella University Of Cantabria, Santander, Spain.	Dr. Mohamed Ameen
16:00 -17:00	**Industry session**		Dr. Mohamed Ameen
17:15 - 18:30	**Poster session**	(NPS-2022-06, 09, 11, 13, 15, 20, 22, 27, 28, 32, 35, 40, 50, 55, 60, 61) (16 posters)	
Day 2: 28 February 2022			
09:00	**Invited Talk**	Dr. Tatyana Sizyuk, Argonne National Laboratory, USA	Prof. VM Nandakumaran
10:00	**National Science Day Lecture**	Prof. G. Ravindrakumar, Distinguished Professor, TIFR, Mumbai.	Prof. C. P. Girijavallabhan
11:00 - 11:15	Break		

11:15		Dr. Suresh Nair, IEEE India Council Track Chair	Prof. M. Kailasnath
11:30 - 13:00	**Oral Presentations**	(NPS-2022-03, 12, 17, 19, 25, 26, 44) In the listed order.	Dr. SKS Nair
13:00 - 14:00	Break		
14:00	**Invited Talk**	Dr. Swapna Nair Central University of Kerala, Kasaragod.	Dr. Saji K J
15:00	**Invited Talk**	Dr. Madhu Veettikazhy Technical University of Denmark, Denmark	Muhammad Rishad
16:15 - 17:30	**Poster Presentations**	(NPS-2022-05, 07, 08, 10, 16, 17, 23, 29, 31, 33, 34, 37, 43, 47, 51, 53, 57, 59) (18 posters)	
Day 3: 01 March 2022			
09:00	**Invited Talk**	Dr. Sonia Mary, The Jackson Laboratory, USA	Dr. Priya Rose
10:00 - 10:30	Break		
10:30	**Plenary Talk**	Dr. Kazuhiko Maeda, Tokyo Institute of Technology, Japan	Dr. Praveen C S
11:30 - 13:00	**Oral Presentations**	(NPS-2022-41, 45, 49, 52, 54, 58) In the listed order.	Dr. Praveen C S
13:00 - 14:00	Break		
14:00	**Invited Talk**	Prof. Radhakrishna Prabhu, Robert Gordon University, Aberdeen, UK.	Prof. M. Kailasnath
15:00	**Invited Talk**	Dr. Renil Kumar Chief Scientist, Motion Imager, Twente, The Netherlands. Industry Talk	Dr. Manu Vaishakh
16:00	**ValedictoryMeeting**		

The codes mentioned in the schedule can be seen in the email received from Morressier.

KEY-NOTE TALK

NPS-2022-KN 1
Compact Terahertz Driven Electron and X-ray Sources

Franz X. Kärtner
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Ultrafast Optics and X-rays Group, Center for Free-Electron Laser Science,Deutsches Elektronen Synchrotron (DESY), and Department of Physics and The Centre for Ultrafast Imaging, Universität Hamburg,Germany

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The use of very high frequencies, in the THz region, specifically 100 - 500 GHz, enables operation of accelerators at higher field strength with lower energetic driverpulses. This opens up the possibility of compact low emittance electron sources andhigh-brightness fully coherent X-ray sources. In this contribution, we summarize theprogress made in the ERC Synergy Grant AXSIS: Attosecond X-ray Science – Imaging and Spectroscopy in source technology. The high acceleration fields and field gradients possible in terahertz devices enables novel electron bunch manipulations, bunch diagnostic and promise ultimately fully coherent X-ray production from compact sources. Latest experimental results in the implementationof electron and X-ray sources based on this technology will be discussed.

PLENARY TALKS

NPS-2022-PL 1

Making artificial photosynthetic assemblies using layered materials

Kazuhiko Maeda
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Metal oxide nanosheets derived from the layered counterparts have attracted attention in various fields due totheir unique structural properties. The anisotropic feature of nanosheets, having a thickness of ~1 nm and lateral dimensions ranging from several hundred nanometers to a few micrometer, is advantageous for heterogeneous photocatalysis, as the diffusion length of photogenerated carriers to the surface is shortened, leading to higher activity.

It is also known that certain nanoparticulate metals or metal oxides on a semiconductor photocatalyst work as cocatalysts to promote water reduction and/or oxidation. In heterogeneous photocatalysis, the effect of cocatalyst size on the water-splitting performance had not been examined at sizes smaller than 1 nm due to thelack of an effective preparation method and a suitable photocatalyst. We have demonstrated that metal nanoclusters (such as Pt) of <1 nm in size could be deposited on the interlayer nanospace of $KCa_2Nb_3O_{10}$ usingthe electrostatic attraction between a cationic metal complex and a negatively charged $Ca_2Nb_3O_{10}^-$ sheet, without the aid of any additional reagent. The material obtained exhibited 8 times greater photocatalytic activity for overall water splitting under band-gap irradiation than the previously reported analog using a RuO_2 promoter. This study highlighted the superior functionality of <1 nm Pt nanoclusters for photocatalytic overallwater splitting.

With further modification by a ruthenium(II) photosensitizer, this material also worked as a H_2 evolution photocatalyst in visible-light-driven Z-scheme water splitting, in combination with a WO_3-based O_2 evolution photocatalyst and a triiodide/iodide redox couple. Pt-intercalated $HCa_2Nb_3O_{10}$ nanosheets further modified with amorphous AlO_x clusters demonstrated a remarkable photocatalytic activity with a dye-based turnover number and frequency for H_2 evolution of 4580 and 1960 h^{-1}, respectively, which were by far the highest among dye-sensitized nonsacrificial photocatalytic systems ever reported.

NPS-2022-PL 2
Optical nanoantennas as light and heat enhancers

Pablo Albella
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Metallic or high-refractive index nanostructures that show resonances when excited with light can act as optical nanoantennas, providing a versatile tool to control light beyond the conventional diffraction limit. On the other hand, depending on their material optical nanoantennas can be appropriate for different applications such as ultrasensitive (bio-) sensing, surface enhanced spectroscopies or photothermal devices. In the case of metallic nanoantennas, plasmonic excitations are possible but known to be present relatively large losses. This fact is undesirable in applications like sensing or spectroscopy, and dielectric alternatives have been successfully proposed to overcome this problem. However, optical losses in metals are necessary when aiming at photothermal applications since they are the source of the thermal generation. In this talk, I will describe and discuss the origins and recent advances in this rapidly developing field of optical nanoantennas and its alternative based on dielectrics. I will pay special attention to the main significant contributions we have made in applications such as sensing, light guiding or those based on photothermal response

NPS-2022-PL 3

BIOMEDICAL OPTICS- Multi-modality imaging, resolution enhancement and effect of nanoscale contrast agents

Murukeshan Vadakke Matham
Director, Center for Optical and Laser Engineering (COLE), NTU, Singapore
Email: MMURUKESHAN@ntu.edu.sg

High-resolution diagnostic biomedical optics is an interdisciplinary branch of science and technology, which uses optics for improving the basic understanding of biological processes to enhance the diagnostic efficiency thereby enabling efficient treatment of human diseases. In most of the cases, conventional types of medical imaging may not be able to detect subtle changes occurring in tissues easily. Each imaging modality has its own advantages and limitations and one cannot fit one single modality for all diagnostic applications. Therefore, the need for a multi or hybrid modality imaging arises. High-resolution imaging with optimal working distance, imaging around opaque obstacles are also of prime importance in today's imaging world. However, the quest for multi-modality settings for the diagnostic imaging has posed subduing effects of certain advantages of the respective individual modalities. From these perspectives, a paradigm shift in medical diagnostics was introduced in the recent pastby way of enhancing different parameters of interest using nanoscale contrast agents. A brief overview on the proposed schemes that can be explored based on the works carried out by the author's group for early diagnosis of cancerous growth in colon, and ocular imaging targeting iridocorneal angle and imaging of cornea will be reviewed from this perspective. A high resolution probe with selective spatiotemporalimaging that can find potential applications in opto-genetics will also be discussed.

NATIONAL SCIENCE DAY LECTURE

NPS-2022-NSL

National Science Day Lecture

Throwing (Huge Amount of) Light at Matter

G. Ravindra Kumar

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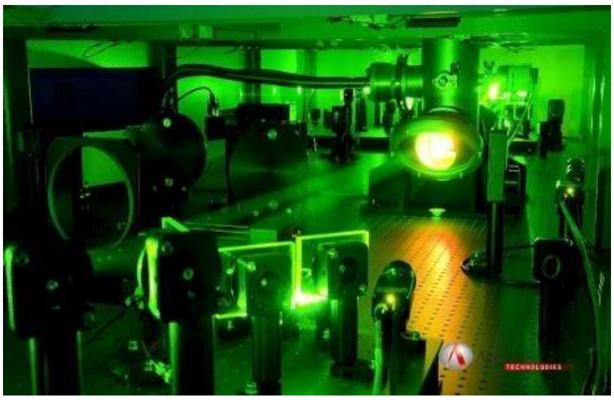
Intense fluxes of light do very interesting things to matter and the resulting nonlinear behavior of matter has been known for decades. The latest forays involve abnormally large intensities of light (in W/sq.cm, the number reminds us of the Avagadro number from our school chemistry!) and provoke matter to display very unusual behavior enabling us to study stars right on a table top in the lab.

This talk will attempt to describe some science with abnormally large intensities of light, citing experiments performed at TIFR – creation of gigantic magnetic pulses (100s of megagauss), passage of relativistic electrons through dense, hot matter and its consequences in terms of MeV ion production, ultrafast hard x-ray emission *etc.*. The emphasis will be on conveying the broad scope of the field as well as some pointers to the future.

Gerard Mourou and Donna Strickland won half the Nobel prize in physics in 2018 for the invention of chirped pulse amplification that facilitated ultrahigh power, femtosecond laser pulses. The most powerful, ultrashort pulse laser that emits 10 petawatt, 25 femtosecond pulses, was inaugurated in Nov 2020 at the ‘Extreme Light Infrastructure- Nuclear Physics’ in Romania.



The 150 terawatt, femtosecond laser system at TIFR

INVITED TALKS

NPS-2022-IT 1

Laser produced plasmas for EUV nanolithography: challenges and advances in development of efficient photon sources

Tatyana Sizyuk
Argonne National Laboratory, USA.
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Extreme ultraviolet (EUV) nanolithography is one of the current approaches for more powerful microchips production by increasing the optical imaging resolution. Two decades of research in this area showed that most feasible photon sources around 13.5 nm wavelength can be developed in laser produced plasma (LPP) devices. Optimizationof these devices depends on the complex parameters involved including laser pulse characteristics, target material and pre-conditioning, and ambient gas in the chamber toprotect the optical collection mirrors. The complexity is increased when dual-pulse laser systems are used to improve the efficiency of EUV source and to reduce the damage to the multilayer mirror (MLM) system due to the energetic ions from LPP. Allthese aspects and the progress in the improvement of EUV sources will be presented based on the comprehensive modeling and benchmarking of LPPs from Tin microdroplets in single and dual pulse systems. Modeling results from the 3D multi- physics package will be presented illustrating the dependences of EUV photon emissionand collection as well as ion kinetic energies on the LPP temporal and spatial evolution.

NPS-2022-IT 2

Optical Fibres and their emerging sensing applications

Prof. Radhakrishna Prabhu
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In the last two decades, fibre optic technology has revolutionized the telecommunications industry, enabling high bandwidth, high-capacity, long-distance communications, and networking at extremely low costs. Opticalfibres have also played important roles in many other applications including sensing. Fibre Optic Sensing is a powerful sensing approach with widespread use in various applications. Over the past few years, there has been growing interest in the development of glass or polymer-based fibre optic sensors. Optical fibres have advantages like smaller size, immunity to electromagnetic interference, freedom from corrosion, chemical inertness and large bandwidth which can accommodate the growing needs of sensing and monitoring in challenging environments. Optical fibres allow real-time remote monitoring of various environmental parameters such as pressure, temperature, strain, and they are capable of carrying out distributed sensing. Further, many point-type sensors can be embedded into fibres and can be monitored remotely, exploiting the large bandwidth associated with fibres. This talk will explore recent developments of a variety of optical fibre-based sensing devices for physical, chemical and biosensing applications, especially focussed on medical, security, oil and gas applications. The small size of fibres allows miniaturization adequate for most common medical applications and support integration of micro/nanosensors on the fibre tip and has the capability to monitor multiparameters in real-time *in-vivo*, making a potential candidate for the emerging robotic based surgeries. They have potential in security applications also. Specialised optical fibres with composite materials or special coatings can detect commonly encountered chemicals in oil and gas wells such as hydrocarbons, hydrogen, oxygen and ammonia with unprecedented accuracy. Sensors based on special optical fibres such as Photonic Crystal Fibres (PCF), Hollow Core Fibres (HCF) will be discussed. Emerging complementary sensing approaches, both intrinsic and extrinsic, will also be discussed for demonstrating multiparameter sensing.

NPS-2022-IT 3

Quantum structures with tailored optical properties for next generation bioimaging and optical sensing

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This era is of quantum structures (QS) and QS based optical devices including LASERs and LEDs are largely conquering the device markets. Exploration of novel nanomaterials with multifunctional properties essential for technological applications and fabrication of functional devices based on them will assume major share in the semiconductor electronics market.

The tuneable optical properties of these quantum systems make them ideal candidates for designing optical biosensors and bioimaging probes as well. However, their enormous production cost is a great challenge for the popularisation of the technology, and therefore, development of novel wet chemistry strategies for the fabrication of ultrafine nano systems such as quantum dots, quantum cubes and quantum cages are the need of the hour.

Tuneable optical band gap is the most appealing property of semiconductor nanoparticles. Especially when the nanoparticles are in the strong confinement regime, tailored band gap can be induced and band engineered nano systems with core shell geometry can be exploited for their vast technological applications in designing QD LEDs, QD LASERS and display devices by incorporation of defect states that falls inside the band gap, which can create systems with tailor made emissions. Size, surface functionalization, shape, the level of doping, and the dielectric environments are the deciding parameters which needs thorough tuning and monitoring. Results on the size, shape and surface modifications etc. on two different candidate systems are investigated.

