NATIONAL PHOTONICS SYMPOSIUM 2020

Advisory Board

Prof. (Dr.) K N Madhusoodanan, Hon'ble Vice Chancellor, CUSAT

Prof. (Dr.) P G Sankaran, Hon'ble Pro-Vice Chancellor, CUSAT

Prof. (Dr.) K Ajitha, Registrar, CUSAT

Prof. Pramod Gopinath (Director, ISP)

Dr. Praveen C S (Convener, NPS 2020)

Prof. C P Girijavallabhan, ISP, CUSAT

Prof. V M Nandakumaran, Amrita University

Prof. V P N Nampoori, ISP, CUSAT

Prof. P Radhakrishnan ISP, CUSAT

Dr. B B Kale (C-MET, Pune)

Dr. M. Krishnamurthy (TIFR, Hyderabad)

Dr. Deepa Venkitesh (IIT, Madras)

Dr. Sudheesh Chethil (IIST, Trivandrum)

Dr. P. Ravindran (SCANMAT/CUTN, Thiruvarur)

Dr. V K Praveen (NIIST, Trivandrum)

Dr. K N Narayanan Unni (NIIST, Trivandrum)

Organizing Committee

Editorial Board

Prof. Sheenu Thomas
Dr. V Manickam
Fathima R
Vijoy K V
Karthika Sankar
Safna Saif
Priya Mary N J
Mubeena Rafi
Shilpa S

Program, Technical & Stage

Prof. A Mujeeb
Dr. Saji K J
Lakshmi B
Soumya S
Anitha Prakash
Nideep T K
Lakshmi R
Cicily Rigi V J
Priyamvada V C

Registration

Dr Priya Rose T
Dr Bini P Pathrose
Jayaprasad K V
Ajina C
Anita Mary Peter

Prof. Pramod Gopinath (Director, ISP)

Dr. Praveen C S (Convener, NPS 2020)

Prof. A Mujeeb

Prof. M Kailasnath

Prof. Sheenu Thomas

Dr. Saji K J

Mr. Muhammad Rishad K P

Dr. Priya Rose T

Dr. Bini P Pathrose

Dr. Retheesh R

Dr. V Manickam

Travel and Accommodation

Dr. Manu Vaishakh
Dr. Retheesh R
Boni Samuel
Vijesh K R
Anand V R
Titu Thomas
Pradeep Kumar V

Conference Proceedings

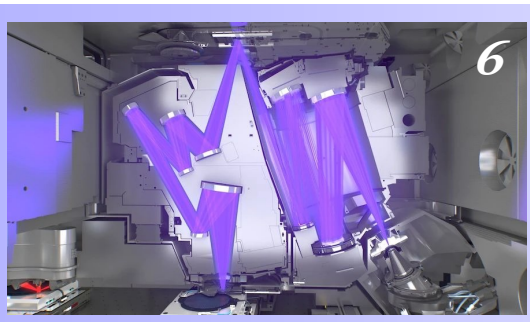
Prof. Pramod Gopinath
Dr. Praveen C S
Dr. Pradeep Chandran
Dr. Vineesh Kumar T V
Pradeep Kumar V
Priya Mary N J

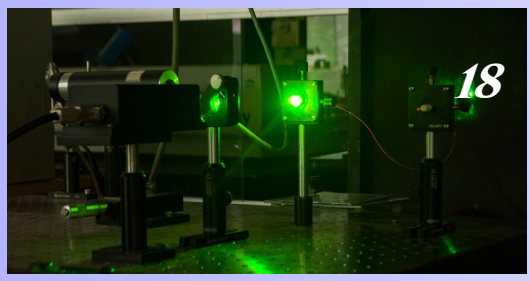
Food

Prof. M Kailasnath
Dr. Kamal P Mani
Anugop B
Divya D Pai
Pooja Gitty
Remya R
Sony U
Hajara P

PHOTONICS NEWS 2020

In short...





DIRECTOR'S MESSAGE

Prof. Pramod Gopinath

It is with great pleasure and happiness we present the 2020 edition of Photonics News, showcasing the events and activities of International School of Photonics. This year, we are celebrating 25 years of the establishment of International School of Photonics at Cochin University of Science and Technology along with 60th year of the invention of lasers. This issue of Photonics News, brings to its readers a commemorative article on the *Diamond Jubilee Year of Photonics* by Prof. C P Girijavallabhan, the Founder Director of International School of Photonics.

International School of Photonics is leaping high with the ongoing collaboration with University of Gothenburg, Sweden and the recently signed MoU with Indian Institute of Technology Madras, for student exchange programs. The School is in the process of signing another MoU with University of Rennes 1, Lannion, France for student exchange.

Photonics News has evolved over the years in its style and content with a mission to illuminate the readers on the recent developments happening in the field of Photonics and related areas. I congratulate the editorial team led by Prof. Sheenu Thomas, for bringing out this issue of Photonics News on time and appreciate the dedication and effort rendered by each team member.

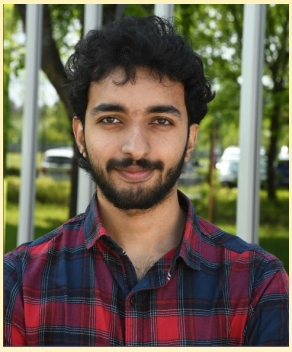
Thank you all.

Pramod Gopinath

Awards & Achievements

ACADEMIC TOPPERS

Mr. Joel George
Nalanda Award
(Highest GPA)
M.Sc. Sem 1)



Mr. Eruthuparna R
Prof. Leggett Award
(Highest CGPA
M.Sc. Sem **10)**

Ms. Maria Merin Antony
P. S. I. Award
(Highest CGPA M.Tech)
Satish John Memorial Award
(Best Project M.Tech)
Best presentation Award
(ICOPEN 2019, Thailand)

Mr. Riswan Asif
Best Mini Project Award
(M.Sc. Sem 6)

Ms. Alina C Kuriakose
Research Scholar
(Best Researcher Award 2019-2020)

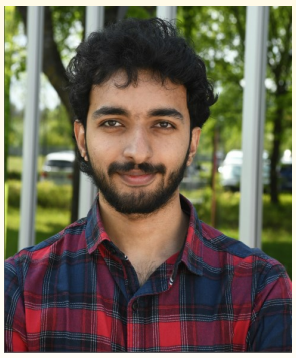
Ms. Anitha Prakash
Research Scholar
(Best Poster Presentation NPS 2019)

C V RAMAN AWARD

(Best Project – M.Sc. Sem. 10)

Mr. Gautham P

Ms. Harsha Surendran



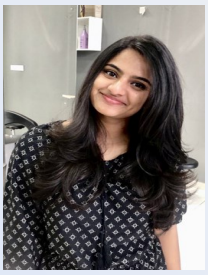
Mr. Eruthuparna R

Recent Placements

Mr. Akheel Ahmmad
(RF Engineer,
RS SPECTRA)

Mr. Hareesh S U
(RF Engineer,
RS SPECTRA)

Mr. Krishna Kumar
(Research Scholar,
University of Helsinki,
Finland)



Ms. Osheen Joseph
(Project Assistant,
IISC Bangalore)

Mr. Sonu Kumar
(Research Scholar,
University of
Hamburg, Germany)

M.Sc Photonics (2014-2019)

Mr. Ronal Issac Vettikattu
(Optics Engineer,
FORUS HEALTH PVT LTD.)

Ms. Stephy V J
(Research Scholar,
The University of Western
Australia)

Mr. Saran Shaju
(Engineer,
VALEO OPTICS)

Mr. Rahul A Rajan

Research Scholar, University of Chinese Academy of Sciences, Guo Photonics Laboratory.

Ms. Maria Merin Antony

Research Associate & Research Scholar, Centre for Optical and Laser Engineering, School of Mechanical and Aerospace Engineering, NTU Singapore.

M.Tech (2017-2019)

Mr. AkhilDutt V

Project Associate, Department of Electrical Engineering, IIT Madras.

Mr. Shinil P K

Optical testing wing ,Tech Mahindra

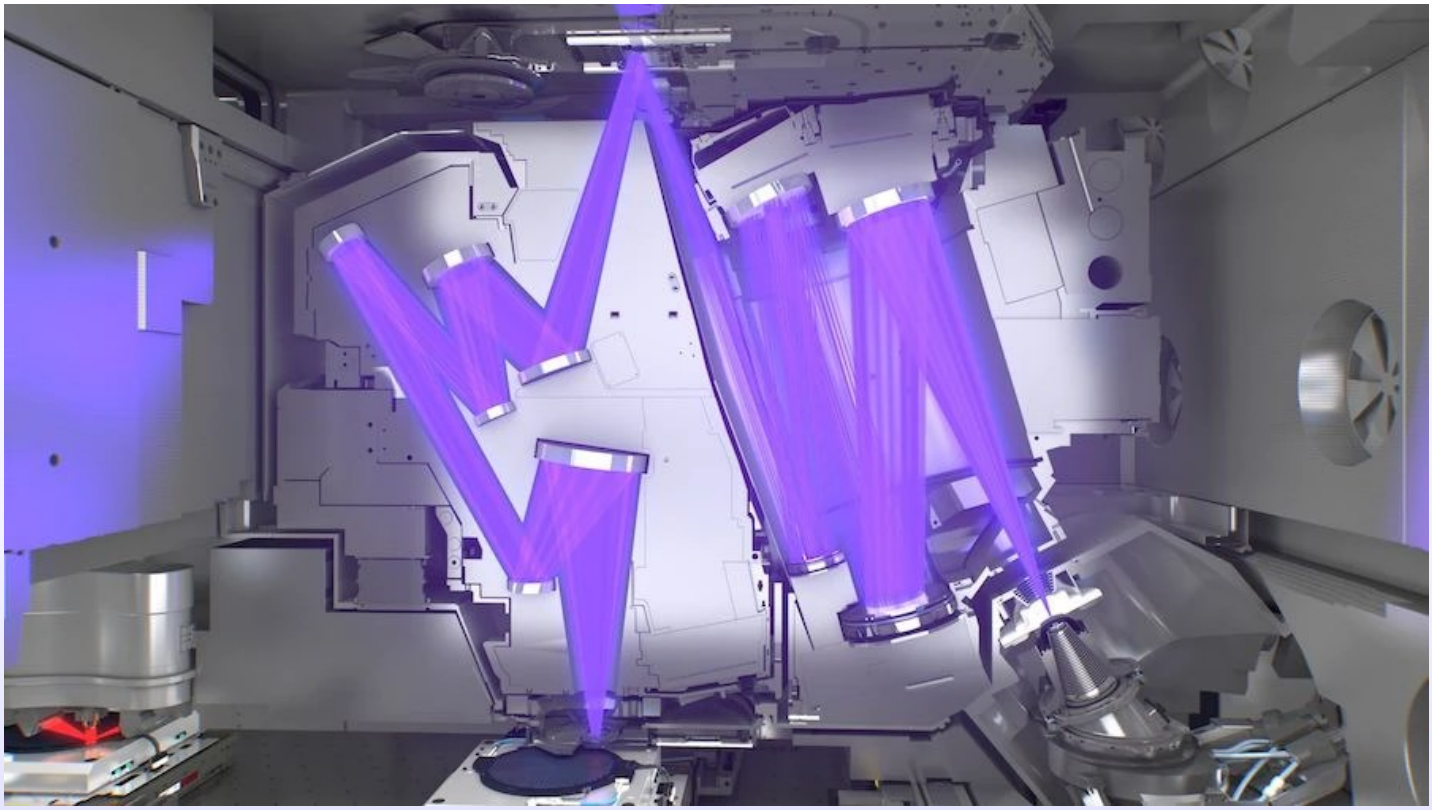
Articles

Diamond Jubilee Year of Photonics

In 2020 we are celebrating the diamond jubilee of Photonics Science and Technology. Sixty years ago the first optical maser gave its output energy as a great red laser pulse. More than light bolted out from Ted Maiman's ruby laser. It was the triggering of a technological revolution the likes of which world has not seen very frequently. Discovery of electric bulb, radio, the transistor and perhaps the DNA structure and a few others like this momentous events only are comparable with the discovery of lasers. Looking back, we can unhesitatingly claim that lasers have penetrated into every conceivable area of human activity; be it science, technology, industry, communication, entertainment, defence or medicine. A whole new branch of science and technology viz., **Photonics** emerged as a result of this path breaking discovery. The prediction was 21st Century is going to be the 'Century of Photonics'. Not only that this prediction turned out to be completely true; but it surpassed all our expectations. According to Eugene G Arthurs, former CEO of SPIE, the best is yet to come in Photonics.

The new millennium included many landmark years vis- a- vis Photonics. The concept of photon, the quantum particle of light proposed by Albert Einstein, completed 100 years in 2005. The half century of lasers was celebrated in 2010. The year 2015 was declared as the International Year of Photonics (IYL) by UNESCO. In 2017 we celebrated one hundred years of stimulated emission (again a concept developed by Einstein). Light and other optical technologies play a dominant role in the daily life of modern man. However, the general public appears to be unaware of this role of Photonics. They take many things for granted. Most of the scientists, teachers and students became aware of this situation when they celebrated the IYL in which common people were invited to participate. Individual scientists, teachers and students in Photonics can play a great role to mitigate this situation. Organizing events like 'Optics Fare' etc. by SPIE, Photonics Society of India and ILA chapters is very welcome gesture in this context.

The impact and influence of photonics in modern technology are prodigious. Modern man is inseparably attached to the device called 'smart phone'. The device is called a phone only by tradition; mostly it is a camera, diary, calculator, navigator, computer and what not! But most users are oblivious of the fact that photonics play a major role in its creation and working. Some of these devices contain as many as 10 billion silicon transistors. The average device sizes in these processor and memory chips are ~7 nm and soon will be 5nm and probably 3 nm later on.



Extreme Ultraviolet Lithography at 13.5 nm for making computer chips: made by ASML, Veldoven, The Netherlands. The source is at the bottom right and the mask is at the top.

Extreme Ultra Violet lithography has become a very useful tool in this context. Without the powerful and reliable lasers, the marvel of printing circuits with active devices of 5 nm size is absolutely impossible. About 25 silicon atoms sit in 5 nm stretch and taking information in and out from these elements using electrons will be restricted by quantum size effects and increasing thermal management problems. The solution obviously lies in replacing electrons with photons which will be at the heart of future smart phones. Thus, photonics technology is bound make our phones and computers smarter and more user friendly with artificial intelligence (AI), the influence of which will be increasingly felt in day to day life in coming years.

Astronomy and astrophysics have always depended on optics for its very existence. Hubble telescope is going to complete 3 decades in orbit around earth. Not only that we have enjoyed the astonishing pictures of the heaven shot by Hubble, it has opened up news vistas in our understanding of the Universe we live in. Better detectors and ultra sensitive imaging devices are sure to revolutionize our vision of the worlds. This is true of experimental particle physics as well. Our hunt for elusive particles of dark matter, tachyons etc. could be made easier by these new kinds of detectors. The role of lasers in LIGO experiments which discovered the gravitational waves is well known. This has opened up a whole new field of gravitational astronomy. In chemistry, condensed matter as well as in plasma studies, attosecond probes are yielding a more fundamental understanding of the dynamics of atoms, molecules, ions and electrons in different states of matter. Considerable progress has been made in the efficient generation of terahertz beams which is supposed to change the imaging technology. Biomedical imaging has revolutionized health care system. Advances in photonics are sure to bring about more compact, portable and less expensive imaging systems that will be a boon to all sections of patients. Google has recently demonstrated that smart phones combined with AI can be used to diagnose and predict many diseases leading to early preventive measures to save human lives.

New developments in photonics are sure to bring in wonderful changes to our lives on this planet. The comforts that we enjoy now in our present day world would have appeared as mere science fiction half a century ago. Commitments and optimism of scientists and entrepreneurs were absolutely essential for pushing the frontiers in the forward direction. It is a happy thing that the young generation of scientists and students has embraced the studies in photonics whole heartedly and their dedication and efforts will certainly contribute to the future developments in this field

Dr. C. P. Girijavallabhan

(Founder Director)
International School of Photonics
Cochin University of Science and Technology

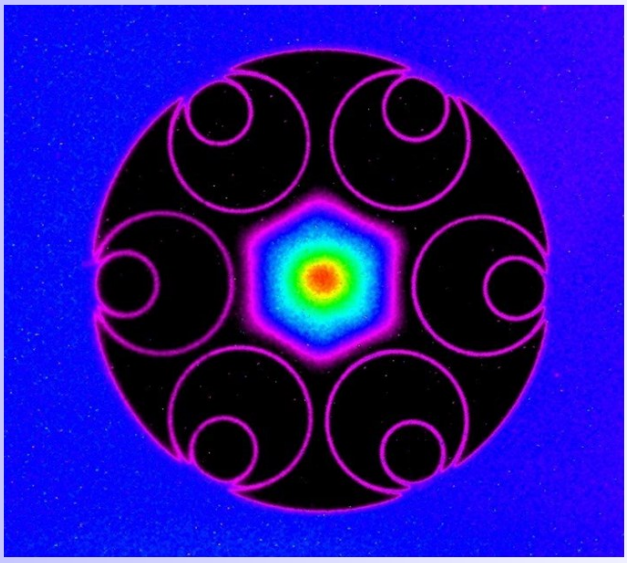
Introduction to Hollow Core Optical Fibers

Conventional glass core optical fibers have a number of limitations such as their finite spectral transparency, susceptibility to optical damage, dispersion and nonlinear optical response. Researchers have now come up with an alternate optical fiber technology based on hollow core silica fibers and using different optical Physics which can address the above limitations.

These fiber designs can enable emerging applications including delivery of powerful picosecond/sub picosecond pulses throughout the visible and near IR, damage free delivery of laser light in the UV and low-loss transmission in the mid-IR.

LIGHT GUIDANCE IN HOLLOW CORE FIBERS

Unlike the fibers based on the use of a photonic band gap, these hollow core fibers have simple structures and are easier to fabricate. Like photonic bandgap fibers, these new designs rely on the presence of air holes running down the fiber length to control the flow of light. These fibers trap light in an optical mode of the hollow core by controlling the microstructure. The fibers work by surrounding the central hole with a wall of glass that is, anti-resonant which enhances the reflections of light back into the core. These fibers are often referred to as anti-resonant hollow core fiber. The shape of the core wall and the number and size of the surrounding air holes are important elements of the structural design. They also have relatively large core diameter (typically 30 λ) which provides several advantages in performance.



Violet colour represents silica and black colour represents air

APPLICATIONS

A) Delivery of ultra-short pulses

Ultra-short pulse fiber lasers have become reliable tools in manufacturing and medical fields. However, conventional SM optical fibers are not able to deliver these ultra-short pulses due to their optical non-linear response and their dispersion. Anti-resonant hollow core fiber addresses both these undesirable effects because of their larger core size and reduced material contribution. As a result, these fibers can transmit highly powerful ultra-short pulses without any distortion. Unlike conventional fibers, where fiber dispersion strongly depends on the operating wavelength, anti-resonant fibers exhibit low dispersion over a broad spectral range which enables them to deliver ultra-short pulses at a number of wavelengths.

B) Mid Infrared (MIR) Applications

Even though silica heavily absorbs at MIR wavelengths, hollow core anti-resonant fibers can transmit MIR light with low loss because the light travels mainly in the hollow core. Hence within the spectral range 3-5µm, silica based hollow core fibers offer the strength of silica fibers, very low non linearity and dispersion and having an optical attenuation comparable to IR glass based optical fibers. This enables their employment in this attractive spectral band with high efficiency and output.

Recently, hollow core fiber with attenuation as low as 0.65 dB/km across the full C&L communication bands have been demonstrated.

C) Guiding UV light

UV radiation passing through conventional fiber causes disruption of the glass matrix at microscopic scale leading to increased absorption. This makes stable transmission difficult at short wavelengths and high powers. However, anti-resonant hollow core fibers offer virtually damage-free transmission of uv light even at high power as the light mostly travels through the hollow core.

CONCLUSION

Even though there are some practical challenges still to be overcome, the day is not far off when the hollow fibers with their attractive advantages make a great commercial impact.