Apart from the bio imaging applications, Metal nanoparticles possess excellent application potential in optical sensing devices due to their Surface plasmon resonance (SPR) and localised surface plasmon resonance (LSPR) properties. Noble metal nanoparticles like gold and silver are the regular choice for these. Plasmonic copper NPs are optimised by our group as an economic alternative to noble metals like gold and silver.

Apart from the technological applications of nanomaterials in sensing and luminescent devices, their application in cellular and live bio imaging is also commendable. Search for novel materials and geometries with low toxicity and high luminescence are underway and non-conventional materials like fluorescent carbon, metallic systems other than gold and silver, core shell semiconductor systems, dye tagged nano systems etc. are being developed and employed for bio sensing and imaging applications. ZnS, and Cu based bio imaging tags with very low toxicity levels is synthesised and the results are presented. Future medical sensing and imaging are looking forward for such multifunctional tailored structures.

NPS-2022-IT 4

Structured Photonic Materials and Devices

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Renilkumar Mudachathi obtained a Ph.D. in Physics from Anna University, Chennai inthe year 2013. His PhD work was carried out at Center for Nano Science and Engineering, Indian Institute of Science, bangalore under the Indian Nanoelectronics Users Program. He had worked as a postdoctoral fellow with Prof. Manoj Varma's research group at CeNSE between 2012 and 2014. In 2014 he has been awarded with RIKEN's prestigious Foreign Postdoctoral Research (FPR) fellowship and joined RIKEN's Metamaterials laboratory for doing research in the fields of plasmonics and metamaterials. Currently he is with Motion Imager, Twente as a chief scientist and visiting scientist at Metamaterials Laboratory, RIKEN, Japan. He has so far published18 journal articles, filed 2 patents, bagged 3 awards.

Periodically arranged micro/nano structured light scatterers are responsible for the iridescent colours found in nature such as butterfly wings, peacock feathers and opals. These periodic arrangements of dielectric scatterers are known as Photonic Crystals (PCs) or Photonic Band Gap (PBG) structures. PCs have been extensively explored forseveral photonics applications owing to their wavelength selectivity arising from the PBG effect in which photon density of states of certain frequency ranges are not permitted. PCs are the main components in integrated silicon photonic devices used in wavelength selective applications such as filtering, routing, switching and bypassing. As in the case of structured dielectrics, light interacts with nanostructured metals through the excitation of localized surface plasmon resonance, which is the collective oscillation of electron clouds on the metal surface. Plasmonic structures have large electric response and have been explored for near field enhancement of electric fields in several applications. They are also explored for structural colour printing applications, because they are one step closer to the conventional pigment based colourprinting, in which preferential light absorption is used. Another class of structured materials are metamaterials which is a combination of structured metals and dielectrics. Metamaterials have properties beyond conventional materials such as negative or zero or large positive values of refractive index. They are known for their tailored electric and magnetic responses to the incident electromagnetic radiation.Metamaterials provide complete manipulation of light and can be used for transformation optics applications where arbitrary bending of light is required.

In this seminar I will give an introduction to the light matter interactions in structured dielectrics, structured metals and structured metal dielectric combinations with a focus on their scientific and technological prospects.

NPS-2022-IT 5

Label-free Nonlinear Optical Imaging and Advanced Image ProcessingTechniques for Translational Research

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Microscopic examination of tissues in the clinical laboratory (clinical histopathology) is an important step in many disease diagnoses. In biomedical research laboratories, histopathological analysis of samples is used tostandardize and confirm findings from a study. The histopathological analysis is a time-consuming, and laborious process which involves, tissue preparation, staining, and image analysis by an expert histologist andhistopathologist. The recent developments in technology and advances in microscopy open new possibilities to advance this field which has stayed mostly unchanged for decades. Here I present different approaches- two-photon excited autofluorescence lifetime imaging (2P-A-FLIM), second harmonic generation (SHG) microscopy, image analysis techniques (Phasor plots, Python-OpenCV tools for feature extraction), we explore at the Microscopy core at JAX and the SHG imaging preliminary results from on-going research in collaboration with our Patient-Derived Xenograft (PDX) core to advance this field of disease diagnosis. And finally, AI-assisted image processing – deep learning using convolutional neural networks (CNN) will bediscussed in brief.

NPS-2022-IT 6

Multimodal optical imaging for early-stage cancer screening

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Modern healthcare strives to provide early-stage cancer screening to mitigate the rampant growth in cancer incidence and mortality worldwide. The histopathological evaluation of resected tissue (biopsy) remains the gold standard for cancer diagnosis, which is inherently invasive and time-consuming. On the contrary, opticalbiopsy could assist pathologists in early cancer screening by exploiting the phenomena of light-tissueinteractions with excellent optical sectioning capabilities, potentially preventing the need for tissue resection. The ongoing research in multimodal optical imaging emphasizes that combining different noninvasive or minimally invasive imaging modalities is the key to retrieving morphological and biochemical attributes of biological tissue for real-time grading and staging of cancer.

With the advent of lensless endoscopes, optical beam manipulations at the optical fiber distal end are viable without any bulky distal optics. Multi-photon light-sheet fluorescence microscopy (MP-LSFM) has emerged as an essential and powerful imaging tool for fast volumetric data acquisition from biological tissues with subcellular spatial resolution as well as reduced phototoxicity. The metabolic information a lensless MP- LSFM endoscope can provide, especially in a fast, minimally invasive manner while not harming the specimen, will be a great aid in determining the cancer stage in vivo and its subsequent clinical translation.

The complementary strengths of additional imaging technologies such as optical coherence tomography (OCT) and Raman spectroscopy could improve sensitivity and specificity and reduce unwanted excisional biopsies. This progressive miniaturization of multimodal endoscopic components will open up novel alternatives in obtaining tissue information in vivo while minimizing the patient discomfort to the possible extent.

CONTRIBUTORY PAPERS

NPS-2022-03

Hierarchical Bi-metallic Nanodendrites on Silicon for SERS-based Biomolecular Sensing

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Surface-enhanced Raman spectroscopy (SERS) is one of the versatile, label-free analytical techniques for rapid, on-field detection of biomolecules in a single shot. In the category of safety concerns, food safety has probably been one of the profound aspects of human life that have been researched vigorously. There have been a few reports that have investigated the possibility of detection of antibiotics (i.e., ampicillin, penicillin, kanamycin), DNA bases (i.e., cytosine, adenine) assorted in the food beverages using low-cost SERS substrates based on Silicon. Bio-compatible noble metal (Ag/Au) based SERS-active substrates are highly desirable and potential candidates for the investigation of biological molecules. In the current work, we report the fabrication of robust, cost-effective, and biocompatible hierarchical AuNPs coated Ag nanodendrites (AgNDs) substrates on Si for the detection of the above-stated molecules. Highly branched with trunks of AgNDs are prepared by a facile wet-electroless etching process. Subsequently, the density dependence studies are explored by varying the AuNPs deposition time via 30 min, 1 h, 2 h, and 3 h. Highly loaded AuNPs on AgNDs are found to be responsible for superior detection of antibiotics and DNA bases. The detection has been extended towards the detection of crystal violet and ammonium nitrate molecules also. The detailed methodology and data analysis will be discussed during the presentation.

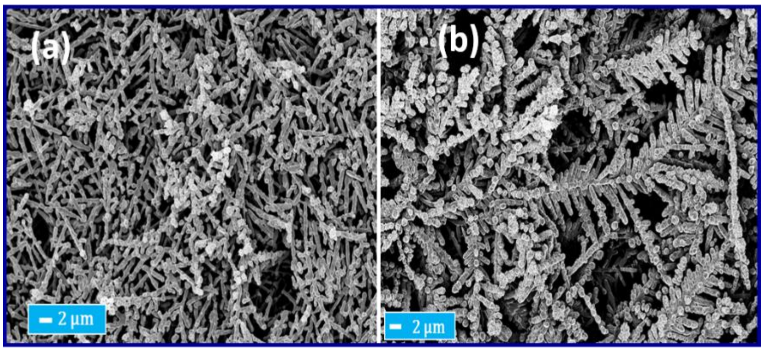

Figure 1 FESEM images of Ag nanodendrites (AgNDs) (a), AuNPs decorated AgNDs (b)

NPS-2022-04

Multi-modal stand-off LIBS-LIF-Raman spectroscopy system for material characterization

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The importance of remote detection of faraway targets with non-invasive or micro-destructive spectroscopic techniques coupled with time-resolved detection has increased due to its widespread applications and continued as a sensitive topic among different fields. However, we focus on the most used remote laser-based novel detection techniques; Laser-induced breakdown spectroscopy (LIBS), Raman spectroscopy, and Laser-induced fluorescence spectroscopy (LIF), which are having the best potential to be selective, fast, sensitive, able to identify many and different materials, and also extensible to new menaces. LIBS utilizes the focusing of high energetic laser pulses to form a transient micro-plasma and fed to the detector coupled spectrograph which disperses the incoming light into its wavelength components, followed by further qualitative and quantitative analysis. Raman employs the inelastically scattered radiation when a monochromatic beam of low energy incident upon the sample surface. In LIF technique, upon laser excitation, an electronically excited state is produced by the species of interest which then radiates subsequently. We have developed a compact multi-modal stand-off spectroscopy system which comprises of a laser, beam expander, telescope and a spectrograph with multi-analytical capability, which makes it fast, compact, reliable, and cost-effective for field-based applications. The various experimental parameters such as gate delay, gate width, laser energy, integration time were optimized using standard samples for acquiring quality signals from a target sample kept at a remote distance. Thus, the new multi-modal sensor fulfills the synergistic measurement scheme essential for a remote instrument that can be utilized for various applications in the future. The optimized stand-off LIBS-LIF-Raman system has been successfully employed for the analysis of different chemicals, minerals, and liquid samples at various distances. We have also explored the feasibility of stand-off single shot measurements using high throughput ICCD coupled CT spectrograph. The common instrumentation for focusing and collection optics, laser source, and a detector enables the hyphenation of LIBS, Raman, and LIF spectroscopy techniques in a single system and can be used as a highly integrated multi-modal instrument for retrieving atomic and molecular fingerprints.

NPS-2022-05

Ultra-low trace elemental detection in liquid sample using Laser Induced Breakdown Spectroscopy Technique

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Laser-Induced Breakdown Spectroscopy (LIBS) has aroused increasing interest in analytical chemistry, biomedical and environmental fields due to its multi and trace elemental analysis and real-time monitoring capability. However, LIBS studies on liquid samples often suffered from the splashing and shorter plasma lifetime in a liquid environment that impede the detection of the ultra-low concentration samples. The important challenge in the ongoing LIBS application is to improve the limit of detection (LOD) from ppm to ultra-low concentration (ppb, ppt) levels, particularly for liquid sample analysis. In the present work, we have compared three different sampling approaches for trace elemental detection in aqueous samples: i) direct bulk liquid ii) liquid jet iii) drop coating deposition of sample solution. Analysis of the results elucidates that highly sensitive and reproducible LIBS spectra can be obtained using the drop coating method. Undeniably, our drop coating deposition results established excellent reproducibility with low limit of detection and it may be applicable for trace level elemental detection in environmental liquid sample. The potential of the approach is demonstrated by investigating the presence and bioaccumulation of trace elements in sediments from an East Antarctic lake and water samples from River Swarna, southwest coast of India. The present study demonstrates that the drop coating deposition technique is more advantageous in investigating environmental applications with a sample volume as small as 10µl sample volume in a single laser-pulse experiment.

NPS-2022-06

Spectroscopic investigation on the luminescent characteristics of Dy^{3+} activated multicomponent borosilicate glasses for W-LED applications

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The spectroscopic exploration of Dy3+ activated multicomponent borosilicate glasses have been performed via optical absorption, photoluminescence excitation and emission, CIE chromaticity co-ordinates and correlated color temperature (CCT) values to investigate their suitability in the advancement of solid state lighting and W-LEDs (white light-emitting diodes). The oscillator strengths evaluated from the absorption spectrum were used to determine the phenomenological Judd-Ofelt (JO) parameters through least square fitting procedure. The photoluminescence emission spectra recorded for the Dy3+ activated multicomponent borosilicate glasses under 348 nm excitation exhibit three emission bands which falls in the yellow (4F9/2 →6H13/2), blue (4F9/2 →6H15/2) and red (4F9/2 →6H11/2) region. The various radiative characteristics such as transition probability, branching ratio, emission cross-section of the synthesised glass were evaluated by using JO intensity parameters. The photoluminescence emission spectra were further characterized through the CIE chromaticity diagram and the estimated color co-ordinates and CCT values recommend the prepared glasses for various photonic applications.

NPS-2022-07

Effects of Initial Phase on Silicon Nanoparticles Formation in Femtosecond laser Ablation

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We report here our results from the ultrafast laser ablation of monocrystalline Si (100), polycrystalline Si, and Si (100) capped with SiO2 layer. The target material was ablated using femtosecond laser pulses (~50 fs duration, 1 kHz repetition rate, 800 nm wavelength) with an energy of ~100 µJ in acetone medium to fabricate Si Nanoparticles (NPs). The optical properties of as-formed Si NPs were characterized by different spectroscopic techniques (UV-Visible-NIR absorption spectra, Photoluminescence, and Raman) and these NPs were characterized for their structural properties by TEM, HRTEM, and SAED analysis. It was observed from the TEM data obtained that the average size of Si NPs produced by monocrystalline Si (100) was found to be less than that of the NPs produced by polycrystalline Si and the ablation of Si caped with SiO2 layer had resulted in the formation of bigger Si NPs along with a low concentration of SiO2 NPs. Further, from HRTEM and SAED analysis, we have observed polycrystalline Si NPs possessed (022), (012) planes from ablation of monocrystalline Silicon; (011), (012), (110), (022) planes from ablation of polycrystalline Si; and (101), (110), (201) (h, k, l) planes from the ablation of monocrystalline Si capped with SiO2 layer. Therefore, we conclude that the initial bulk Si substrate type has majorly produced only polycrystalline Si NPs possessing crystallite grains in different orientations (planes). Complete details of the experiments and data analysis will be presented at the meeting.