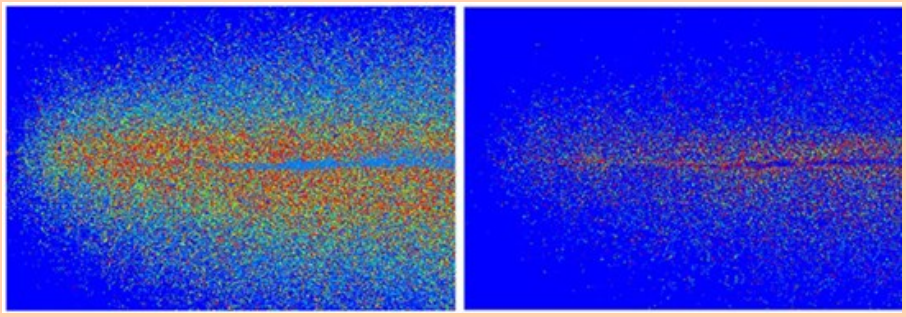
Ref: Photonics Spectra and Laser Focus World

Prof. (Dr.) P. Radhakrishnan
(Former Director)
International School of Photonics
Cochin University of Science and Technology

ELSI for ST

In most of the cases in Electronic Laser Speckle Imaging (ELSI) technique, a speckle image of the unstressed object is captured, recorded using CCD camera and stored in the computer. The object is then stressed causing the object's surface to displace. This causes the beam path length of the light reflected off the object surface to alter, which in turn causes the unique speckle pattern to change. The frame corresponding to the deformed state of the object can be subtracted or added pixel by pixel from the original stored speckle image to generate correlation fringes displayed on the monitor. Digital image processing techniques are used to process the results and to perform a quantitative evaluation. In the subtraction process, the CCD camera video signal corresponding to the image plane speckle pattern of the un-deformed object is stored electronically. The object is then deformed and the live video signal detected by the CCD camera is subtracted from the stored image. This subtracted signal is filtered and displayed on the monitor. Live correlation fringes are observed which contours of constant phase changes are corresponding to the surface displacement of the object. For the addition mode, the speckle fields corresponding to the two states are added sequentially. The camera detects the added light intensity and the signal is then filtered as in subtraction process. The correlation fringes are again observed on the monitor. The importance of ELSI is its capability to display correlation fringes in real-time on a monitor without the need of optical filtering. One of the promising research options is to utilise ELSI in the field of structural testing (ST) analysis.

Functional materials inevitably suffer mechanical damage during their use, as a result of scratching, abrasion, fracture or impact. Preventing material failure by managing the effects of damage is one of the foremost challenges in the design of high-performance materials. Self healing has emerged as a powerful approach to spontaneously repair damage before it can lead to catastrophic failure of the material as a whole. Encoding self-healing capabilities in new materials is thus a promising strategy to enhance the durability and reliability of functional materials and coatings. A diversity of self-healing strategies has been developed in the past decades. At its core, intrinsic self-healing is driven by the dynamics of polymer chains and supra molecular bonds at the molecular scale. However, it remains a major challenge to experimentally unravel these dynamics in situ with appropriate spatial and temporal resolution. Although different probes have been widely employed for real-time monitoring of bond failure, methods to quantitatively visualize bond reformation are unavailable. Yet, such experiments are not only crucial to understand self-healing materials but could also aid in the rational design of new and improved materials. Molecular mechanisms of repair confine strongly to the site of damage, and may involve a wide range of characteristic relaxation time scales. Thus, to directly probe these mechanisms in situ with high resolution requires new methods that quantify microscopic polymer dynamics in both space and time. Here the promising option is to utilize the optical method, Electronic Laser Speckle Imaging (ELSI) to study and visualize the micro scale dynamics in such materials.



Also, delayed fracture has been observed in a wide variety of solids, ranging from brittle solids, such as ceramics, to ductile metals, heterogeneous (porous) media, plastics, two-dimensional crystals, and a range of soft materials. Depending on the ratio of the applied load to the critical fracture stress, where crack nucleation is instantaneous, the delay time between loading and failure can vary from seconds to hours, days, or even years. The combination of the wide range of possible delay times and the absence of visible precursors to the failure makes delayed fracture difficult to predict. Consequently, this failure mode gives a significant threat to the operational safety and lifetime of a wide variety of common materials. Because of the microscopic mechanisms that govern the time delay between stress application and the moment of catastrophic failure remain elusive, its prevention has remained highly challenging. Moreover, stresses well below the critical fracture stress can lead to highly unpredictable delayed fracture after a long period of seemingly quiescent stability. Thus delayed fracture is a major threat to the lifetime of materials, and its unpredictability makes it difficult to prevent. In this case also, we can utilize ELSI to study the origin of delayed fracture in a soft solid. The method can be used to study delayed fracture and find delocalized zone of very small strains well before it manifests macroscopically.

References

[1] van der Kooij H M, Susa A, García S J, van der Zwaag S and Sprakel J 2017 " Imaging the molecular motions of autonomous repair in a self-healing polymer "Adv. Mater. 26 1701017

[2] Ansari, Mohammad Z., and A. Mujeeb. "Assessment of microscopic repair dynamics in self-healing polymer by modelling laser speckle images." Laser Physics 28, no. 12 (2018): 126003.

Prof. (Dr.) A. Mujeeb
(Former Director)
International School of Photonics
Cochin University of Science and Technology

Large-Area Texturing of Silicon Surfaces

Recently we used Nd: YAG laser pulses (λ=532 nm, τ =7 ns) to perform large-area laser micro/nano-texturing of silicon(100)surfaces.Hierarchical surface structures have been developed by the line scanning method to create parallel micro-channels with proper overlap between the lines, employing laser fluences ranging from 2 J/cm^2 to 4 J/cm^2.The bottom of the craters formed due to single and multi-pulse laser irradiations are found to be rather flat. However, some concentric nano-ripple features are present along the rim of the craters, resulting in the formation of multiscale surface morphology. The topography of the samples has been investigated using AFM and SEM. The wetting property is measured through sessile drop contact angle measurements. The combination of micro scale channels with self-organized surface patterns and random nanoparticle decoration result in highly hydrophilic silicon surfaces. Contact angle values are measured to be around 5°, indicating potential superwetting applications for these textured Si surfaces.

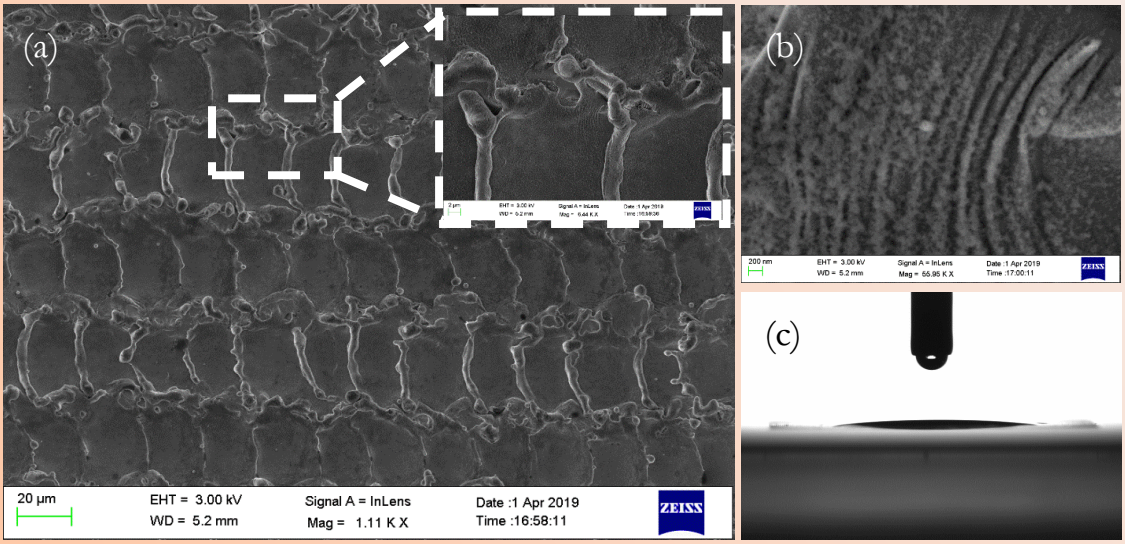


Figure : SEM and contact angle images of the laser-textured silicon surface. Peak laser fluence used is Fp = 3.5 J/cm^2. (a) SEM image showing the parallel line scanning pattern. Inset is a zoomed view of the marked position. (b) SEM image of the nano-ripples formed along the rim of the laser-irradiated spot. (c) photograph of a water droplet (1µL) on the textured silicon surface exhibiting super hydrophilic behaviour (contact angle ≈5°).

Prof. Reji Philip
Light and Matter Physics Group
Raman Research Institute , Bangalore, 560080, India

Exploring the Potential Energy Landscape with Density Functional Theory

Heterogeneous catalysis is forecasted to play vital role in the development of sustainable energy solutions in the near future. Even though the basic principles underlying the catalytic processes are the same as at the time when they were recognised, our understanding of the details of the materials deepened since then due to a tremendous development in the experimental and theoretical techniques. Since an atomic resolution to the chemical processes are accessible, the focus of the research has turned more towards designing catalytic structures to control catalytic activity and selectivity. Although the experimental techniques have been largely upgraded, certain domains still remain out of the reach in the laboratories. With the exponential growth in the computer power and the development of robust algorithms, theory and computation has become an inevitable part of the contemporary catalysis research. Electronic structure theory calculations have the largest impact in the area of catalyst development. Due to its extreme capability to deal with highly complex systems density functional theory (DFT) has become the first choice to go for as a theoretical tool for the catalyst development. Understanding of catalytic processes at the molecular level help us not only to identify the crucial properties of a catalyst but also to suggest how to develop new catalysts or optimise the already existing ones. This will help the experimentalists to abandon the traditional trial-and-error approach and to focus on developing the catalyst to deliver maximum yield and selectivity by proper engineering.

The consequences of CO_2 emission and the rapid depletion of fossil carbon sources together with an accelerating global demand for energy consumption calls for alternative ways for the sustainable production of fuels and chemicals [1]. In this context, the usage of carbon dioxide (CO_2) as an alternative carbon source, has gained remarkable interest for the chemical and energy sectors as it is readily available as a non-toxic by-product. In particular, the effective hydrogenation of carbon dioxide to methanol and formic acid could play an important role in supply chains with reduced carbon footprint economies. Methanol can serve as an energy carrier and a versatile basic chemical for several potential applications [2,3], with a worldwide production of approximately 30 Mt y^{-1} and formic acid is an efficient Hydrogen carrier. Methanol can be blended with gasoline or used directly in a fuel cell. Dimethyl ether (DME), a potential substitute of diesel oil due to its superior combustion performance, can be synthesised from methanol via dehydration. Notably, methyl formate (MF) can be used to produce several industrially important chemicals such as acetic acid, ethylene glycol, methanol, and formic acid. In particular, both formic acid and methanol can be obtained simultaneously by simple hydrolysis reaction of MF, which is very beneficial from a commercial point of view. Therefore, MF can serve as an intermediate in the continuous synthesis of thermodynamically-unstable formic acid with methanol as by-product, starting from CO_2 and H_2, since methanol can be directly produced by CO_2 hydrogenation.