NPS-2022-08

Surface Plasmon Polariton Assisted Self-Assembly of Nanoparticles for SERS Applications

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SERS is essentially a surface phenomenon that depends on the near-field optical properties of the plasmonic nanostructures. Though lone nanostructure can facilitate enhancement, it is the junction between these nanoparticles known as the 'hotspots' which maximizes the enhancement. Herein we demonstrate a surface plasmon polariton (SPP) assisted assembly of metallic nanoparticles for SERS applications. Total internal reflection based Kretschmann geometry was used to generate SPP at gold metal/dielectric interface. This SPP excitation created an optical potential which was further harnessed to assemble plasmonic nanoparticles.

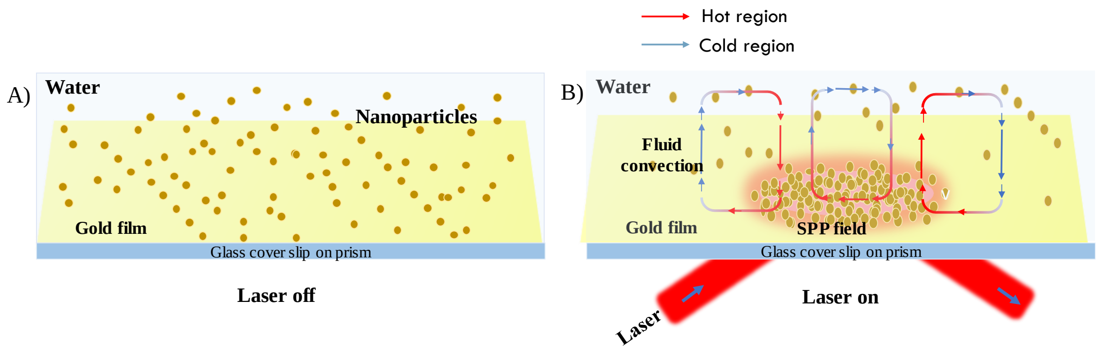

Figure 1: Schematic representation of SPP field assisted self-assembly of plasmonic nanoparticles. *(A) The* nanoparticles dispersed in the water medium when laser is off. (B) Nanoparticles assemble at the excitation spot due to the combined effect of fluid convection and SPP field when laser is on.

NPS-2022-09

Highly chromatic red light emitting Ca(1-x)Zn2(PO4)2: xPr3+ phosphors for blue- chip excited WLEDs

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A concentration dependent spectroscopic analysis of highly chromatic red emitting Ca(1-x)Zn2(PO4)2: xPr3+ (x= 0.02- 0.08) phosphors synthesized by solid state reaction method have been performed. The obtained phosphors had a triclinic structure with $P\bar{1}$ (2) space group. The optical properties including reflectance, excitation, emission and the color coordinates were investigated. The band gap of the phosphors was calculated from diffused reflectance spectra data using the Kubelka- Munk function. The photoluminescence (PL) excitation spectra showed the excitation peaks ranging from 430 to 490 nm. Under 444 nm blue photon excitation, the phosphors emit red light due to 1D2→3H4 and 1D2→3H5 transitions of Pr3+.The optimal concentration of Pr3+ was identified to be x= 0.04 after which concentration quenching occurs. The colorimetric results suggest the phosphor to be of high color purity ~ 100% and could be an eventual choice as the red component in tricolor system used for solid state lighting.

NPS-2022-10

A D-shaped Elliptical Hollow Core Fiber SPR Sensor

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A D-shaped elliptical hollow core fiber surface plasmon resonance (SPR) sensor is proposed and analyzed here using gold and titanium oxide layer. The fiber geometry consists of a doped elliptical core with a concentric central elliptical air hole. A finite element method-based simulation software COMSOL Multiphysics is used for numerical analysis. Both gold and TiO2 layers are optimized. The sensor responds over a wide range of refractive index (RI) from 1.33 to 1.40. The average sensitivity obtained for the designed sensor is 4142.85nm/RIU (RI Unit) whereas that for a single mode fiber (SMF) is only 897.55nm/RIU. So, our designed sensor gives more than 4 times enhanced sensitivity and proves to be a potential alternative of SMF based low cost, compatible SPR sensors by covering the low sensitivity issue suffered by SMF sensors.

NPS-2022-11

Evolution of Barium Bismuth Titanate Ceramic by Modified Solid State Process and its Characterization

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Layered aurivillius bismuth-based prerovskite. Barium-bismuth titanate, BaBi4Ti4O15 (BBiT), was prepared from stoichiometric amounts of barium titanate and bismuth titanate by modified solid state process. Sintering process was performed in atmospheric condition after mixing in agate mortar-pestle. The thermal analysis of BaBi4Ti4O15 was studied by DSC-TGA to identify phase transformation zone and consequent sintering at 1100 °C for 10 h and 15 hours heat treatment to be performed. Phase developed was identified from XRD pattern. The bonding analysis and characteristics of BBiT ceramic powders were identified using FTIR spectroscopy and Raman spectroscopy for its chemical formulations. The microstructure and morphological development was analyzed from FESEM & HRTEM image. The granular size, shape was observed from morphological features. The microstructure of BaBi4Ti4O15 exhibits plate-like grains typical for the Bi-layered structural materials and spherical and polygonal grains. The Ba2+ addition leads to changes in the microstructure development leading to change in the average grain size. The optical property of BBiT was characterized by UV-VIS spectroscopy. Band gap was estimated using Tauc relation and noted to be about 1.67, 1.62eV (Direct & Indirect) while dielectric properties were estimated using LCR meter.

NPS-2022-12

Evolution of Sodium Niobate based Glass-Ceramic by Melt Quenching and its Characterization

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Glass-ceramic material based on sodium niobate in silica glass matrix doped with Eu3+was synthesized by melt quenching process followed by controlled heat treatment. The activation energy for crystallization of glass-ceramic was evaluated by Kissinger, Ozawa and Augis-Bennet model. Activation energies were noted to be about 260.569kJ/mole, 279.37 kJ/mole and 269.98 kJ/mole respectively. Ceramization of glass was carried at by double-stage heat-treatment at 650°C for nucleation and crystal growth at varying temperatures of 700°C and 800°C for 5 h. Crystal phase developed through ceramization was identified by XRD analysis followed by chemical bonding analysis through FTIR. Intensive chemical bonding analysis was carried by Raman spectroscopy. Refractive Index was evaluated using a Prism Coupler refractometer. Transmission spectra were evaluated using UV-VIS-NIR spectra while band gap was evaluated using Tauc plot. For base glass band gap was noted to be 3.502eV while after crystallization by ceramization heat-treatment band gap was reduced to 1.623eV respectively. PL spectra of the glass-ceramic sample also studied to note emission behaviour after excitation of samples at 395nm using Xenon lamp.

NPS-2022-13

Synthesis, linear and nonlinear optical properties of Ag and Al_2O_3 nanoparticles

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This work reports a detailed study of the synthesis, characterization and third order nonlinear optical properties of silver (Ag) and alumina (Al2O3) nanoparticles. The nano particles were prepared by chemical precipitation method. X-ray diffraction studies confirm the purity, the crystalline nature of the sample and also find out the crystallite size. The linear optical properties and the structural morphology of the nano particles were confirmed by using the UV-visible spectroscopy and SEM analysis. Open aperture Z-scan technique was used to study the nonlinear absorption of the samples with a Q-switched CW Nd:YAG laser at 532 nm. Third order nonlinear optical susceptibility(χ(3)) and nonlinear absorption coefficient(β) was observed to be of the order of 10-4 esu and 10-6 cm/W respectively which reveals that the samples are potential candidates for photonic applications.

NPS-2022-14

Fabrication of oxide photonic crystal thin film using scalable RF sputtering method

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Photonic crystals (PCs) are optical analogues of electronic crystal lattice where light propagation is governed by the spatial periodicity in the dielectric function. These not only exist in nature as a variety of colors in biosystems, but they can be engineered using advanced synthesis tools and intricate symmetry designing. Nevertheless, the ability to confine light and also forbid a certain range of frequencies, imparts PCs a widespread utility in various applications such as optical communication, sensing, energy harvesting etc.1

Photonic band gaps(PBG) are the range of forbidden frequencies (energy band) formed in photonic crystals due to periodicity of refractive indices. Thus, it is very important to design and fabricate structures of long range periodic order. Mostly lithographic techniques are used to fabricate such PCs, however, those are of limited scalability and throughput. In this work we demonstrate fabrication of Photonic crystal structure of oxide opals thin films which could be used for various applications such as energy harvesting, sensing etc. Copper Cobalt Oxide (CCO) is semiconductor with nearly 3 eV of band gap, however it shows a significant absorption over the entire visible spectrum due to various defects. Here we use a self-assembled polystyrene microsphere template followed by radio frequency magnetron sputtering technique to obtain a large area photonic crystal with a sharp stop gap in the near IR region (peak at 1100 nm) due to periodicity of 500 nm. CCO is a high spectral selective solar absorber material and its Opal PCs are developed for enhanced photothermal conversion.

NPS-2022-15

Nonlinear optical properties of polyaniline doped with cardanol based dye

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We report the third-order nonlinear optical properties of polyaniline doped with an azo dye synthesized using cardanol. Cardanol, which is distilled from CSNL (Cashew Nut Shell Liquid), is a renewable resource since it is a byproduct of the Cashew nut industry. The linear absorption spectrum of the sample was determined in the wavelength range 100 – 800 nm. FTIR spectroscopic data of undoped and azo dye-doped polyaniline samples were compared. The morphology and structure of the azo dye-doped polyaniline is studied using SEM images and XRD. Nonlinear absorption studies were carried out using the single beam z scan technique. A Q- switched Nd: Yag laser operating at 532 nm wavelength with a pulse width of 7 ns was used as the source of light. The nonlinear absorption coefficient and nonlinear susceptibility were determined to be of the order of 10-11 m/W and 10-13 esu respectively. These results indicate that the material is a good candidate for optoelectronic applications.

NPS-2022-16

Design and analysis of micro-channelled Quasi D-shape optical Fiber plasmonic Sensor

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This study reports on numerical investigation carried out over a newly designed open micro-channel incorporated, side polished single mode fiber (SMF) based plasmonic sensor. Proposed sensor operates on the principle of surface plasmon resonance (SPR) phenomenon to enhance sensing performance. Commercially available COMSOL Multiphysics software tool is used to design the sensor and finite element method is used for numerical investigation. From the detail study, an average sensitivity of 1757 nm/RIU (refractive index unit) is obtained with nanoscale gold strip for wide range of analyte RIs from 1.33 to 1.38. Result indicates that the designed sensor can be effectively used in RI measurement in the various fields like chemical and biological sensing.

NPS-2022-17

Digital Laser Combustion Method: Synthesis of Silver Nanoparticles (AgNps)

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Laser combustion is a green and simple method for synthesis of metal nanoparticles without surfactant or chemical addition, and the properties of nanoparticles are unique. A variety of preparation techniques have been reported for the synthesis of silver NPs; notable examples include, laser ablation, gamma irradiation, electron irradiation, chemical reduction, photochemical methods, microwave processing, and biological synthetic methods. In the present work is relates to the design and development of digital combustion instrument for synthesis of nanoparticles by laser combustion method. From this instrument we can able to control the synthesis just by giving digital i/p, from this instrument we can prepare more sample of linearly varying different physical variables with digital accuracy and it consume less time and power, this instrument prepare a sample in such a way that it helps to further characterization(XRD, SEM and UV-Vis).

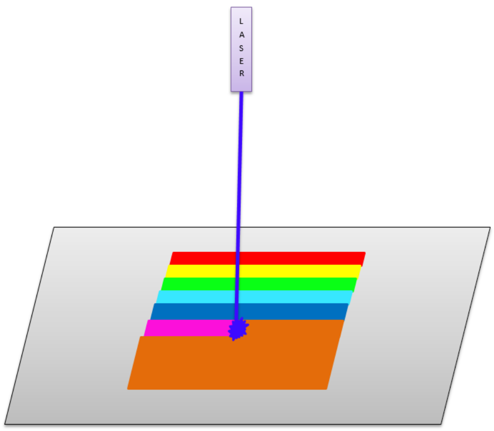

Fig. Digital laser Combustion Instrument

NPS-2022-19

Estimation of Random Duty Cycle in Periodically Poled Lithium Niobate Through Second Harmonic Generation

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Periodic poling of lithium niobate (PPLN) is a technique for obtaining quasi-phase matching (QPM) [1] of nonlinear interactions and Quasi-phase matching is a technique for phase matching nonlinear optical interactions. PPLN involves processes which generate a periodic reversal of the domain orientation in a lithium niobate, and sign of the nonlinear coefficient also changes along the axis perpendicular to the optic axis of the crystal. There are numerous of techniques which were developed for producing PPLN chips, but now a days electric-field poling at room temperature is accepted as the most reliable one to date.

Fabrication of QPM devices from ferroelectrics crystals generates inevitable randomness in the domain-wall locations in the QPM grating and we all know that errors (randomness) are inherent in the fabrication process, which cannot be removed but can be minimized. One of the possible causes of such errors is distribution of initial nucleation sites due to local strong electric field effect and the deviations can lead to decreased efficiency or undesired function of the devices such as parasitic harmonic generation which can cause green induced infrared absorption (GRIIRA). Therefore, it is essential to keep RDE minimal.

In this paper, we analyse the influence of random duty error in PPLN devices which are formed in the fabrication process (Electric Field Poling) and calculated the influence of the random duty-cycle errors degenerate noise in second harmonic generation (SHG) consisting of PPLN and we found that the normalized SHG Intensity-noise efficiency consists of two components. The first component represents a flat PPLN noise ~ $\frac{1}{2N}\left(1 - e^{-(\pi\epsilon q)^2}\right)$ that is independent of the average duty ratio, but depends upon disorder and the number of periods in the sample. The second part behaves as sinc2 (πNq) at SHG orders peaks, but reduced by the amount of $e^{-(\pi\epsilon q)^2}$.