Several approaches have been reported to produce MF from CO_2, for instance, by photocatalytic reduction and hydrogenation (in the presence of methanol) of CO_2. The CO_2 hydrogenation has demonstrated using both homogeneous and heterogeneous catalysts. Interestingly, heterogeneous catalysis offers great advantages to transform a large amount of reactant(s) in a short span of time, credit to ease of continuous operation as well as facile product/catalyst separation methods developed so far. Cu on ZnO/Al_2O_3 and supported Au materials were reported as effective heterogeneous catalysts promoting this reaction. In the absence of CH_3OH the formation of MF is completely supressed. It is believed that the surface formates play pivotal role in forming methyl formate in the presence of metal catalysts. However, the roles of metal and support as well as reaction mechanisms including the type of reactive formate species have not been clarified in the CO_2 hydrogenation mechanism and therefore it attracts a great deal of attention from the scientific community.

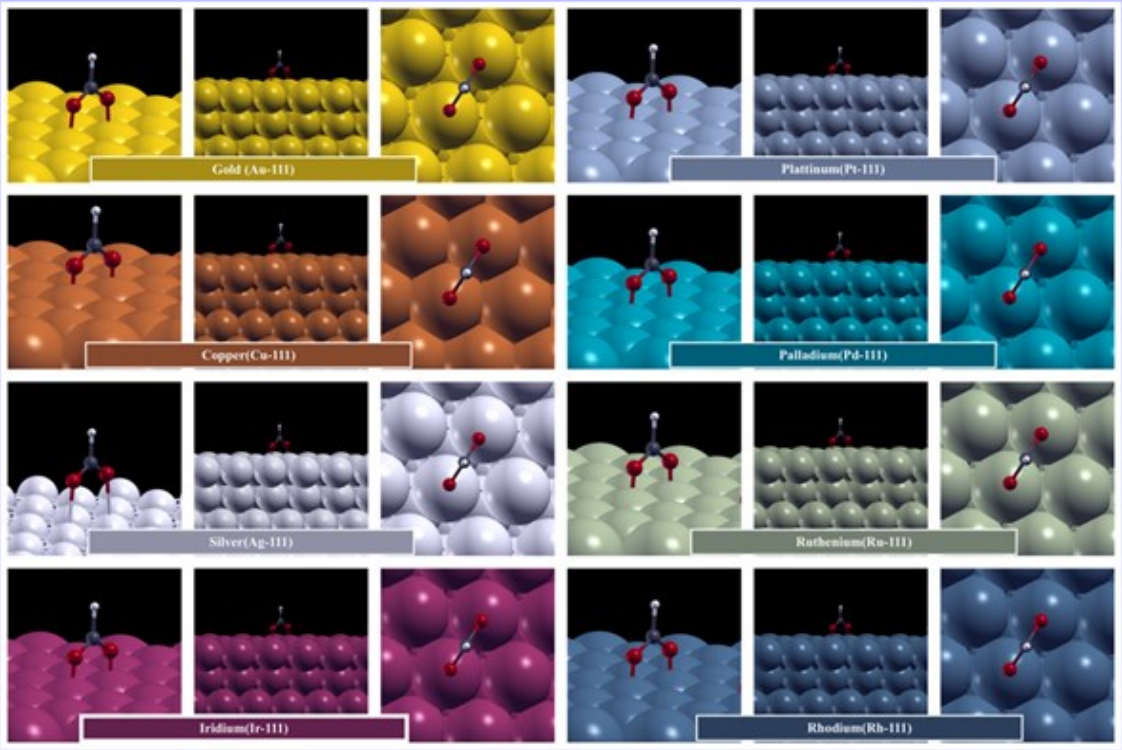


Figure 1 shows inclined, side, and top views of DST optimized structure of formates on different metasurfaces

Several approaches have been reported to produce MF from CO_2, for instance, by photocatalytic reduction and hydrogenation (in the presence of methanol) of CO_2. The CO_2 hydrogenation has demonstrated using both homogeneous and heterogeneous catalysts. Interestingly, heterogeneous catalysis offers great advantages to transform a large amount of reactant(s) in a short span of time, credit to ease of continuous operation as well as facile product/catalyst separation methods developed so far. Cu on ZnO/Al_2O_3 and supported Au materials were reported as effective heterogeneous catalysts promoting this reaction. In the absence of CH_3OH the formation of MF is completely supressed. It is believed that the surface formates play pivotal role in forming methyl formate in the presence of metal catalysts. However, the roles of metal and support as well as reaction mechanisms including the type of reactive formate species have not been clarified in the CO_2 hydrogenation mechanism and therefore it attracts a great deal of attention from the scientific community.

Recently we made an effort to go much deeper in understanding the catalytic conversion of CO_2 to methanol at an atomic scale via formate route. With the help of transient in situ and operando vibrational spectroscopy studies our colleagues have demonstrated that Ag metal is particularly active among coinage metals in continuous MF synthesis from CO_2, H_2 and CH_3OH due to its superior activity in the formation of surface formates and subsequent formic acid. Through an intensive computational study we have identified that the crucial point in this catalytic mechanism is the formation of the formates, which needs a thorough understanding.

In an earlier work, we have calculated the activation barriers for formate formation are 0.61, 0.71, and 0.97 eV on Ag, Cu, and Au, respectively for the coinage metals. Based on the DFT results, we find that the activation energy for the formation of surface formates (HCOO) is simply given by the interplay between weak and strong adsorption bonding of H and HCOO, respectively [4]. Therein we have proposed an activation energy estimator, E* ≈ 0.6EbHCOO – EbHbased on the data we generated for the coinage metals. The lowest energy barrier for formate formation over Ag is attributed to its weak binding to H and sufficiently strong binding to HCOO. Both factors promote this reaction step in a synergistic way, since one reactant is destabilized (H) while the product is stabilized (HCOO). In contrast, Au binds HCOO too weakly, whereas Cu binds H too strongly. In the present work, he have included five more fcc metals [Ir, Pt, Pd, Ru, Rh] into the screening process and estimated the adsorption energies of H and HCOO on corresponding 111 surfaces as shown in Fig 1. The corresponding activation energies are estimated using the activation energy estimator we have proposed. The corresponding data is depicted in Fig. 2. It is obvious from the figure that Ag is still far better than any other metals based on the interpretation proposed above. Therefore, DFT has been shown to a very accurate tool for predicting barrier for catalysis.

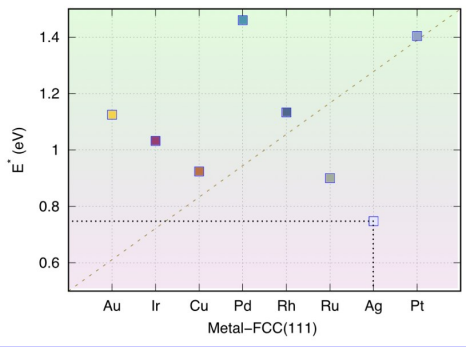


Fig2: Activation energy of fcc non-magnetic metals using activation energy estimator

References

[1] Transport, Energy and CO_2, Internal energy agency (2009)
[2] Q. Liu, L. Wu, R. Jackstell, M. Beller; Nature Commun. 6 (2014) 5933
[3] Y. Nitta, O. Suwata, Y. Ikeda, Y. Okamoto; T. imanaka, Catal. Lett. 26 (1994) 345
[4] Juan José Corral-Perez, Atul Bansode, C. S. Praveen ,Anton Kokalj, Helena Reymond, Aleix Comas-Vives, Joost

Dr. Praveen C S
(DST INSPIRE Faculty)
International School of Photonics
Cochin University of Science and Technology

New comers

PhD Scholar	Area of Research	Research Guide
Anugop B	Polymer Based Waveguide Devices for Photonic Applications	Dr. M Kailasnath
Lakshmi R	Optical Studies of Duel State Emissive Synthetic Dye	Dr. Pramod Gopinath
Priya Mary N J	Thermo-Optic Studies for Studying the Optical properties of Materials	Dr. Manu Vaishakh
Vijoy K V	Ultra Sensitive Biosensors Using MoS_2 Thin Film Transistors Fabricated by RF Magnetron Sputtering	Dr. Saji K J

Faculties at ISP

Dr. Pramod Gopinath
Professor & Director

Dr. M Kailasnath
Professor

Dr. A Mujeeb
Professor

Dr. Sheenu Thomas
Professor

Dr. Saji K J
Assistant Professor

Dr. Manu Vaishakh
Assistant Professor

Mr. Muhammed Rishad K P
Assistant Professor

Dr. Priya Rose T
Assistant Professor

Dr. Bini P Pathrose
Assistant Professor
[On Contract]

Dr. Retheesh R
Assistant Professor
[On Contract]

Dr. V Manickam
Assistant Professor
[On Contract]

Dr. Praveen C S
INSPIRE Faculty

Dr. C P Girijavallabhan
Visiting Professor

Dr. V P N Nampoori
Visiting Professor

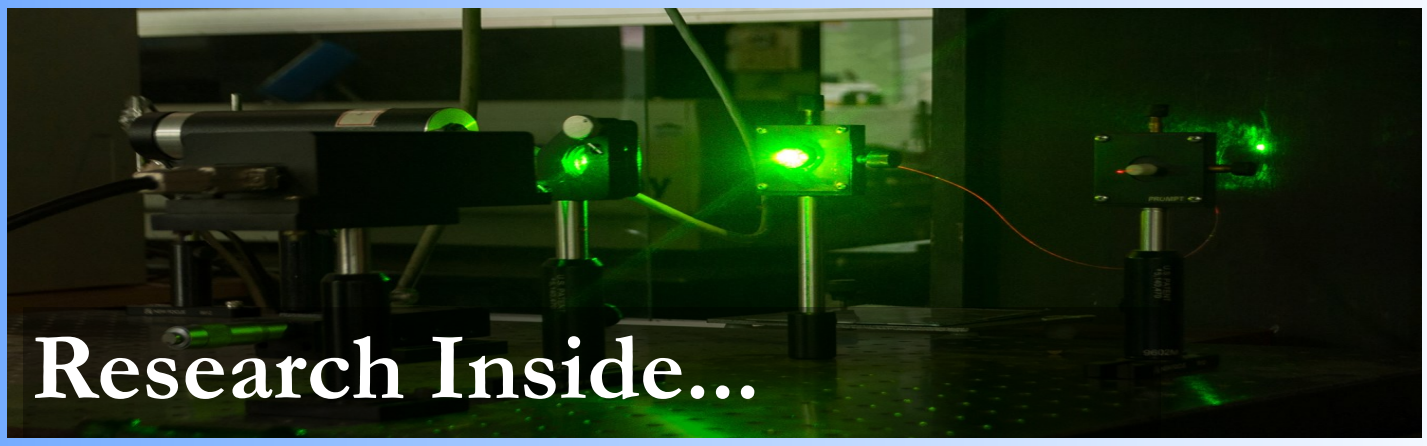
Dr. P Radhakrishnan
Visiting Professor

Dr. Reethama Thomas
Visiting Professor

Prof. A Varadarajan
Visiting Professor

Administration

Mr. Siraj S
Section Officer



Research Inside...