NPS-2022-20

Quality Evaluation of Quasi-Phase Matching (QPM) by Diffraction-Noise

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QPM is a method for achieving efficient energy transfer between interacting waves in nonlinear process, which was first proposed by Armstrong et al. in 1962 . It is most efficient and practical form of this technique is based on a spatial modulation of the nonlinear properties along the interaction path in the material. Such a spatial modulation can be obtained in ferroelectric crystals by periodically altering the crystal orientation so that the effective nonlinearity changes according to the orientation and achieved great success with optical frequency conversion devices such as second harmonic generation (SHG) and optical mediated oscillator. Fabrication of QPM devices from ferroelectrics crystals generates inevitable randomness in the domain-wall locations in the QPM grating. For a reasonably good QPM device, its standard deviation, called the random duty-cycle error (RDE), gives quantitative estimation of the device quality. If the RDE is large, then lead to decreased efficiency or undesired function of the devices such as parasitic harmonic generation which can cause green-induced infrared absorption, etc. Therefore, it is essential to keep RDE minimal. Various methods have been proposed to quality evaluate of QPM devices. Among them microscopic imaging methods of chemically etched crystal surface are more direct and accurate, but takes a long time, which is not desirable for either device makers or users. Other methods based on nonlinear optical effect and indirect method, among them, wavelength-tunable SHG is a representative one and gives a direct estimation of the performance as other types of frequency conversion devices. The relationship between the RDE and the efficiency of the SHG pedestal has been established in Ref, but same experimental difficulties such as tunable narrow-line width sources, and the tuning range is significantly limited by the tunable range of the pumping source. So, we propose a simple method to assess the quality of the QPM device by analyzing the diffraction-noise pattern (uniform and Gaussian beam) from the QPM device. In the uniform and Gaussian beam diffraction-noise method, from 1st to 2nd order diffraction-noise patterns from the QPM were analyzed to evaluate the RDE, the results were further verified by statistically analyzing the microscopic image of the QPM grating. RDE with a Gaussian beam didn't produce high-frequency component between the diffraction orders so we can measure more accurate noise away from the peaks compared with uniform beam.

NPS-2022-21

Nanoparticle Enhanced Femtosecond Laser Induced Breakdown Spectroscopy of Aluminium Sheet coated with gold Nano-particle Embedded nanofibers

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Nanoparticle LIBS is useful in improving the sensitivity in detection of solids like metals, precious gemstones and liquid samples. Femtosecond laser induced breakdown spectroscopy (LIBS) signals can be enhanced in the presence of nanoparticles. We demonstrate two times enhancement in the femtosecond LIBS spectra of aluminum sheet coated with the gold nanoparticles embedded electro spin polyvinyl alcohol nanofibers. Gold nanoparticles were fabricated using the femtosecond laser ablation the mean size of the nanoparticles fabricated using laser ablation is 10 nm-15 nm. Enhancements were observed in the atomic and molecular AlO emissions. The technique can further be optimized for better signal enhancement in the molecular bands in of explosive traces.

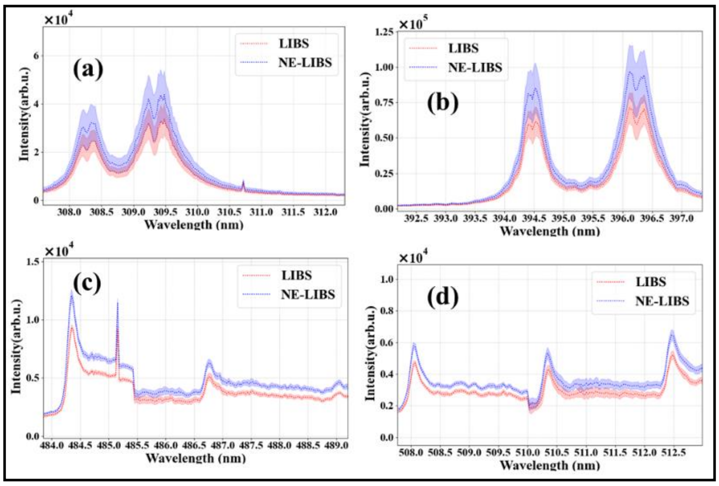

Figure 1: Shows the Aluminium (a) and (b) atomic, (c) and (d) molecular peaks. Regular LIBS Spectra in red and NE-LIBS spectra in blue with mean and standard deviation of 25 spectra each.

The presence of gold nanoparticle embedded nanofiber coating enhanced the major peaks of aluminum at 308.4 nm, 309.2 nm, 394.4 nm, 396.15 nm Al I peaks. Similarly the enhancement was observed for AlO molecular emissions resulted from B2Σ+ → X2Σ+ transition bands for Δυ=-1, 0, 1 were observed in the range of 450nm-550 nm, 510-520 nm, 480-500 nm and 465-460 nm respectively. Twenty five spectra of each sample were recorded, the mean and standard deviation of all the spectra with and without nanoparticles were plotted. The aluminum spectra and the enhanced peaks are as shown in the figure1above.

NPS-2022-22

Enhanced Temperature Sensing Based on the Randomness in the Multilayered 1D Photonic Crystals

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A high sensitive temperature sensor is proposed based on the random properties of the one dimensional photonic crystal (1DPC). The structure is designed with two layers consisting of silicon (Si) and silica (SiO_2) materials. The transmission spectra of the proposed photonic crystals are studied for the different temperatures from 25°C -100°C. Thermal characteristics of the proposed random structures are examined with the effect of thermal expansion and thermo-optic effect. As the temperature increases the transmission peak shifts towards the higher wavelength due to the thermal parameters of the dielectrics used. It is found that the temperature-sensitive transmission peak shift is considerably enhanced due to the insertion of the third material that constitutes the ternary photonic structure ($Si/SiO_2/TiO_2)N$. For the above multilayer structures, based on the dependence of the layer thickness and the number of materials used, the numerical results show the sensitivity of 0.04nm/°C. When the third dielectric material (TiO_2) is replaced by the polymer material (PS), the wavelength of the transmittance peak shift can be enhanced to 0.08nm/°C. These properties favour the fabrication of versatile temperature sensors.

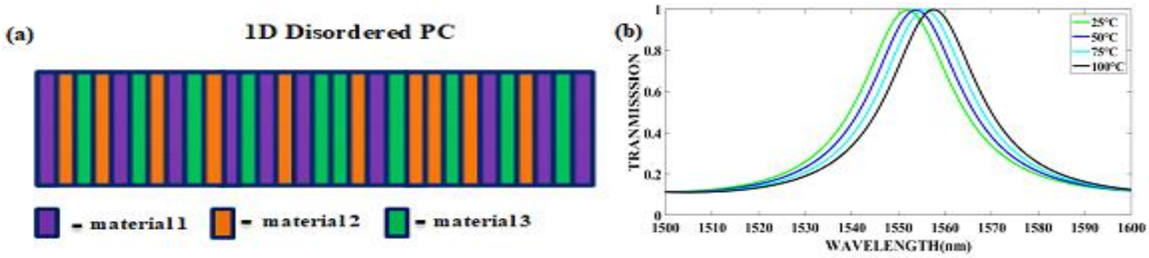

Fig1. (a) Schematic of the ternary 1DPC; (b) Transmission spectra of the ternary 1DPC for different temperatures

NPS-2022-23

Generation of Parabolic pulse by nonlinear pulse reshaping inside a Silicon on Insulator (SOI) Waveguide

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In recent times, Silicon Photonic attracts a lot of attraction of researchers. It is the technology that converts many functions of the circuit on the thumb size chip [1]. Nowadays, there are many kinds of technology platforms to build photonic integrated circuits using different systems such as high index glass, semiconductors, polymers, and silicon. In our work, we have used Silicon to designed a rectangular Silicon on Insulator (SOI) buried waveguide. This type of waveguide has shown great potential in the field of pulse reshaping [2]. We have used the effective index method for calculation group velocity dispersion and nonlinearity. Though the two-photon absorption and free-carrier generation contribute significantly to loss parameters, the highly nonlinear buried waveguide is found to be capable of reshaping Super-Gaussian pulse input into Parabolic Pulse (PP) shape. Moreover, the values of input chirp, pulse width, peak power are further optimized for the generation of a high-quality parabolic pulse. The length required for Parabolic pulse (PP) reshaping is much shorter when compared to the optical fibres. Thus, our design waveguide has potential in the domain of pulse generation, signal processing, and many more.

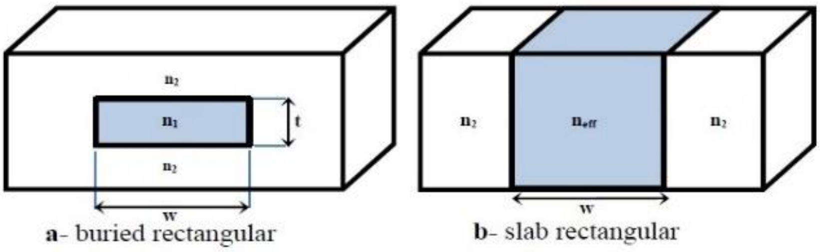

Fig.1: Simplifying the waveguide structure by using the effective index method.

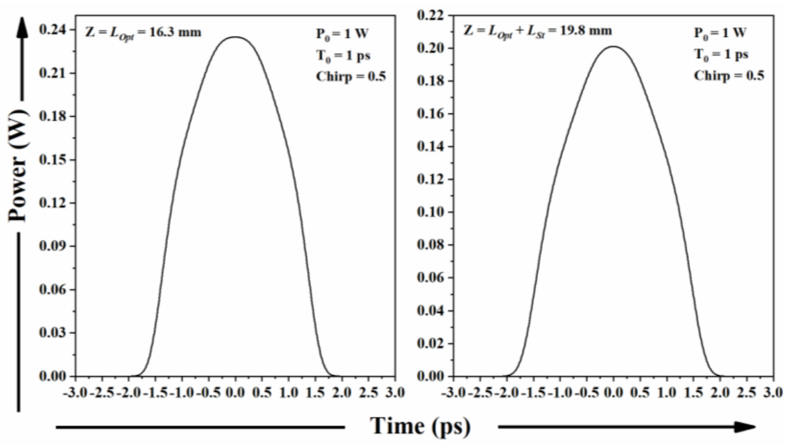

Fig.2: Reshaped parabolic pulse at optimum length and at the end of stability length.

NPS-2022-24

Ultrasensitive Detection of Thiram and Nile Blue using Au Nanostars Decorated Laser-patterned Au Substrate

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In recent years, abundant procedures have been introduced to fabricate extremely sensitive, reproducible, and stable surface-enhanced Raman scattering (SERS) substrates because of its increased potential for practical applications.[1, 2] In this contribution, we demonstrate the construction of a highly sensitive and reproducible SERS substrate by immobilizing the gold nanostars on the laser-patterned gold (Au) surface. Here, the Au nanostars were synthesised by a simple wet chemical approach and patterned structures on bulk Au target were obtained through picosecond laser ablation technique in air.[3, 4] The shape and size of obtained Au nanostars was investigated methodically using HR-TEM and UV-visible absorption spectroscopic techniques. The morphology of the laser patterned areas on the Au surface was studied by UV-visible reflection and SEM measurements. The Au nanostars decorated laser-patterned Au SERS substrate exhibited superior reproducibility of the Raman signals and larger SERS enhancement factors for thiram (a pesticide molecule) in comparison with the laser-patterned Au as well as Au nanostars decorated flat Au substrates. Additionally, Nile blue detection (concentrations of 5×10-10 M) was achieved with relative standard deviation (RSD) of <10% which indicates the fabricated SERS substrate had excellent sensitivity and repeatability. The TEM image of synthesised nanostars is depicted in figure 1(a). The SERS spectra were acquired for thiram (5 μM) on (i) laser-structured Au and Au nanostars decorated (iii) flat Au (iii) laser-processed Au and data is plotted as a stack plot as depicted in figure 9(b). The data for calculated SERS intensities from each substrate (shown as bar chart) is depicted in figure 1(c).

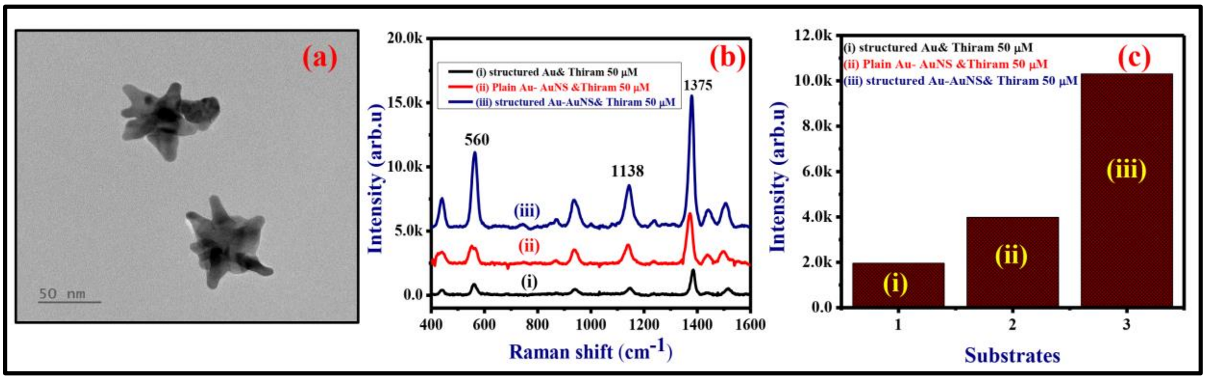

Figure 1. (a) TEM images of Au nanostars (b) SERS spectra of thiram 50 μM recorded on (i) laser-patterned Au (ii) Au nanostars on a flat Au substrate (iii) Au nanostars decorated on a laser-patterned Au substrate (c) estimated SERS intensities for the major mode of thiram (1375 cm-1) obtained from (i) laser-patterned Au (2) Au nanostars decorated laser-patterned Au substrate, respectively.

NPS-2022-25

Generation of high-frequency pulse train by designing a buried SOI waveguide

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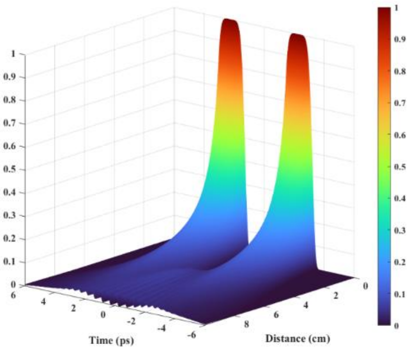
Silicon photonics has attracted tremendous research interest in recent times because of its compact size, easy-to-build nature, and high values of nonlinearity. Though the study of pulse interaction inside planer SOI waveguide is done [2] but confinement of light is better in case of buried waveguide. A buried rectangular SOI waveguide is designed which possesses a small value of group velocity dispersion (β2) ~2.432 (ps2/m) and a quite high value of nonlinear coefficient (γ) of ~ 441.19 (W.m)-1. When the propagation of a pair of pulses of lower repetition rate (~GHz) is investigated, we have found that the pulse pair interact with each other as they overlap and generate a high-frequency (~THz) pulse train. The effect of timing jitter on high-frequency generation is also studied. This study as a whole enables potential device applications in the domains of tunable high frequency (THz) pulse generators and many more.



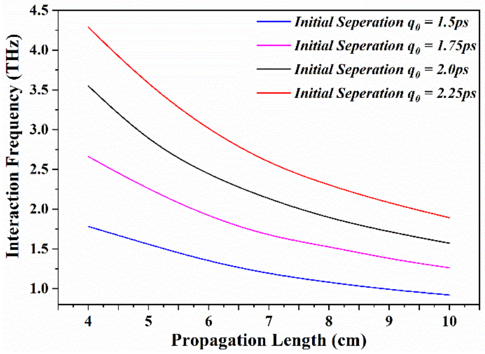


Fig.1: Interaction of pulses inside an SOI waveguide. Fig.2: Variation of Interaction frequency with length.

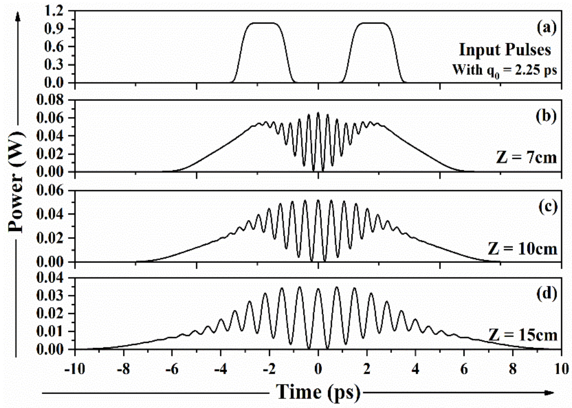


Fig.3: Generation of different interaction frequency with length.

NPS-2022-26

Si-based incident angle-sensitive reflective wavelength separator: a single-step FIB lithography based nanopatterning application

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Inspired by nature, morpho-butterfly for example, the topic of research on engineering light at nanoscale using subwavelength nanopatterns or nanostructures fabricated on surfaces of various materials including dielectric, metallic and metalodielectric has been receiving significant attention in recent years. The nanostructure-influenced visible colours arise from resonant scattering of light from subwavelength structures and hence referred as structural colors. Due to the enhanced color purity (via selective absorption of a narrow band of incident light wavelengths) structural colors show great potential for several applications including colour printing, optical security, energy-efficient displays, ultrahigh-resolution imaging, ultrahigh-sensitivity biosensors and building-integrated photovoltaics. Manipulating light by the organized array of nanopatterns/nanostructures is primarily dependent on the shape and dimensions of the individual pattern/structure element. It is also influenced by the spatial arrangement of the pattern/structure element. In this piece of work, we demonstrate generation of vivid colours in reflection mode from the nanopatterns fabricated on a silicon substrate, which is less expensive, has high-index and well applied in all the above-mentioned applications. Nanopatterns were produced on Si by focused ion beam based nanolithography technique in a single step. Basic element of the nanopatterns was a conical-shaped etch-pit, with diameter ranging from 100 to 300 nm and depth from 50 to 150 nm on Si. Influence of the spatial arrangement of the pattern elements on the reflected light and wavelength separation was qualitatively and quantitatively analysed and discussed.

NPS-2022-27

Structural, Cytotoxic and Anti Cancerous Studies on $Er^{3+}:Y_2O_3$ Nanophosphors

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Lanthanide doped upconverting nanomaterials are widely used in the field of biomedical imaging because of its high luminescent efficiency and low cytotoxicity. The upconverting nanomaterials are used for the imaging since These materials have excitation in Near Infra-Red region1,2,3. Y2O3: xEr3+ (x= 1,2 and 3%) were prepared by sol citrate gel method and calcinated at temperature 6000C for 2hrs.Structural studies of the synthesized samples were carried out by XRD analysis. The pattern obtained shows cubic phase4 and the crystallite size obtained for the samples were 6.1nm,6.4nm and 7.2nm respectively. Flakes like morphology was obtained from SEM micrographs. EDS study confirmed the chemical composition. Optical band gap energies obtained for samples x=1,2 and 3% are 5.50eV,5.46eV and 5.43eV respectively. Cytotoxic and anticancerous studies done on samples proved that the prepared samples have low toxicity which can be used for biomedical applications.

NPS-2022-28

Study Of Conversion Efficiency For Second Harmonic Wave From Fundamental Wave (Under Plane-Wave Approximation)

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In this paper we observed the role of phase match and phase mismatching conditions, when a plane fundamental wave, which depleted 80% enters in the crystal then fundamental wave is converted into second harmonic. From the MATLAB simulation result, we found that when increased the intensity of fundamental wave at phase matching condition, then the position of normalized length of crystal decreases, where fundamental and second harmonic wave are equal ($I\omega$=$I2\omega$) and increased the conversion efficiency at the end of crystal (Figure 1 & 2).

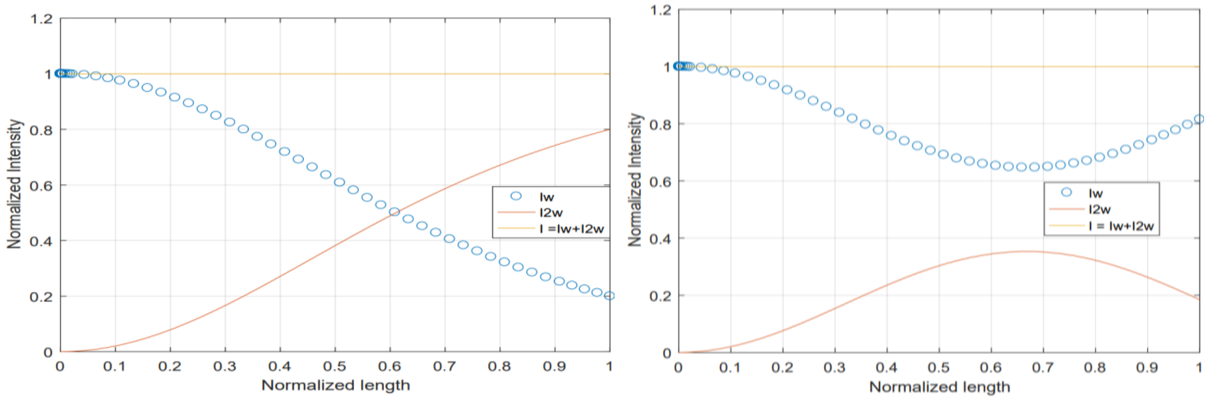

Figure. 1 Fundamental and second harmonic intensity along the sample length with phase matching and mismatching.

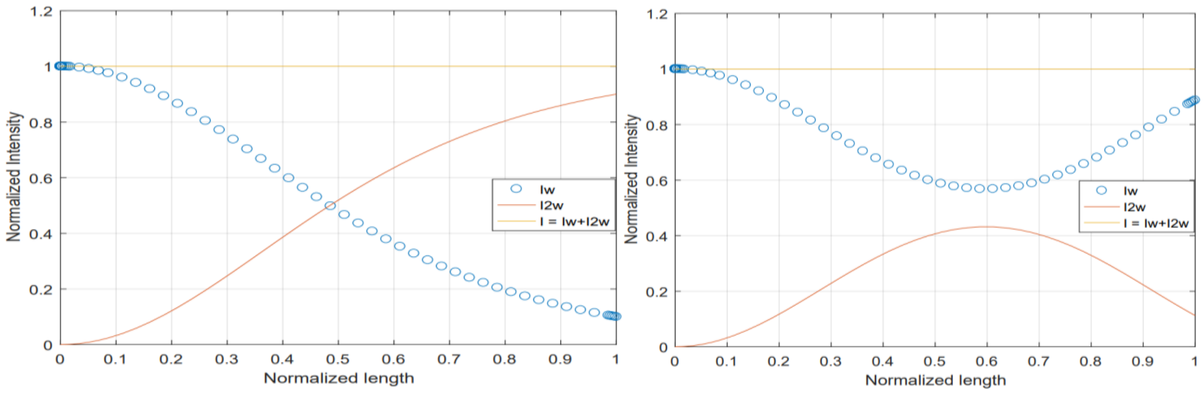

Figure. 2 Fundamental ($4I_{\omega}$) and second harmonic intensity along the sample length with phase matching and mismatching.

NPS-2022-29

Efficient optical limiting behavior of carbon encapsulated zinc sulfide core-shell nanostructures

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The tremendous advancement in the field of laser technology calls for the requirement of controlling and limiting optical beams of very large intensities in order to ensure the safety of delicate optical instruments, human eye and other sensory parts from accidental exposure. A strong optical limiter which is transparent at low input fluence but clamps the output at high input fluence can serve this purpose.
Carbon wrapped nanoparticles are known for their exceptional nonlinear optical properties and ultrafast response. In this work, we observe the improved absorptive nonlinearity and optical limiting behaviour of zinc sulfide (ZnS) nanoparticles upon the formation of core-shell structure with graphite. The ZnS@C core-shell nanostructures were prepared by nanosecond Pulsed Laser Ablation in Liquid (PLAL) technique. A distinct absorption peak at 288 nm confirms the presence of a graphite layer outside the nanoparticle suppressing the characteristic absorption peak of ZnS at 271 nm. The open aperture z- scan studies conducted on the sample revealed that the effective nonlinear absorption coefficient for the core-shell structure was amplified by three times when compared to pristine ZnS nanoparticles. The sample also exhibited excellent optical limiting threshold value ideal to be utilized in optical limiting and ensuring laser safety.

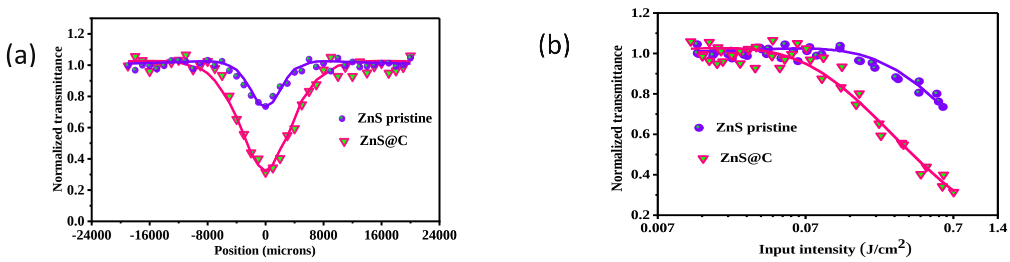

Fig: Open aperture Z-scan signature(a) and Optical limiting behavior (b) of ZnS@C core-shell structure (pink) and pristine ZnS nanoparticles (violet) at 0.138 GW/cm^2

NPS-2022-31

Copper-based Surface Plasmon Coupled Emission Steering for Biosensor Applications

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Surface plasmon resonance (SPR) is an established technique, used to study bio-chemical and bio-molecular interactions, detection of lipid bilayer membranes, detection of molecules, etc.1 SPR coupled with fluorescence has been widely used in the field of research for fluorescence imaging, molecular detection, etc. Surface plasmon coupled emission (SPCE) based on Reverse-Kretchmann (RK) configuration utilises near field interaction of fluorescence with metal thin films. This is a promising strategy for optical biosensors because of its great directionality of emission, better surface selectivity, emission tuning as well as better plasmon excitation.2-3 Substrates like silver (Ag) and gold (Au) thin films are widely used for SPR applications due to its high plasmon oscillations within visible region4-5. Few works on SPR sensors were based on copper (Cu) substrates. While several literatures report on SPCE based on Ag and Au substrates, there are very few reports on SPCE based on copper substrates. In the present work we have explored plasmon coupled emission studies on Cu substrates.

Samples for SPCE studies were fabricated by stacking metal-dielectric layers. Copper metal (thickness ~ 55 nm) was first deposited on a cleaned glass substrate by sputtering technique. Rhodamine B dye mixed with Polyvinyl Alcohol (PVA) in DI water was then coated on top of Cu film by spin coating method. Thickness of dielectric layer was varied by varying PVA concentration and by varying spin parameters. Fabricated films were then coupled to a hemicylindrical prism arranged in RK configuration. The fluorescence molecules within PVA were excited using 512 nm laser. Emission spectra were then recorded from prism side (RK configuration) using an optical fibre coupled compact spectrometer. Angle dependant emission spectra were recorded for all the fabricated samples. All the samples show emission directionality confirming SPCE. As the thickness of PVA was increased, the emission direction shifts to higher angle of detection showing a correlation of emission directionality with dielectric layer thickness. Thus, by coupling SPR with emission, we could conveniently steer the emission.

NPS-2022-32

Synthesis and Characterization of Oleic Acid mediated growth of Single crystal perovskites: Optimisation of trap density and mobility

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In recent years, organic-inorganic hybrid perovskite single crystals advanced to the frontline of various applications such as photodetectors, photovoltaic devices, light emitting devices, sensors and memory devices owing to facile synthesis and its outstanding optoelectronic properties. Addition of exotic ligand molecules in single crystal perovskites can refine the morphology, trap density and mobility. Long chain amine ligands can improve interfacial carrier transport, and defect passivation efficacy. This paper presents the synthesis and characterization of ligand mediated growth of single crystal to improve the performance and stability of methyl ammonium lead iodide single crystals. Oleic acid, an unsaturated hydrocarbon chain with one double bond and a carboxylic acid group, added as the ligand, can enhance the carrier mobility, reduce trap density and improve surface morphology.