Lakshmi B

Magnetoplasmonics – Cobalt and Nickel Based Systems

Cobalt and nickel pure metallic and ferrite based systems show considerable magneto-optic effects such as Kerr and Faraday effects (MOKE and MOFE). When plasmonic noble metals are incorporated to such systems, the magneto-optic effects can be enhanced as well as tuned owing to the strong field confinement associated with the surface plasmon resonance of these nanoparticles. This is the crux of the field of magnetoplasmonics. In addition to conventional magneto-optic effects, relatively newer effects such as Longitudinal magnetic photonic intensity effect, transverse MOKE etc are also reported to be enhanced due to plasmonic contributions. The present work in magnetoplasmonics in the department deals with exploiting such effects in nanostructures synthesized in comparatively simpler chemical synthesis techniques. The most important part is the synthesis of such systems with the sizes of the magnetic and plasmonic parts strictly controlled such that considerable magneto-optic and plasmonic responses are shown. The field offers exciting applications in many field such as sensing, magnetic data storage and telecommunications.

Jessy Simon

Synthesis and Characterisation of Nano Photonic Materials

Synthesis and optical properties of metal nanoparticles are of primary importance due to their unique properties which are different from those of bulk materials. Among them, gold nanoparticles have been very attractive and are widely used for optoelectronic and biomedical applications. The interaction of light with surface electrons on gold nanoparticles would lead to their collective oscillation called Surface Plasmon Resonance (SPR) resulting in strong absorption of light at specific wavelength. The particular wavelength at which SPR occurs is characteristic of the gold nanoparticle size, shape, morphology and agglomeration state. Gold nanoparticles can be prepared by various methods like chemical, physical and biological. Chemical method involves the reduction of metal ions and the chemisorption of ligands on the surface of metal ions to prevent them from coagulation. Physical method makes use of different approaches such as evaporation/condensation and laser ablation of metal targets. Biological method synthesizes gold nanoparticles with the help of naturally available materials as reducing agents.

Anitha Prakash

Studies On Certain Dyes for Optoelectronics Applications

The enormous potential and utilization of different dyes for various researches makes its use for diverse applications in the field of optoelectronics. Different types of dyes such as natural and synthetic dyes are utilized for such research purpose. Among the different types of dyes, because of the properties such as availability, the ease with which structural modifications can be made and compatibility made organic dyes more attractive. The organic dyes can also be used as solid state host materials. These properties make the field wide open for further research. The most important aspect on these dyes is their application as lasing materials. These organic dyes can be used as laser active material and are tunable in a wide spectral range. The thermal and photochemical stability of dyes is of utmost importance for laser applications.

Nonlinear optical characterization of organic dyes is another area which currently draws attention of many research groups due to its widespread applications. Fluorescent dyes and fluorescence spectroscopy are attracting much interest in the areas of research and development in basic and applied sciences like material science and molecular biology etc. Number of researches is going on organic dyes for developing novel materials which can be used for applications such as optical power limiters, optical logical gates, optical communication, optical data processing, DSSC and many other related fields.

Anugop B

Polymer Optical Fiber Random Lasers for Speckle Free Imaging

Light sources with high radiance are required for full-field real time imaging. Ideal light source should possess both high radiance for high-quality real-time imaging and low coherence for preventing interference induced speckle. Due to high temporal and spatial coherence, commercially available lasers are poorly suited for imaging, which generates speckles that affect image quality. During image formation, spatial coherence leads to interference resulting in intensity modulations that appear as additional features that are not present in the object, thereby corrupting the image. Sources with incoherent nature such as LED and thermal sources, do not produce speckles, but have the disadvantage of low intensity.

Random lasers are good candidates for such imaging applications because of its brightness and low spatial coherence. Random lasers are unconventional lasers in that they are made from disordered materials that trap light via multiple scattering. The emission of a random laser occurs in all directions due to random scattering inside the medium. A directional output is required for efficient imaging. Random fiber lasers have emerged as a means of resolving these issues. Recently the polymer optical fiber random lasers are being investigated due to their flexibility, ease of handling and low cost. By putting the random lasing action in a flexible architecture together with electrical pumping, we can imagine a portable device that can be used for in situ imaging applications.

Shilpa S

Investigations On Laser Produced Collisional Plasma

Laser produced plasmas (LPP) are formed when a high power pulsed laser is focused onto a solid dense target at an irradiance typically in excess of $1GWcm^{-2}$. Colliding laser produced plasma is produced as a result of collision of two rapidly expanding laser ablated plasmas. Its characteristics are strongly dependent on many parameters including the laser characteristics like intensity, laser wavelength, pulse duration, irradiation spot size etc., and on the nature and geometry of target materials, ambient gas composition and ambient pressure etc.. There are several diagnostic techniques for characterizing laser-produced plasma including optical emission spectroscopy, mass spectroscopy, laser induced fluorescence, Langmuir probe, faraday cup etc. Spectrally filtered time-gated intensified charge coupled device imaging was used to obtain information about the spatial dynamics and temporal evolution of the collision process, while time-resolved imaging spectroscopy was used to determine the spatial and temporal distributions of electron temperature and density within the interaction region. Laser produced colliding plasma have found potentially attractive applications such as in material science, analytical science, in the field of X ray lasers, pulsed laser deposition, laser ion sources, for stimulated Raman scattering experiments, for indirect drive inertial confinement fusion, extreme ultraviolet (EUV) lithography etc.. Even though there are numerous experimental and theoretical progress in the dynamics of single laser produced plasmas, attention towards collisional plasma is minimum. So, it is worth to study the nature and dynamics of laser produced colliding plasma because of their several emerging applications.

Vijoy K V

Metastable Phase Control and Phase Transition Dynamics in Transition Metal Dichalcogenides on Metallic Substrates

2D transition metal Dichalcogenides fascinates scientific community by its enchanting unique polymorphic features such as the semiconducting 1H , metallic 1T and quasi-metallic 1T' phases which can be used in electronic and photonic devise applications. Semiconducting 1H phase is stable under ambient condition for well known TMD materials such as MoS_2,WSe_2. In addition, the metallic 1T phase which will spontaneously relax to a distorted 1T' quasi metallic phase. The 1T' phase has very high applications such as superconducting electrodes, dipolar Ferro electricity, weyl semimetal etc. There are 1H and 1T' phase engineering processes. However the obtained 1T/1T' phases are found to be unstable. Now it remains a challenge to stabilize the metastable phase of TMDs under ambient conditions. A novel phase control mechanism of 1T' phase and semiconducting (1H) to quasi-metallic (1T') phase transition dynamics of TMDs on metal substrates theoretically predicted recently. Literatures predict that Mo, W and Hf surfaces not only stabilize the metastable 1T phase against the common 2H phase, but also prevent the structural transformation of 1T - 2H by increasing the transition barrier. High yield 1H-to-1T' phase transition of monolayer-MoS_2 on Cu and monolayer-WSe_2 on Au via an annealing-based process is reported. These reports give immense possibility of direct conversion of MoS_2 1T phase from 1H phase on appropriate metal substrate at particular temperature. If such synthesis is possible it will be a novel material for contact application in thin film transistor applications and 1T phase related applications.

Praveen P

CdTe Based Thin Film Solar Cell

The direct conversion of solar energy to electricity is an important solution to reduce the dependency on fossil fuel. The photo-voltaic conversion of solar energy for the energy harvesting has become the most important research area for the past decades. The market share of solar cell is dominated by mono or poly crystalline silicon material. But silicon is an indirect band gap semiconductor and it has less light absorption coefficient, so high amount of material is needed to harvest solar energy. Cadmium telluride (CdTe) is commercially successful thin film solar cell material with 5 to 6% market share. It is a direct band gap (~1.48eV) material with high absorption coefficient which makes it very suitable for solar cell applications. Also it is very stable and can be produced from different synthesis techniques. We propose to develop a fully sputtered CdTe based solar cell using RF magnetron sputtering unit, without breaking the vacuum during the synthesis or annealing of each layer. The effect of moisture or other impurity absorption from the atmosphere, during the synthesis of each layer transfer of sample from sputtering system to annealing chamber, can be avoided in this system. The intentional band gap grading of absorber layer can increase the open circuit voltage and short circuit current of the solar cell. The band gap grading can be achieved by doping the Se in CdTe. The defect densities are also low in Se incorporation even when the strong band gap grading is introduced, which reduces the recombination losses.

Divya D Pai

Laser Produced Plasma Spectroscopy and Imaging

When intense short duration laser pulses are focused onto a solid target, material of the target gets vaporized and ionization takes place resulting in the formation of a hot plume over the target surface, known as plasma. The properties of generated plasma depends on many factors like the nature of the target material, properties of laser pulse (wavelength, fluence, time period) as well as medium into which the plasma expands. Laser produced plasma is a transient system because excitation /ionization and recombination mechanisms governs the processes involved in production and decay of species. Laser-plasmas are found to persist for 5-15μs time delay after the laser pulse is irradiated over the target surface. Hence diagnosis of the emissions from the plasma is acquired using detectors with gating features in nanosecond time scale. Laser Induced Plasma Spectroscopy (LIPS), known as Laser Induced Breakdown Spectroscopy (LIBS) offer wide possibilities to diagnose laser plasma. The light emitted from the plasma are collected and fed to a spectrograph connected to a detector such as a Charge Coupled device (CCD)/ Intensified CCD (ICCD) to obtain the emission spectrum. The spectrum is identified for emission lines and plasma properties such as electron temperature and electron density are determined spectroscopically. Fast gated imaging using ICCD camera adds further information regarding plume expansion such as evolution of plume size, shape, velocity, geometry etc. This information also helps to develop expansion models for the laser plasma.