NPS-2022-33

Effect of Solution and Dry processing techniques on the Optical and transport properties of Inorganic CsPbBr3 Perovskite films

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Caesium based inorganic, CsPbBr3 perovskite material possesses remarkable optoelectronic properties, such as high light absorption coefficient, high carrier mobility, and long diffusion length, and hence has promising applications in solar cells, photodetectors, and high-energy radiation detectors, among others. Because of its simplicity, low cost, and high efficiency, spin-coating deposition for CsPbBr3 perovskite layer for such diverse has been widely used. However, the spin-coating technique has a technological constraints when it comes to uniformly depositing large area films. Thermal evaporation, on the other hand, is inexpensive and produces a uniform and repeatable thin film. In this study, the stability, energy band alignment, surface morphologies, and light absorption of a CsPbBr3 perovskite layer produced by spin coating and thermal evaporation are investigated and discussed.

NPS-2022-34

Semiconductor Core Optical Fibers for the Purpose of Nonlinear Pulse Reshaping

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In this work, we have designed semiconductor core normal dispersion optical fibers in single mode regime to observe the phenomena of nonlinear pulse reshaping through them.

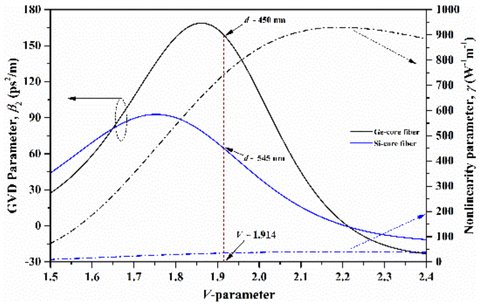

Fig. 1: Variation of β_2 and γ with V-parameter for 2 different types of fibers

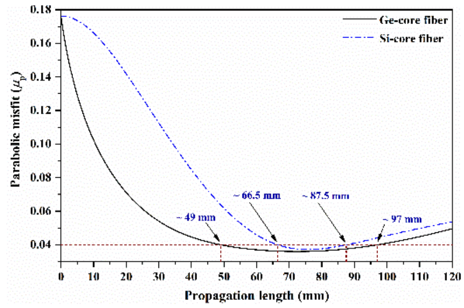

Fig. 2: Lengthwise variation of the Misfit parameter

Initially a Ge-core fiber is proposed, considering pure silica material as the cladding of the fiber. It is observed that the designed fiber is capable of generating semi-parabolic pulse (SPP) (Mismatch < 4 %) within a much shorter fiber length (~ 5 cm) while a Sech pulse of very low peak power (~100 mW) is taken as input at the operating wavelength of 2.8 µm.

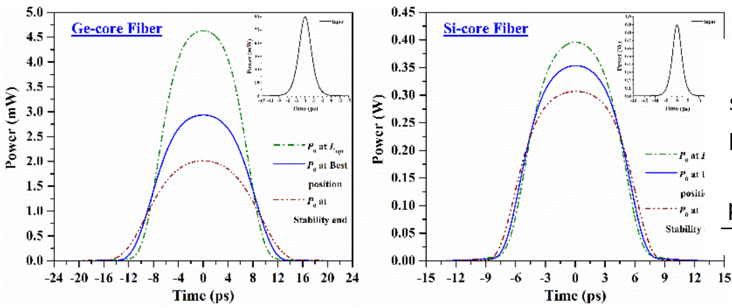

Fig. 3: Temporal shape of the output pulse for 2 different fibers at 3 various propagation lengths

Various fiber parameters and the pulse parameters are optimized next for the betterment of the generated pulse. Finally, a comparative study between the Ge-core and Si-core fiber is done to identify the best possible fiber for the generation of efficient SPP at sufficiently small fiber length.

NPS-2022-35

The optical linear and nonlinear exploration in a newly synthesized organic chromophore for photonic applications

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The present article demonstrates the optical linear and nonlinear studies of the chromophore 2,2'-(hexane-1,6-diylbis(9H-carbazole-9,3-diyl))bis(ethene-1,1,2-tricarbonitrile (HCzN). Herein the carbazole as rich in electron mobility and attached with a strong electron-withdrawing nitrile Group (EWG), shows the bear an enhanced dipole moment. We have synthesized this molecule and the structure of this molecule has been confirmed via IR and NMR spectroscopies. The linear optical study has been done with the help of UV-Vis absorption and emission spectra in solution form (Acetone as solvent) at a concentration of 10-3 M. The different linear optical characteristics as transmittance, absorption coefficient (α0), refractive index (n0), optical conductivity (σ) and optical bandgap (Eg) have been calculated at this concentration. The magnitude of these parameters is comparable with those of reported compounds. The nonlinear optical study for this chromophore has been done using the Z-scan technique in the solution form (Acetone as solvent). We have explored the third-order nonlinear optical characteristics of HCzN at the different solution concentrations of 1, 2, 3, and 4 mM employing both close and open aperture z-scan method using the Diode laser at 520 nm with a maximum power of 120 mW. This chromophore evinces the self-defocusing and saturable absorption nature for close and open aperture scans respectively. We have calculated third-order nonlinear absorption coefficient (β), nonlinear refractive index (n2), nonlinear optical susceptibility (χ(3)), and second-order hyperpolarizability (γ) for all concentrations and at 25 mW laser power. The values of n2, β, χ(3), and γ are found to be with the order of 10-6 cm2/W, 10-3 cm/W, 10-5 esu, and 10-27 esu respectively. The magnitude of n2, β, χ(3) increases almost linearly with an increase in the solution concentration whereas the magnitude of γ decrease almost linearly with concentration. The values of NLO parameters of HCzN are found to be comparably large with those of related reported molecules. These large values of NLO parameters support the good NLO behavior of HCzN. Hence this chromophore is a good candidate for different photonic applications like optical communication, optical switching, and optical data storage devices.

NPS-2022-37

Microfabrication using direct laser writer

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Direct Laser Writing (DLW) is a mask-less lithographic technique which is emerging as an interesting new technology for micro/nano fabrication. In this method, a laser beam (405 nm) is used to transfer the pattern from a soft mask onto a photoresist coated substrate in serial fashion. We have fabricated various microstructures such as microcantilevers, micro-bridges, controlled micro-patterns and electrodes for 2D materials using DLW and wet chemical etching methods. Various process parameters optimized such as stiction, laser dose, pre- and post-baking temperature/time will be discussed [1]. Resonance frequency and curvature of successfully released devices were carried out using nano vibration analyser and 3D optical microscope. Ultrasensitive and ultrafast RH sensing using surface enhanced microcantilevers is demonstrated [2]. Photo-induced deflection in Au/Si microcantilevers was also studied for non-contact actuation and temperature sensing applications. It is shown that a maximum temperature sensitivity of ∼ 62 mK/nm can be achieved by tuning the laser parameters and microcantilever dimensions .

NPS-2022-39

Sensing and dynamic switching of toroidal resonances in a bilayer terahertz-metamaterial

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Toroidal resonances, a new class of electromagnetic excitations, demonstrate exceptional properties as compared to electric and magnetic dipolar resonances. The active switching of dual toroidal resonances in the bilayer metamaterial (MM) is investigated in our study. The narrow line width in toroidal resonance is utilized to explore the sensing capability of the MM in the terahertz (THz) frequency range. Sensitivity calculation proves the significance of the design for use as a terahertz sensor. The interaction of near field coupled toroidal resonances has been recently studied and its significance in passive switching from dual to single resonance has been reported. The dynamic modulation of toroidal excitations in MMs provide a better platform in the study and development of actively tunable toroidal MMs. Our study focuses on the dynamic switching of toroidal excitations in a bilayer toroidal MM. The study further investigates the sensing capacity of the toroidal resonance. The sensitivity (S) of the toroidal MM is reported. It also explores the sensing of common oils. The ardent study of such toroidal bilayer MMs could provide significant potential in the development of bio-molecular and chemical based metamaterial sensors, switches and modulators.

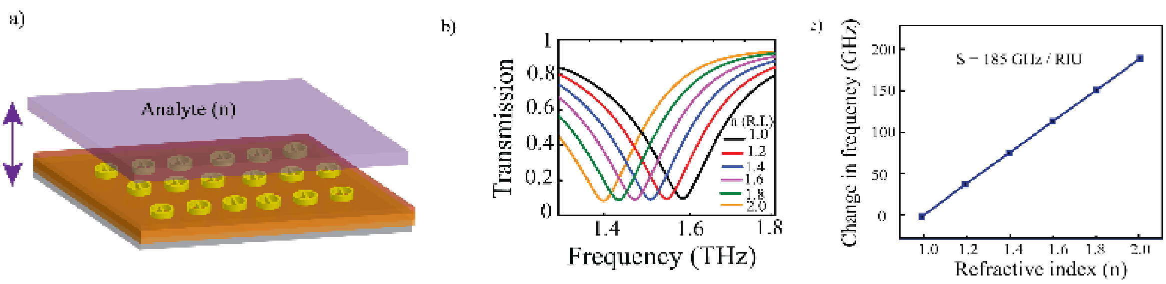

Figure 1 a) Bilayer MM used for sensing of analyte of refractive index (RI) ‘n’. b) Transmission spectrum of analyte with varying RI. c) Plot of frequency change versus refractive index.

NPS-2022-40

Hardware Development for Internet of Things-based Real-Time Blood Glucose Monitoring Using Photoplethysmography

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Diabetes has been recently listed the tenth largest cause of mortality, accounting for 1.5 million fatalities, and it causes blindness, kidney failure, coronary artery disease, and even diabetic agony. The global diabetes compact has established by the world health organization (WHO) in 2021, bringing together governments, nongovernmental groups and academic and research institutions to collaborate on a goal of lowering diabetes risk and ensuring cheap and high-quality treatment and care for all people. Preexisting diabetes and hyperglycemia, when discovered during pregnancy, may have major effects on both the mother's and the baby's health; in particular, these disorders raise the chance of miscarriage and perinatal morbidity and death. Worldwide, it is estimated that one in every seven pregnant women has hyperglycemia, and many cases of gestational diabetes go undetected, with potentially fatal consequences for both mother and child.

In recent years, bedside blood glucose monitors have become the predominant form of patient assistance. Using non-invasive wearable devices and the Internet of Healthcare Things (IoHT), blood glucose levels may now be monitored more accurately. ICU patients and expectant mothers have a constant battle to keep their blood glucose (BG) levels in check, which includes dealing with both hyper and hypoglycemia. Since internet-based healthcare systems heavily rely on technology, ensuring adequate glucose control for pregnant women and the ICU must be addressed cost-effectively. Using photoplethysmograph and machine learning approaches, this research developed a hybrid non-invasive internet of things based BG monitoring using near-infrared (NIR) spectroscopy. The developed IoT gadget is designed with Max30102 and Mlx90614 for blood glucose absorption and body temperature measurement respectively. The developed Hardware and support vector machine (SVM) model is deployed in Raspberry Pi 4B computer with graphical processing unit (GPU) support. A non-invasive glucose monitor that is more accurate than existing GM technology would be a big step forward. This hybrid model offers 93.76% prediction accuracy and adaptability within the range of clinical laboratory precision criteria.

NPS-2022-41

Power dependent nonlinear optical characteristics and two-photon absorption of NiO/PVA thin film

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The NiO/PVA thin film was prepared by drop-casting the NiO nanoparticles synthesized by chemical precipitation method. The structural and optical properties of the film were studied by the XRD and UV-VIS absorption. The surface roughness and particles distribution were realized by atomic force microscopy and FESEM. The optical nonlinear property of the Nickel oxide thin film was studied by the open aperture Z-scan method at 532 nm. The two-photon absorption coefficient of the film was calculated with different optical intensities. The nonlinear absorption coefficient has undergone a reduction with an increase in input intensity. This is attributed to the saturation two photon absorption process. The process can be explored for optical limiting applications.

NPS-2022-42

Fast imaging and spectroscopic study of single and colliding laser produced plasmas

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The propagation dynamics of single and colliding laser-produced aluminium plasmas were investigated using fast imaging and spectroscopic techniques. The collision of two laser-produced seed plasmas resulted in the formation of a stagnation region in the collision front. Time gated Intensified Charge-Coupled Device (ICCD) imaging was used to study the temporal evolution of plasma. The forward expansion velocity of the stagnation region was less than that of single plasma due to the additional complex collision process underlying the stagnation region. Time-resolved spectroscopy was used to obtain information about the distribution of neutral and ionic species in single plasmas and seed and stagnation region of colliding laser-produced plasmas. Greater concentration of ionic species was found in the stagnation region with a longer life time. Electron density and temperature were also calculated from the emission spectra.

NPS-2022-43

Characterization of Laser-Driven Air Sparks Using Self Emission and Rayleigh Scattering Studies

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Air plasma produced in a laboratory atmosphere by focusing the second harmonic radiation from a Q switched Nd: YAG laser (532 nm,10 ns,10 Hz) is characterized using optical methods. Self-emission from the plasma is studied at earlier times of its lifecycle, using emission spectroscopy arrangement. The setup is used to analyze the optical emission lines and Rayleigh scattered lines from the air plasma as a function of the vertical angle with the direction of polarization. Measured line profiles of different ionic species were used to calculate the plasma electron temperature and density at different angular positions. Line intensities of excited states of singly ionized Nitrogen (N II) were used for electron temperature calculations. Stark broadened profiles of singly ionized species and Hα lines have been utilized for electron density measurements. The assumption of local thermodynamic equilibrium conditions is verified in light of the measured plasma parameters.