Cicily Rigi V J

2D Transition Metal Dichalcogenides for Application in Transistors

New physical properties emerge when a bulk macroscopic crystal is thinned down to two dimensional layers. With the discovery of graphene and its extra ordinary properties, many 2D materials, that can form atomic sheets also gained importance. Among them two dimensional transition metal dichalcogenides (2D TMDCs) have led to a variety of promising technologies for nano-electronics, photonics, energy storage and opto electronics to name a few TMDCs like MoS_2, $MoSe_2$, WS_2, WSe_2 etc. are almost as thin, transparent and flexible as graphene. Unlike graphene these 2D TMDCs are semiconducting in nature and have direct bandgap in monolayers. So they are considered as an excellent choice for channel material of field effect transistors and it is expected that by using these materials, it will be possible to continue miniaturization much beyond the physical limits of current silicon based technology.

Further studies in 2D TMDCs could lead to the manufacturing of low cost, fast switching, and low power consuming field effect transistors owing to the high mobility, tunable bandgap and other features of monolayer TMDCs. Even though 2D TMDCs exhibit a breadth of new properties, developing such materials into large-scale and defect-free atomic layers with thickness controllability on desired substrates is challenging. So industry viable radio frequency magnetron sputtering method is exploited to prepare MoS_2 and WS_2 on different substrates in a large area. The advantages of the sputtering technique such as low temperature, low power synthesis, layer controllability etc. could be utilized efficiently so as to produce good quality thin films.

A.K. Sooraj Viswam

Laser Speckle Imaging Techniques

A speckle pattern is the granular dark and white spots formed on a screen due to the constructive and destructive interference of light coming from a monochromatic, coherent source. In 1970, the scientist Leedertz recognized that the speckle pattern is the signature of the surface of the object illuminated by a laser source. The ability to observe and extract useful information from the temporal evolution of a speckle pattern gave birth to dynamic speckle analysis. Dynamic speckle analysis is used to study objects that display changes with time, for example the drying of paint and dispersions, temporal characteristics of a biologically active cell/ tissue etc. With the advancement in computational technology and better recording equipment the field continues to grow.

The speckle imaging technique can be used for non- destructive study of a variety of phenomena. The scope for this field has been continuously improving with the advancement of image processing and data analysis techniques. It has been already used for a variety of applications like, determining the roughness of a surface, displacement of a surface due to various phenomena, movement of objects of interest, speed of motion of particles etc.

Fathima R

Investigations on Gold-Silver Alloy Nano Particles for Photonics and Related Applications

The bimetallic nanoparticles of silver and gold are of greater importance as the resulting optical, electrical and catalytic properties can be tuned by controlling their composition. Both silver and gold have well defined SPR band in visible region of the spectrum. Silver-gold bimetallic nano particle can be used as a model system to study the composition and structural

dependent change in properties of NPs. Also both have simple fcc lattice structure with matching lattice constants, 4.0783˚A for Au and 4.0862˚A for Ag .Gold nanoparticles have great chemical stability, better bio compatibility, bio conjugation and surface functionalization properties than silver. But silver NPs have better plasmonic features like stronger molar absorption co-efficient, narrower plasmon line width and a more sensitive SPR peak. Combining all the properties of silver and gold, the resulting silver- gold alloy nanoparticles are more

promising as they have greater plasmonic features than gold, and increased stability and bio compatibility than silver. Considering these enhanced properties, the application of alloy NPs can be extended further. Even though gold NPs have no acute cytotoxicity reported, silver NPs have some toxicity and protein denaturation issues. But when they form alloys the resultant toxicity decreases, and hence it is suitable for several biological applications.

Soumya S

Chalcogenide Glasses for Photonic Applications

Research work on chalcogenide glasses have potential applications in the field of Photonics because of its notable physical, optical, thermal and electrical properties. Chalcogenide glasses are inorganic glassy materials and are made of one or more chalcogen element which consists of sulphur, selenium, tellurium along with the network formers such as, arsenic, germanium, gallium, antimony etc.

Chalcogenide glasses have high transmission in the IR region of the spectrum which makes them a good candidate for the fabrication of active and passive IR devices especially for bio-sensing applications. The high refractive index of ChG scan be put to use for the fabrication of micro resonators since the light could be more confined inside the resonator thereby decreasing the modal volume. In addition to this, glasses offer attractive properties like high nonlinearity, low phonon energy, high photosensitivity and good rare earth solubility can be exploited for making amplifiers and lasers.

Karthika Sankar

Design, Fabrication and Characterisation of One Dimensional Photonic Crystals

Photonic crystal is a periodic optical nanostructure that affect the motion of photons in the same way an ionic crystal lattice control the motion of electrons in solids, i.e., photonic crystal is an optical analogue of regular solid crystals where the atoms and molecules are replaced by macroscopic media with differing dielectric constants and the periodic potential is replaced by a periodic dielectric function. We can design and construct photonic crystals with photonic band gaps preventing light from propagating in certain directions with specified frequencies. If for some frequency range a photonic crystal prohibits the propagation of electromagnetic waves of any polarisation travelling in any direction from any source, the crystal is said to have a complete photonic band gap. We are using transfer matrix method for designing the photonic crystal with desired band gap range. MATLAB programming is used for performing the transfer matrix operations on the layered structure of our interest.

Safna Saif

Responsive Photonic Crystals

Photonic crystal based devices is an emerging area of research since the last 30-35 years. Photonic crystals are periodic macroscopic structures with periodicity in the order of wavelength of light. As evident, these structures could therefore control and manipulate the flow of light. Based on the structural periodicity, photonic crystals can be 1D, 2D and 3D. Many groups have reported the application of photonic crystal structures as wide variety of sensors. Responsive photonic crystals (RPCs) are required to realize photonic crystal sensors. RPCs are materials with photonic band gap properties tunable via some external stimuli. Such materials can be made by coupling a stimulus-response mechanism with the photonic crystal structure. In principle, stimuli-responsive changes in any parameter that appears in the Bragg equation and contributes to the determination of diffraction wavelength can be employed for the creation of responsive photonic crystals. One method to create an RPC is to incorporate a stimuli-responsive material into a photonic crystal. A number of RPCs have been reported so far like thermo-responsive PCs, chemically responsive PCs, mechanically responsive PCs, optically responsive PCs, electrically responsive PCs, magnetically responsive PCs, etc. Polymer based thermo-responsive PCs are a good example of RPCs that combine a functional and responsive polymer matrix with colloidal crystals. As temperature increases, polymer expels water & contracts such that the inter particle distance in the colloidal crystal decreases, leading to a blue shift in diffraction. The diffraction wavelength was found to be tunable from 460 nm to 704 nm. These RPCs can be employed as optical switches and different types of sensors like pH sensor, humidity sensor, chemical and biological sensors . RPCs are gaining commercial interest as a number of start-up companies started pushing the RPC- based technologies to the market place.

Aggregation Induced Emission in Synthetic Dye

Lakshmi R

Fluorescence spectroscopy is an indispensable tool in numerous fields of modern medicine science and technology. Its applications stretch from sensor technology to microscopy and imaging, to single molecule detection, to the development of novel fluorescent probes, and to proteomics and genomics. Organic dyes were the first fluorescent materials used for analytical purposes, and we observe that they retain their leading positions against strong competition of new materials – conjugated polymers, semiconductor nanocrystals, and metal chelating complexes. The outstanding potentials of such dyes are exploited to meet the widespread application in diverse field of science and technology. There is continuing interest in the technical application of synthetic fluorescent dyes. Many dyes are strongly fluorescent in solution, whereas there are only a few dyes with a strong solid state fluorescence. The advances in the field of fiber optics communication and integrated optoelectronics increased the interest in dye doped optical fibers, dye doped waveguides etc. and thus expanded the horizon of technical applications.

Fluorescence characteristics demonstrate remarkable sensitivity to variations of physicochemical parameters of the environment like polarity, viscosity, temperature, electric potential, local electric field, pressure, pH, etc., can be registered successfully using the modern sensitive apparatus for fluorescence detection. The sensitivity cannot be enhanced by using high fluorophore concentration due to the notorious concentration-quenching effect. The small numbers of the dye molecules in dilute solutions can be quickly photo-bleached when a harsh laser beam is used as the excitation light source. To mitigate the ACQ effect, various chemical, physical and engineering approaches developed a novel phenomenon called "aggregation-induced emission" (AIE), because the non-luminescent molecules were induced to emit by aggregate formation. The novel AIE effect is exactly opposite to the notorious ACQ effect. The phenomenon is of academic value: whilst there are matured theories to explain the ACQ effect, new models will need to be established to understand the abnormal AIE effect. It will permit the use of dye solutions with any concentration for bioassays and enables the development of "turn on" or "light up" nano-sensors by taking advantage of luminogenic aggregation.

Light– Matter Interaction using Laser based Thermo Optic Effect and Coherent Interactions with Different Types of Media

Jayaprasad K.V

The topic of research to be undertaken is the investigation of light- matter interaction using laser based thermo optic effect and coherent interactions with different types of media. Several aspects of radiation and medium can be understood using such coherent interactions employing different techniques.

A systematic study of light matter interaction helps to analyze the thermal and optical properties of novel materials using thermo optic studies and stimulated scattering of light. Materials that exhibit efficient optical non-linearity, fluorescent quantum yield and high values of stimulated Raman scattering cross section are potential candidates for efficient photonic materials. Photo-thermal Spectroscopy along with stimulated Raman scattering and coherent back scattering are highly sensitive technique to study various aspects of weak optical absorptions and coherent optical processes which can be used to investigate optical and thermal characteristics of samples.

.

Thursday Seminars

Every Thursday we organize seminars at our department which include talks by ISPians or invited guests. ISP Student Chapters of SPIE (The International society for optics and photonics), Optical society of America and Photonics Society of India are the sponsors of this weekly venture.