NPS-2022-44

Laser ablated silver nanoparticles doped blue light emitting polymer optical fiber with enhanced photostability

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Here we present the fabrication of stable 1,4-Bis(2-methylstyryl) benzene (Bis-MSB) doped polymer optical fiber containing silver nanoparticles. Spherical silver nanoparticles of approximate size 15nm were fabricated using nanosecond laser ablation. The emission characteristics of the polymer optical fiber were analysed using a Q-switched Nd:YAG laser operating at 355 nm. The pump pulse energy (PPE) dependent emission spectra from the fiber were analysed. The observed fluorescence emission was turned to amplified spontaneous emission (ASE) at a PPE of 2.5mJ. The study shows that, at an optimum concentration of Ag nanoparticles, the fiber offers better photostability. The proposed fiber may find potential applications in the development of stable directional optical sources in the blue region.

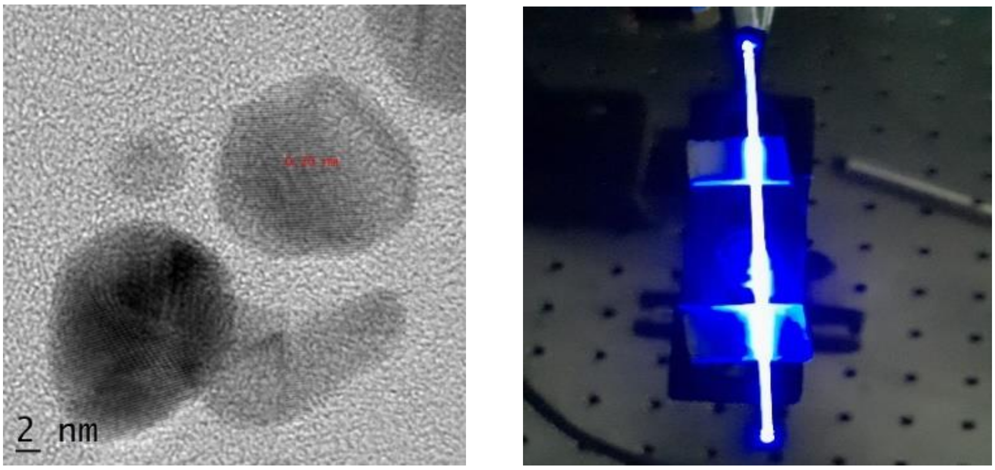

Fig.1. (Left) HRTEM image of laser-ablated Ag nanoparticles in MMA (Right) Photograph of amplified spontaneous emission under 355nm pulsed laser excitation

NPS-2022-45

Non-Linear Optical Properties of AIE Dye upon Restriction of Intramolecular Motion

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Aggregation Induced Emission (AIE) is an interesting photophysical phenomenon by which non-emissive molecules in solution become emissive in solid state. It overcomes the demerits of Aggregation Caused Quenching (ACQ) effect shown by most fluorophores. Restriction of Intramolecular Motion (RIM) or structural rigidification and thereby reducing non-radiative decay is the basic principle behind AIE mechanism. In this study, purposeful restriction of intramolecular motion in AIE dye named Tetraphenylethylene (TPE) is achieved by changing binary solvent's volume ratio (Acetonitryl:Water) and also by dispersing it in PMMA matrix. Linear-optical studies were conducted using UV-VIS spectrophotometer. Non-linear optical (NLO) absorption of TPE were investigated with open aperture Z-scan technique using Nd:YAG laser pulses operating at 532nm by varing dye concentrations and PMMA weight percentage. Reverse Saturable Absorption (RSA) is observed in TPE dopped PMMA films while RSA in SA behavior is noted for TPE at varied water fractions suggesting a RIM dependent NLO behaviour.

NPS-2022-46

Transmission properties of one-dimensional periodic structure of metamaterials and dielectric materials with different configurations

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In this work, we have investigated the tunable transmission properties of one- dimensional (1D) periodic structure of metamaterials and dielectric materials in different configurations. For the study of the optical properties of considered periodic structure, we have used transfer matrix method (TMM) which is based on the solution of Maxwell's equations and it connects with the electric and magnetic fields at each interface of materials layers in periodic structures. The different configurations of considered periodic structure shows tunable transmission properties with type of configurations, number of layers, type of material and incident angle of electromagnetic wave of particular wavelength. The proposed structure can be used in the large variety of opto-electronic and photonic applications including optical filter, multichannel filter, reflectors, switches and more optical devices.

NPS-2022-47

Investigation on Nonlinear Optical and Optical Limiting Properties of Cd0.7Zn0.3Te Quantum Dots

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The intensity depended nonlinear optical parameters of Cd0.7Zn0.3Te quantum dots were investigated using the Z-scan experimental set up using a continuous wave DPSS 532 nm laser source. The open aperture Z-scan set up is used to find out the nonlinear absorption coefficient β of the Cd0.7Zn0.3Te quantum dot. The transmittance of the sample showed a sharp dip at the focal point of the laser which indicates reverse saturable absorption. The optical limiting property of the sample is investigated through the open aperture set up. The quality of optical limiter is measured with the optical limiting threshold value and for Cd0.7Zn0.3Te quantum dot it was obtained around 4.6 KJ/cm2. The sign and magnitude of the nonlinear refractive index of the Cd0.7Zn0.3Te quantum dot is find out using closed aperture set up. Here the intensity variations are monitored through a small aperture kept in front of the photodetector. A negative sign is obtained for the nonlinear refractive index of the Cd0.7Zn0.3Te quantum dot which is attributed to the self-defocusing phenomena. The nonlinear studies indicate that the sample exhibits good nonlinear properties and find applications in optical limiting materials.

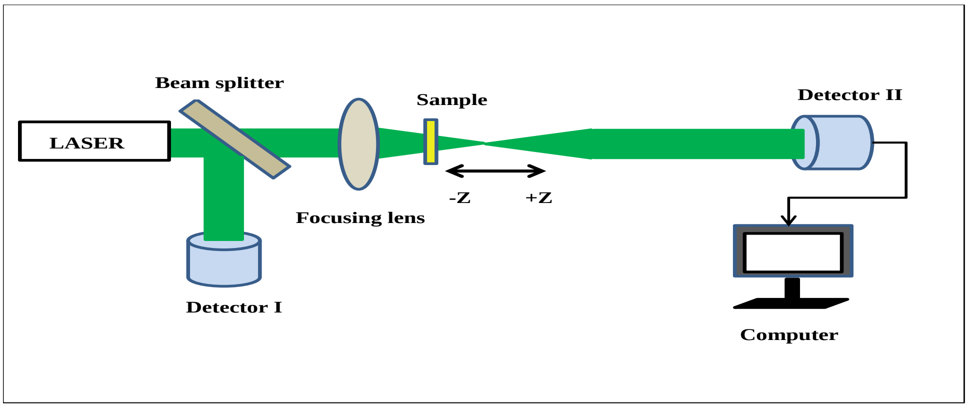

Figure 1. Schematic representation of open aperture Z-scan setup.

NPS-2022-48

Inline Fabrication of SERS Substrate for Point of Care Sensing Applications

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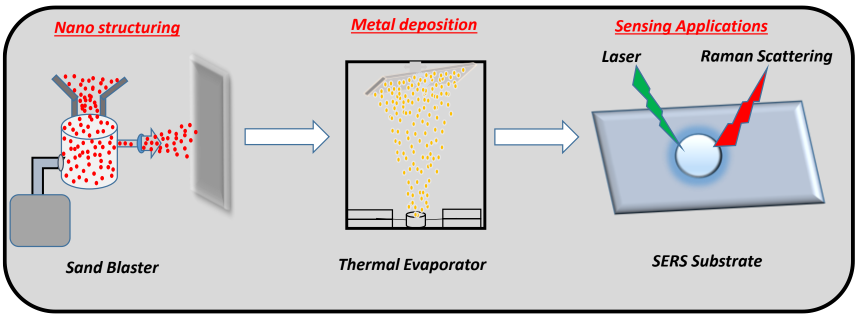
Raman Spectroscopy is a non-invasive molecular vibrational fingerprinting technique used for material identification. However, Raman spectroscopy suffers from low scattering efficiency limiting its usage mostly to bulk materials identification. Surface Enhanced Raman Scattering (SERS), discovered by Fleischmann et. al.,1 is a promising method to attain picomolar and attomolar range sensitivities. The main identified challenges are ease and cost of fabrication, process reproducibility, and performance uniformity.2 Presently, the available SERS substrate preparation methodologies can be broadly classified into two. The first one involves the preparation of colloidal nanoparticles and their deposition and the second involves the preparation of nanostructured surfaces followed by deposition of a thin layer of plasmonic metals to the selected substrates. Most of these established methods for SERS substrate fabrication demand costly, and sophisticated setup.

This work explores a novel and scalable process for the preparation of a high-performing SERS plasmonic substrate. Surfaces having nanowedges were prepared via abrasive blasting and then converted to plasmonic active SERS substrate by the deposition of a nanolayer of coinage metals through thermal evaporation. The studies revealed that SERS substrates have got an enhancement factor of ~106, and less than 10% variation in batch to batch and point to point measurements making it suitable for reliable identification of picomolar concentrations analytes. Further, the potential of the current substrate for the sensitive detection of one of the biomarkers for kidney function, creatinine, is investigated in detail.



NPS-2022-49

Investigating the Langevin Behaviour of Faraday Rotation in Soft Ferromagnetic $CoFe_2O_4$ Nanoparticles Dispersed in PVA-Water Medium

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Magneto-Optic Faraday Rotation (MOFR), defined as the phenomenon of rotation of the polarisation plane of linearly polarised light passing through a magnetized medium, with the magnetization parallel to the propagation direction of light, has many interesting applications, from both, practical as well as fundamental theoretical point of view. MOFR studies in fluidic media are generally performed by dispersing superparamagnetic (SPM) Nanoparticles (NP) in suitable carrier liquids. The SPM size limit sets the ideal criterion to form stable magnetic dispersions, thus limiting the MOFR studies only to SPM NP. Exploring the magnetization and MOFR behaviour of NP with sizes above the SPM limit, could be an interesting domain, that is however, generally excluded, due to the constraint in forming stable fluidic dispersions. Here, we report the MOFR studies performed on CoFe2O4 NP that belong to a soft ferromagnetic size range at room temperature. The constraint of forming stable dispersions of the NP with sizes above the SPM critical diameter, is efficiently overcome by choosing a 2 Wt % PVA-water solution as the dispersing medium. The dispersions thus formed are found to be stable for a very long period, approximately, over a month, due to the efficient matrix-like behaviour of PVA-layers that prevent the particles from agglomerating. The samples were prepared at two different concentrations (CoF-1 and CoF-2) so as to investigate the concentration dependence of MOFR. The FR values measured with applied magnetic fields upto 3000 Oe were fitted with Langevin function and it was observed that MOFR exhibited a saturation tendency similar to the magnetization of the sample. The sample at the lower concentration, namely CoF-1, exhibited saturation at around 1800 Oe, whereas the sample with the higher concentration, CoF-2 exhibited saturation at a higher magnetic field, at around 2200 Oe. The FR values were also found to be higher for the CoF-2 sample with the saturation value of rotation being 0.10°. The study opens up possibilities for MOFR measurements on dispersions of ferromagnetic NP, which may pave way for discovering newer exciting magnetic phenomena in fluidic samples.

NPS-2022-50

Development of visible light sensor using nanostructured cadmium sulfide thin films

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A visible light photosensor based on metal chalcogenide-cadmium sulfide (CdS) thin film is demonstrated. In this study, nanocrystalline CdS thin films were grown on precleaned commercial glass substrates using chemical bath deposition (CB D) technique. The X-ray diffraction confirms the formation of hexagonal CdS thin films with strong diffraction peaks along (002) direction. The EDX results reveal the stoichiometric behavior of constituent elements. The interconnected flakes structured morphology enhances the conduction mechanism. Optical studies suggest a strong green emission band near 507 nm and have bandgap energy near 2.25 eV. The electrical characterization of CdS thin films in visible light displays a fast, reversible, and stable response. The high photosensitivity of 9564% and quick photoresponse are attributed to the superior film quality. This opens up the possibility of using CdS based photodetectors for commercial applications by cost-effective routes.

NPS-2022-51

Statistical analysis of drying phenomenon of an epoxy adhesive

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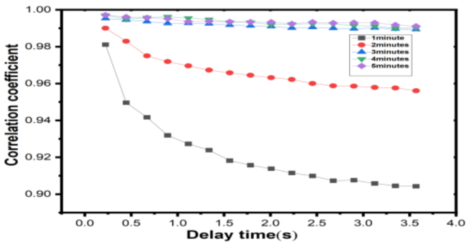
Epoxy materials are high performance structural adhesives which are inevitably been used in automotive and aerospace applications. Monitoring the drying phenomenon of such material can improve the efficiency and quality of the material. This work presents the application of a robust methods of cross-correlation and inertia moment to process the dynamic speckle images that resulted by the drying process of an epoxy adhesive.

Recently, dynamic laser speckle imaging has been developed to explore the time dependent dynamics of turbid materials. When the turbid materials are illuminated with coherent radiation, multiple scattering of light was resulted and the scattered light intensities followed different diffusive paths. The difference in their path lengths is responsible for generating speckle images. The scatterers in the materials are in random zig zag movement, the Brownian motion; due to which speckle images are varied in intensities and there by produces dynamic speckle images. Efficient method of cross-correlation is applied for five different time intervals of drying phenomenon. For each interval, 1345 speckle images of 640×480 pixels were collected. The variation in correlation coefficient with delay time and inertia moment with drying time are presented in Fig 1&2.



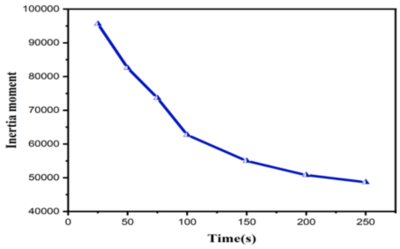


Fig. 1. Correlation coefficient with delay time **Fig. 2. Inertia moment with drying time**

The increase in correlation coefficient indicates that the epoxy is drying. At around five minutes, correlation coefficient approaches unity indicates the complete drying of epoxy. Also for each stage, correlation coefficient decreases with delay time. It also indicates the drying process of the epoxy.