SEMINAR TOPIC	PRESENTED BY
Surface Plasmon enhanced UV detection	Pradeep Kumar V
FRET sensor for the detection of ambroxol hydrochloride drug	Alina C
Ultra low threshold Raman laser using a spherical dielectric micro cavity	Arindam Sarkar
Evaluation of activity from binary patterns in dynamic speckle analysis	Keerthana S H
Photovoltaics: Beyond Shockley queister limits	Praveen P
Application of gold nanoparticle in calorimetric and fluorescence sensors	Fathima R
Laser damage resistance of polystyrene opal photonic crystals	Safna Saif
One dimensional photonic crystals as sensors	Karthika Sankar
Advancements of laser wake field accelerators	Shilpa S
Single –shot memory effect video.	Sooraj Viswam A.K
Resolving metastable phase control and phase transition dynamics in transition metal dichalcogenides on metallic substrates	Vijoy K.V
Coherent nonlinear optical response spatial self phase modulation in $MoSe_2$ nano sheets	Titu Thomas
Mode splitting based whispering gallery mode micro sensors	Anugop B
Spatial self phase modulation of a laser beam propagating through liquids with self induced natural convection flow	Jayaprasad K.V
Plasmonics in sensing calorimetry in fiber-optic sensors	Dr.Rithesh Raj D
Mechanism of fluorescent molecular rotors and aggregation induced emission	Lakshmi R
Magnetoplasmonic sensor	Mubeena Rafi

Invited Talks by Experts

TOPIC	PRESENTED BY
A new direction in the design of rechargeable cells –Li-S cells in connection with the international day of women and girls in science (OSA)	Dr. S Jayalekshmi Emeritus Professor Department of Physics, CUSAT
MRI compatible optical fibre based sensors	Prof .Radhakrishna Prabhu Robert Gordon University , Scotland
Zero to light spend in a centimetre	Dr. Rajeev P P Rutherford Appleton Lab , UK
Discovery of exoplanets and search for the habitable world	Dr. Anand Narayan Associate Professor in Astrophysics IIST
High energy mid infrared laser for attosecond pulse generations	Dr. Krishna Murari Agarawal Creol
Spectral narrowing of coherent light sources based on gallium ni-tride laser diode emitting in the blue range	Dr. Stephane Trebaol Assistant Professor Institute FOTON, France
Nanotechnology for solar energy conversion	Dr. Prasanth R Associate Professor Centre For Green Energy Technology, Pondicherry University
Make your 15 minutes count	Dr. Amal Choudhry IIT Delhi OSA travelling lecture
Imaging arithmetic :physics U math > physics + maths	Prof. Gaurav Sharma University of Rochesta SPIE fellow travelling lecture

Recent Publications

1 Patent, 26 International journal papers and 30 International/National conference papers were published in the year 2019-2020

Patent

1. Nanohybrids of conducting polymer-reduced Graphene oxide for Triboelectric nanogenerators to power up portable devices. Honey John, Divya Jose, Jelmy E J, Saji K J, Vijoy K V, Antony Sharon, M K Jayaraj. Indian patent, 202041006974, filed February 18, 2020.

Journal Publications

1. Ramya, M., Nideep, T. K., Nampoori, V. P. N., & Kailasnath, M. (2019). Particle size and concentration effect on thermal diffusivity of water-based ZnO nanofluid using the dual-beam thermal lens technique. *Applied Physics B*, *125*(9), 181.
2. Ramya, M., Nideep, T. K., Nampoori, V. P. N., & Kailasnath, M. (2019). Understanding the role of alcohols in the growth behaviour of ZnO nanostructures prepared by solution based synthesis and their application in solar cells. *New Journal of Chemistry*, *43*(46), 17980-17990.
3. Ramya, M., Nideep, T. K., Varier, M. M., Nampoori, V. P. N., & Kailasnath, M. (2019). Concentration dependent thermo-optic properties of yellow emissive ZnO quantum dots. *Materials Research Express*, *6*(12), 126208.
4. Nideep, T. K., Ramya, M., & Kailasnath, M. (2019). The influence of ZnS buffer layer on the size dependent efficiency of CdTe quantum dot sensitized solar cell. *Superlattices and Microstructures*, *130*, 175-181.
5. Nideep, T. K., Ramya, M., Sony, U., & Kailasnath, M. (2019). MSA capped CdTe quantum dots for pH sensing application. *Materials Research Express*, *6*(10), 105002.
6. Nideep, T. K., Ramya, M., Nampoori, V. P. N., & Kailasnath, M. (2020). The size dependent thermal diffusivity of water soluble CdTe quantum dots using dual beam thermal lens spectroscopy. *Physica E: Low-dimensional Systems and Nanostructures*, *116*, 113724.
7. Simon, J., Nampoori, V. P. N., & Kailasnath, M. (2019). Facile synthesis of Au-Ag core shell and nanoalloy using femtosecond laser ablation and their optical characterization. *Optik*, *195*, 163168.
8. Kuriakose, A. C., Nampoori, V. P. N., & Thomas, S. (2019). Facile synthesis of Au/CdS core-shell nanocomposites using laser ablation technique. *Materials Science in Semiconductor Processing*, *101*, 124-130.
9. Kuriakose, A. C., Nampoori, V. P. N., & Thomas, S. (2020). Energy transfer kinetics in Basic Fuchsin dye sensitized CdS quantum dots. *Materials Chemistry and Physics*, *242*, 122560.

10. Kuriakose Alina C., Nampoori, V. P. N., & Thomas, S. (2020). Enhancement of optical properties in Neutral Red Dye through energy transfer from CdS Quantum Dots. *Chemical Physics Letters*, *738*, 136851.
11. Viswanathan Anupama, & Thomas, S. (2019). Tunable linear and non linear optical properties of GeSeSb chalcogenide glass with solute concentration and with silver doping. *Journal of Alloys and Compounds*, *798*, 424-430.
12. Musfir, P. N., Nampoori, V. P. N., & Thomas, S. (2019). Variations in the linear and nonlinear refractive indices of chalcogenide glass thin films for photonic applications. *Materials Research Express*, *6*(11), 115207.
13. Ansari, M. Z., & Mujeeb, A. (2019). Application of temporal correlation algorithm to interpret laser Doppler perfusion imaging. *Lasers in medical science*, *34*(9), 1929-1933.
14. Ansari, M. Z., & Mujeeb, A. (2019). Interpreting Blood Perfusion Variations in Laser Doppler Imaging. *EC Cardiology*, *6*, 621-625.
15. Vijesh, K. R., Musfir, P. N., Thomas, T., Vaishakh, M., Nampoori, V. P. N., & Thomas, S. (2020). Enhanced nonlinear optical properties of solution dispersed carbon dots decorated graphene oxide with varying viscosity. *Optics & Laser Technology*, *121*, 105776.
16. Fathima, R., & Mujeeb, A. (2019). Tuning of photo thermal and linear optical properties of eosin B dye with surfactant-free gold nanoparticles. *Nanotechnology*, *31*(11), 115402.
17. Shaji, M., Saji, K. J., & Jayaraj, M. K. (2019, September). Fabrication and characterization of p-type boron doped Cu2O thin film and Cu2O: B/n-Si heterojunction. In *Nanoengineering: Fabrication, Properties, Optics, Thin Films, and Devices XVI* (Vol. 11089, p. 110891X). International Society for Optics and Photonics.
18. Barros, R., Saji, K. J., Waerenborgh, J. C., Barquinha, P., Pereira, L., Carlos, E., & Fortunato, E. (2019). Role of structure and composition on the performances of p-type tin oxide thin-film transistors processed at low-temperatures. *Nanomaterials*, *9*(3), 320.
19. Eqbal, E., Raphael, R., Saji, K. J., & Anila, E. I. (2019). Fabrication of p-SnO/n-SnO2 transparent pn junction diode by spray pyrolysis and extraction of device's intrinsic parameters. *Materials Letters*, *247*, 211-214.
20. Bhamu, K. C., Haque, E., Praveen, C. S., Kumar, N., Yumnam, G., Hossain, M. A., & Sharma, G. (2020). Improving the Optical and Thermoelectric Properties of Cs2InAgCl6 with Substitutional Doping: A DFT Insight. *arXiv preprint arXiv:2001.07337*.
21. Thomas, J., Periakaruppan, P., Thomas, V., John, J., Mathew, S., Thomas, T., & Mujeeb, A. (2018). Morphology dependent nonlinear optical and photocatalytic activity of anisotropic plasmonic silver. *RSC advances*, *8*(72), 41288-41298.
22. John, J., Mathew, R. M., Rejeena, I., Jayakrishnan, R., Mathew, S., Thomas, V., & Mujeeb, A. (2019). Nonlinear optical limiting and dual beam mode matched thermal lensing of nano fluids containing green synthesized copper nanoparticles. *Journal of Molecular Liquids*, *279*, 63-66.
23. Thomas, J., Perikaruppan, P., Thomas, V., John, J., Mathew, R. M., Thomas, J., & Mujeeb, A. (2019). Green Synthesized Plasmonic Silver Systems for Potential Non-Linear Optical Applications: Optical Limiting and Dual Beam Mode Matched Thermal Lensing. *Australian Journal of Chemistry*, *72*(6), 460-466.
24. Rejeena, I., Thomas, V., Mathew, S., Elizabeth, A., Radhakrishnan, P., & Mujeeb, A. (2019). Nonlinear optical studies of calcium tartrate crystals. *Journal of Taibah University for Science*, *13*(1), 611-615.
25. Pathrose, B. P., Prakash, A., Nampoori, V. P. N., Radhakrishnan, P., & Mujeeb, A. (2019). Tuning thermo-optic properties of BF and NR dyes using plasmonic silver nanoparticles. *Optical Materials*, *92*, 399-404.
26. Jose, J., Thomas, V., Raj, A., John, J., Mathew, R. M., Vinod, V., & Mujeeb, A. (2020). Eco-friendly thermal insulation material from cellulose nanofibre. *Journal of Applied Polymer Science*, *137*(2), 48272.

Books published/Edited

1. AIP Proceedings of *The 3rd International Conference on Optoelectronic and Nano Materials for Advanced Technology (icONMAT 2019)*, Editors: M. K. Jayaraj, Honey John, K. J. Saji, Pillai Aswathy Mohan and K. S. Anju, American Institute of Physics, ISBN: 978-0-7354-1812-7.