NPS-2022-52

Investigations on Optical Properties of Ge-Sb-Se Chalcogenide Glass Films Towards Infrared Photonics

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The present study focuses on the optical properties of thermally evaporated films of Ge-Sb-Se chalcogenide glass system using UV-Vis-NIR Spectrophotometer. The optical constants: refractive index and extinction coefficient, dispersion parameters: oscillator energy and dispersion energy, and the thickness of the films were determined using open-source software PRISA which uses the transmission spectrum to get more accurate results.

NPS-2022-53

Dual-Channel based LSPR Biosensor for Multi-Analyte detection

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A surface plasmon resonance (SPR) based sensor with multiple sensing cavities is proposed for the qualitative and quantitative analysis of biochemical analytes, antigen-antibody interaction, DNA/RNA binding, etc. Detection and analysis of different analytes by means of the proposed dual-channel based plasmonic structure is numerically analysed using finite element method via absorption cross-section profiles. The sensor structure consisted of two segments of a square silver disc and ring with a channel/cavity in between acting as the sensing region. 1The optical sensor monitors the change in resonance position corresponding to the field localization near plasmonic channels accompanied by the change of refractive index of the analyte embedded in the cavity. A maximum refractive index (RI) sensitivity of 1778.16 nm/RIU is obtained for concentration analysis of 0.07-0.12g/ml glucose-lactose solution via their respective RI values. The dual absorption peak maxima obtained with multiple analytes in each channel indicates the independent sensing behaviour of the structure that can potentially quantify multiple analytes simultaneously.2 Further, when only a single analyte is loaded in both cannels, merging of the two peaks into a single peak with equal charge distribution on both cavities is observed which in turn finds the possible single or multiple analyte detection. Moreover, the independent sensing behaviour can be effectively tuned with changing the material or geometric parameter of any one of the segments. The proposed structure exhibits a super ultra-broad RI sensing range of nearly 0.4 to 1.8 RIU with resonant peaks across near-IR region. The reduction of size of the sensing channel to 10 nm further improves the performance. Sensitivity, figure of merit (FOM), and Q-factor values of 4267.60 nmRIU-1, 82.23 RIU-1, and 116.51 observed after optimization reveal the promising applicability of designed SPR sensor in the areas of medical diagnostics, pharmaceuticals, chemical industries, and food processing. Those simultaneous sensing channels proposed promises repeated confirmation analysis, analyte comparison study, and multi-parameter detection together with the advantage of simple and easy manufacturable structure profile.

NPS-2022-54

Photocatalytic activity of Gd_2O_3 doped $Er_4Zr_3O_{12}$ Nanoceramic

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Water, the essential resource on which all life depends is alarmingly polluted. Dye from industrial effluents is one of the main causes of water pollution. Simple and effective approaches aiming at the rapid removal of dye from the environment are in demand. The aim of this work is to investigate the effect of photocatalytic activity of $Er_4Zr_3O_{12}$ system by Gd_2O_3 doping and a detailed investigation on photocatalytic activity mechanism of Gd_2O_3 doped nanoparticles on pollutants using kinetic model. Nanoceramic materials can be synthesized by different methods. Here we use cost effective, environment friendly combustion synthesis for the synthesis of nanoparticles. Here we successfully synthesized $Er_4Zr_3O_{12}:Gd^{3+}$ nanoceramic with enhanced photocatalytic activity by auto-ignited combustion and wet mixing method. The purity and reusability of water after photocatalytic degradation is also checked. The structural and morphological characterization of the sample was done by X-ray diffraction (XRD) and Field Emission Scanning Electron Microscopy (FESEM) analysis, respectively. Photocatalytic activity study reveals that the reaction occurring in the irradiation process is a first order type chemical reaction. Reusability of water after photocatalytic dye degradation is evaluated using the parameters like pH, total dissolved solids, conductivity and dissolved oxygen. Water quality assessment test reveals that the water is reusable for industrial purposes.

NPS-2022-55

The effect of temperature and power on the structural and optical properties of r.f sputtered ZnO thin films

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ZnO thin films were deposited on glass substrate by r.f magnetron sputtering from a zinc oxide target. The effect of r.f power and substrate temperature on the properties of ZnO thin films was studied. The structural and optical properties were investigated by X-ray diffraction (XRD), field emission scanning electron microscopy (FESEM), UV-Vis absorption spectra and photoluminescence (PL). All the ZnO films were highly oriented in c-axis (002) and the film deposited at 450℃ with a sputtering power of 50W exhibited the larger grain size. PL emission was obtained at UV and green region for the excitation wavelengths of 280 nm and 390 nm respectively. Dependence of temperature and power on absorption spectra is also discussed.

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Network like silver nanostructures as SERS substrates

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Surface enhanced Raman scattering (SERS) spectroscopy is a powerful technique that provides molecular information through enhanced Raman scattering from minute amounts of substance near nanostructured metallic surfaces. In this work, network like silver nanostructures were prepared using polyol method, maintaining a constant polyvinyl pyrrolidone to silver nitrate molar ratio. The structure, morphology and plasmon resonance properties of these nanostructures were investigated in detail using field emission scanning electron microscopy and UV-visible spectroscopy methods. The morphology of the network like structure consists of silver nanowires, with average length 7 μm, arranged in a periodic fashion. The surface enhanced Raman scattering activity of these network like nanostructured silver substrates were tested with 4-nitrophenol as probe molecules under 514 nm laser excitation. Investigations indicated that these network-like nanostructures are promising candidates for application as substrates for surface-enhanced Raman scattering.

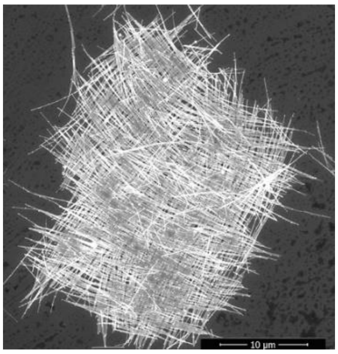

Fig 1: FESEM image of AgNWs

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ANTI-CANCER ACTIVITY OF TRIANGULAR LIKE SILVER NANOPARTICLES

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Cancer is a multifactorial disease caused by environmental and genetic factors. Even though anti-cancer drugs available, they are not capable to reach the target site in optimum level and also causes many other health issues. Nanotechnology offers a wide variety of tools for delivering therapeutic agents directly at target cells. The unique physical and chemical properties of silver and gold nanoparticles make them suitable candidates for application in anticancer treatments.

Herein, triangular silver nanoparticles (TSNPs) were synthesised by a two-step seed mediated method. At first spherical silver seeds were obtained by the reduction of silver nitrate with sodium borohydroxide and then these seeds acted as the nucleation sites for the formation of triangular shaped nanoparticles. Surface resonance characteristics of these nanoparticles was studied using UV Visible spectroscopy. Structural determination of the nanoparticles was done using X-ray diffraction and its morphology was confirmed with high resolution transmission electron microscopy (HRTEM) and field emission scanning tunnelling microscopy (FESEM). In vitro cytotoxicity of the TSNPs were evaluated against human cancer cell lines, MCF-7 (Human Breast Adenocarcinoma). The results indicated that the TSNPs exhibit concentration dependent anti-cancer activity in the tested cell lines.

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Broadband Photoacoustic Imaging for Biodegradable Bone Implants Applications

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Abstract: Magnesium-based biodegradable implants are a novel alternative to temporary implants used to treat bone fractures [1]. Ultrasound and Photoacoustic (US-PA) imaging has the potential to non-invasively monitor the tissue changes during the bone healing process, while the implant is degrading. However, the US-PA imaging technologies typically work either in the lower frequency or in the higher frequency due to the limitation of broadband transducers and data acquisition (DAQ) systems. Here we used an innovative open architecture system that enables the co-localization of ultra-high and low-frequency photoacoustic signals within the frequency range of 71-1 MHz. The technology is optimized for imaging small to large structures and provides unique opportunities for translational research in monitoring tissue remodeling and implant osseointegration.

Introduction: Photoacoustic (PA) is an innovative imaging technology based on acoustic waves generation induced by pulsed laser light. Sound waves are detected and reconstructed just as conventional ultrasound signals to form imaging of the optical absorption. In PA imaging, the limited acoustic frequency range has a significant impact on the resolution and the depth of imaging. Here we are proposing an optimization of the broadband US-PA imaging set up to monitor the tissue remodeling in the vicinity of a biodegradable implant.

Methods: We developed a tissue-mimicking phantom that includes an Mg implant. Multi-spectral PA imaging (sPAI) has been acquired ranging from 680-970nm. The sPAI has been acquired at multiple frequency bands using US transducers at a nominal center frequency of 6MHz, 15MHz, and 30MHz. A novel superpixel unmixing framework has been developed to automatically extract the molecular tissue components from sPAI. Due to the broadband nature of the acquisition, the approach can create multiscale and multi-contrast images of structures ranging from small to large and facilitate respective spatial resolutions.

Results: In this study, the optimized US-PA multi-spectral and multi-frequency approach offers the possibility of combining multiple photoacoustic information in customized phantoms with unprecedented details.

Conclusion: In summary, the innovative ultra-high and low-frequency PA imaging technology opens many opportunities to monitor tissue remodeling in presence of biodegradable implants on a clinical level.

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Sunlight Driven Photocatalytic Degradation of Organic Pollutant by Au Doped Anatase TiO_2 Nanoparticles

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Photocatalysis is considered a promising strategy for the removal of organic contaminants from water bodies. Metal oxide-based photocatalysis is very effective for this application and in which TiO_2 is the benchmark one. Owing to the properties such as low toxicity, and chemical and thermal stability, TiO_2 can be used for the organic dye degradation from polluted water [1,2]. In the present study, we have synthesized the pure anatase phase of TiO_2 nanoparticles by a simple route from the tetra isopropyl orthotitanate precursor and its surface is modified with spherical Au nanoparticles. The Surface Plasmon Resonance of Au nanoparticle shifts the photon response of pure TiO_2 from 320 to 600 nm which is confirmed from the diffused absorbance measurements. From the micro-Raman and XRD analysis, the anatase phase formation of TiO_2 is verified and the surface area analysis by BET method indicated that the specific surface area of pure TiO_2 increases from 72.50 to 96.80 m^2/g after Au incorporation. The surface state analysis of Au doped TiO_2 nanoparticles was performed by using X-ray photoelectron spectroscopy. FESEM and HRTEM analysis indicated that these nanoparticles are spherical in shape. The photocatalytic degradation by the photocatalysts was carried out by selecting Nile Blue Chloride dye as a model pollutant and the experiment was carried out under direct sunlight. The photocatalytic degradation experiment shows that the Au incorporated TiO_2 nanoparticle almost completely degrade the NBC content from its aqueous solution within 27 min of sunlight exposure and the increase in activity of Au: TiO_2 nanoparticles are mainly arising from the enhanced visible light absorption and the increased surface area compared to pure TiO_2 nanoparticles.

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Optical Studies in Eu^{3+} Doped Calcium Magnesium Silicate ($CMS: Eu^{3+}$) Phosphor

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Phosphors play a vital role in modern technology because of their ability to convert incident electromagnetic radiation to visible light, for white Light Emitting Diodes (wLEDs) applications [1]. The present study focuses on the effect of pH, and surfactants on optimizing the crystal structure and microstructure of Eu^{3+} doped calcium magnesium silicate phosphor ($CMS: Eu^{3+}$) and its influence on luminescence. Calcium magnesium silicate and Eu^{3+} doped (1mol %) calcium magnesium silicate were synthesized separately via the sol-gel method and annealed at 1200˚C. Samples were prepared at a pH of 2.2 using HNO_3 as catalyst and pH of 9 and 11 using NH_3 as catalyst with and without Cetyl Trimethyl Ammonium Bromide (CTAB) as surfactant. The crystal structure variation with pH and surfactant were studied using X-Ray Diffraction (XRD) analysis. XRD pattern of sample prepared at a pH 9 shows impurity phases. However, presence of a combination of monoclinic structure with merwinite and diopside phases and tetragonal structure with akermanite phase was confirmed in samples prepared at pH 2.2 and pH 11. The addition of CTAB does not affect the crystal structure formation in the synthesized samples. Hence acidic pH of 2.2 and alkaline pH of 11 supports the formation of $CMS: Eu^{3+}$ phosphor without any impurity phases due to the better metal ion-oxygen bond polymerization. The microstructure evolutionwas studied using Field Emission Scanning Electron Microscopy (FESEM). The morphology analysis confirmed the grain formation at a pH of 2.2, while agglomerated morphology was obtained in samples prepared at alkaline pH 9 and 11. A gradual reduction to the extend of agglomeration is noticed with CTAB probably due to the reduction in the surface energy. The photoluminescence studies using spectrofluorometer confirmed $^5D_0 \rightarrow {}^7F_J$ (J= 0-4) transitions of Eu^{3+} with maximum emission at 614nm irrespective of pH.

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Investigation of Intensity Dependent Nonlinear Absorption in Cerium Phosphate Nanoparticles

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Abstract: Cerium Phosphate ($CePO_4$) is a material that has attracted attention because of its unique properties, redox capabilities and awide variety of applications. Cerium Phosphate nanoparticles with a nanowire structure were successfully synthesized by a hydrothermal synthesis procedure using Cerium Nitrate Hexahydrate (Ce $(NO_3)_3.6H_2O$) and Diammonium Hydrogen Phosphate ($(NH_4)_2HPO_4$) as the precursors without adding any surfactants. The synthesized $CePO_4$ nanowires were characterized using X-ray Powder Diffraction (XRD), Transmission Electron Microscopy (TEM) analysis which showed pure monoclinic nanowire structures. The optical properties were analysed by UV-visible absorption and photoluminescence (PL) study. The Nonlinear Absorption was measured by the open aperture Z-scan technique using Q switched Nd-YAG laser at 532nm. The Z-scan curve exhibited reverse saturable absorption. In this study, the dependence of nonlinear absorption on the intensity of incident light was investigated, the non-linear absorption coefficient was measured and found the non-linear absorption increasing with the increasing intensity.

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