Conference proceedings

1. Nideep T.K., Ramya M., Kailasnath M, Amplified spontaneous emission from MSA capped CdTe QD synthesized using colloidal method, Sept. 19-21, (2019), ICPN, Mangalore University, Karnataka, India.
2. NideepT.K, Ramya M, Meenakshi.M.Varier, M. Kailasnath, A study of nonlinear optical property of cadmium based quantum dots with comparable particle size, Oct. 19-22, (2019), ICOL, IRDE, Dehradun, Uttarakhand, India.
3. Ramya M,Nideep T.K., V.P.N.Nampoori and M. Kailasnath, Synthesis and Nonlinear Optical Characterization of ZnO Nanoplates and its PVA Composite Film**,** ICPN, September, 19-21, (2019), Mangalore University, Mangalagangothri.
4. Ramya M., NideepT.K.,V.P.N.Nampoori and M. Kailasnath, Measurement of thermal diffusivity of organic solvents based ZnO nanofluids using thermal lens technique, ICOL, October 19-22,(2019), IRDE, Dehradun.
5. K Anlin Lazar, V J Cicily Rigi, P Hajara, P Praveen and K J Saji, Deposition of tin disulphide thin films by thermal evaporation and sulphurization, AIP Conference Proceedings 2162, 020078 (2019);
6. V J Cicily Rigi and K J Saji, Study of sulphurization of molybdenum foils using tubular furnace,NPS-2019 Conference Proceedings
7. Praveen, P., Sunitha, A. P., & Saji , K. J, MoS_2 Quantum Dots as Up conversion and Down conversion Centers for Solar Cell. National Photonics Symposium (2019), International School of Photonics, Cochin University of Science and Technology, Kochi, India.
8. Jessy Simon, V.P.N. Nampoori, M. Kailasnath ,Gold nanoparticles: Synthesis by nanosecond and femtosecond laser ablation, National level Annual Physics Symposium APS 2019, St. Teresa's College, Ernakulam, January 7-8, (2019).
9. Aparna Jyothikumar, M. Kailasnath, Jessy Simon, S. Mathew, BSA Stabilized Gold Nanoparticles: Synthesis and Characterization, Materials Today: Proceedings 9 (2019) 111–115
10. Jessy Simon, V.P.N. Nampoori, M. Kailasnath, Stability studies of proteins capped with gold nanoparticles, NLS – 28, VIT, Chennai, January 8-11, (2020).
11. Jessy Simon, V.P.N. Nampoori, M.Kailasnath, Interaction of gold nanoparticles with common proteins, APS, St.Teresa's College, Ernakulam, January 23-24, (2020).
12. M.M Raj sha, V.P.N Nampoori, A. Mujeeb, Concentration-dependent thermal diffusivity studies of silicon nanoparticles in isopropyl alcohol, Oct. 19-22, (2019), ICOL, IRDE, Dehradun, Utharakhand, India.
13. Adrine Antony Correya, Abdul Nadeer, VPN Nampoori and A Mujeeb Sol-gel synthesis of bismuth titanate for novel thermal applications**,**National Photonics Symposium (2019), International School of Photonics, Cochin University of Science and Technology, Kochi, India.
14. Lakshmi B, Anniemol Thomas and Pramod Gopinath, Enhanced Room Temperature Ferromagnetism in Chemically Synthesized Co_3O_4 Nanoparticles, AIP Conference Proceedings 2082, 030022 (2019).

15. Lakshmi B, Babitto Joe Thomas and Pramod Gopinath " Optical Absorption Studies of Cobalt Ferrite Nanoparticles Dispersed in Ethylene Glycol", at the International Conference on Optics and Electro-Optics (ICOL-2019), IRDE, Dehradun from 19-22 October, 2019.
16. Shilpa S., Divya D. Pai, Pramod Gopinath, Influence on collision frequency on dispersion characteristics of surface plasma waves in laser produced carbon plasmas, Aug 8-10, (2019),7th PSSI-PSC, IAR, Gandhinagar, Gujarat, India .
17. Shilpa S, Divya D. Pai, Pramod Gopinath, Dispersion characteristics of surface plasma waves in laser produced carbon plasmas, Oct. 19-22, 2019, ICOL, IRDE, Dehradun, Uttarakhand, India.
18. Divya D Pai, Shilpa S, Pramod Gopinath, Imaging temporal evolution of laser produced plasma, 7th PSSI-Plasma Scholars Colloquium (PSC-2019) 8-10 August 2019, Institute of Advanced Research, Gandhinagar, Gujarat, India.
19. Divya D Pai, Shilpa S, Pramod Gopinath, Time evolution of electron temperature and electron density in laser produced plasma from brass target, International Conference on Optics and Optoelectronics (ICOL-2019), October 19-22, 2019, IRDE, Dehradun, Utharakhand, India.
20. Maria Merin Antony, C. S. Suchand Sandeep, Murukeshan Vadakke Matham, Monitoring system for corrosion in metal structures using a probe based hyperspectral imager, Proc. SPIE 11205, Seventh International Conference on Optical and Photonic Engineering (icOPEN 2019), 1120518 (16 October 2019); doi: 10.1117/12.2542907
21. Anugop. B, M. Kailasnath, Influence of Plasmonic interaction of Ag on the Optical and Thermo-Optical .properties of Manganese Oxide nanoparticles, Oct. 19-22, 2019, ICOL, IRDE, Dehradun, Uttarakhand, India
22. Pradeep Kumar.V, P. Radhakrishnan, and A. Mujeeb, Thermal diffusivity measurement of PVP capped nickel oxide nanoparticles by dual beam thermal lens technique, International Conference of Optics and Electro optics (ICOL – 2019), IIT Delhi from 19 to 22, October 2019.
23. K.R. Vijesh, V.P.N. Nampoori, S. Thomas White light emission by controlled mixing of carbon dots decorated graphene oxide and Pyrromethene 567, Oct. 19-22, 2019, ICOL, IRDE, Dehradun, Uttarakhand, India.
24. Vijesh K R, Titu Thomas, Jayaprasad, Manu Vaishakh, V P N Nampoori and Sheenu Thomas, “Effect of thermal convection in Carbon dots decorated graphene oxide in different solvents” NPS-2019, ISP-CUSAT,Kochi-22.
25. P. Hajara, K J Saji, Effect of Sputtering parameters on Structural, Optical and Electrical properties of ZnO thin films deposited from metal target, National Photonics Symposium 2019, International School of Photonics, Cochin University of Science and Technology, Kochi, India.
26. Boni Samuel, V P N Nampoori, A Mujeeb. *Fluorescence quenching in CdSe quantum dots*, National Photonics Symposium- 2019, Cochin university of science and technology, Kochi
27. Pooja Gitty, Vijesh.K.R, V.P.N. Nampoori, M. Kailasnath, Effect of calcination temperature on the thermal characteristics of Dysprosium doped hydroxyapatite nanoparticles; ICOL 2019,IRDE,Dehradun.
28. Anupama Viswanathan and Sheenu Thomas, Linear and non linear optical properties of solution processed chalcogenide glass". NPS 2019, ISP CUSAT.
29. Anupama Viswanathan, Ajina Cheruvalath, Musfir P N and Sheenu Thomas, Germanium Based GeSeSb Chalcogenide Glass Waveguides For Bio-Molecular Detection. International Conference on Theoretical and Experimental Physics(ICTEP 2020), Feb 5-6, Farook college, Calicut.
30. Soumya S, Sheenu Thomas. Preparation and Characterization Studies on Ternary Se Rich Chalcogenide Glasses with Ga Content for Infrared Photonics. International Conference on Physics of Materials and Nanotechnology (ICPN). Department of Physics, Mangalore University, Karnataka, on 19th-21st September 2019.

We shake hands with…

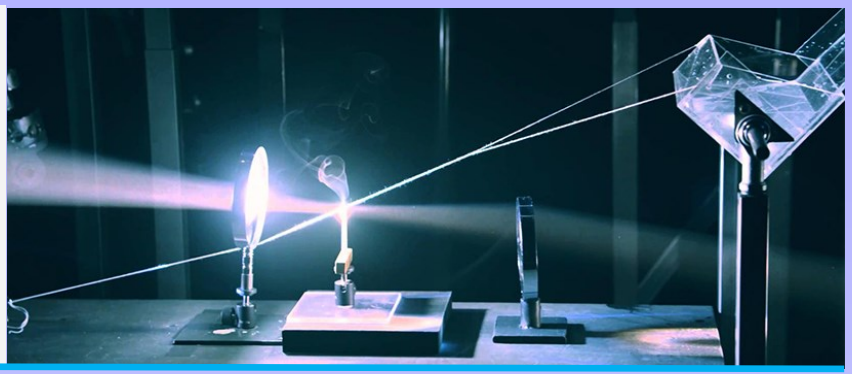
International School of Photonics team up with the premier institutes around the globe to enhance the learning platform for ISPians.

Gothenburg University, Sweden

Robert Gordon University, Scotland

Indian Institute of Technology, Madras

Technical Events at ISP



National Photonics Symposium 2019

The National Photonics Symposium is a nonpareil event conducted by International School of Photonics annually during the month-end of February. The symposium is a platform for researchers across the country to present and discuss their research work related to the thrust area. This also provides the opportunity for networking which opens the door for future collaborations. The event include seminars by professors from the premier institutes across the country and abroad & oral and poster presentations by researchers. The focal theme of NPS-2019 was *Ultrafast Optics* and was conducted from 27 February 2019 to 01 March 2019. The event was inaugurated by the then Vice Chancellor of Cochin University of Science & Technology, Prof. (Dr.) R. Sasidharan. Prof. (Dr.) A. Mujeeb, then Director, ISP welcomed the gathering.

Dr. Rajesh Menon from University of Utah delivered the keynote address and released the souvenir, *Photonics News 2018-19*. The coordinator of NPS 2019, Mr. Muhammad Rishad K P, Assistant Professor, ISP thanked and concluded the inaugural session. The major areas of discussion were Nano photonics, Plasmonics, Metamaterials, Biophotonics, Nonlinear Optics and Laser Technology, Quantum Optics and Quantum Computing, Optical Fiber based devices, Optoelectronic devices, Photonic/Optoelectronic Materials, Laser induced plasma, Ultrafast laser-matter interactions .

The invited speakers were,

Dr. Rajesh Menon ,University of Utah, USA
Dr. C S Suchand Sangeeth NIT Calicut
Dr. V. Narayanan , IIT Jodhpur
Dr. Sai Santhosh Kumar Raavi, IITH
Prof. Unnikrishnan Nayar, Kerala University
Dr. Dinesh N Naik - IIST
Dr. Nizamudeen, Kannur University
Dr. Achanta Venugopal, TIFR Mumbai
Dr. Ratheesh, CMET Hyderabad

International Day of Light 2019

International School of Photonics became a part of the global celebration of the second edition of the International Day of Light on 17 May 2019. Dr. R. Rajesh, Naval Physical & Oceanographic Laboratory, DRDO was the chief guest. The International Day of Light is an official observance of UNESCO that provides an annual focal point for the continued appreciation of light and the role it plays in science, culture and art, education and sustainable development and in fields as diverse as medicine, communications and energy.

The broad theme of light allows many different sectors of society worldwide to participate in activities that demonstrates how science, technology, art and culture can help achieve the goals of UNESCO – education, equality, and peace. As the Director General of UNESCO Audrey Azoulay states in a special message for the International Day of Light 2019 : "All its natural benefits and its scientific and technological applications make light an essential part of the daily life of our societies; these benefits and applications make light an important issue for the Sustainable Development Goals of the 2030 Agenda for Sustainable Development."

The Vice-Chancellor of Cochin University of Science & Technology, Dr. K. N. Madhusoodhanan inaugurated the function. Prof. (Dr.) A. Mujeeb, then Director of ISP delivered the welcome address. The chief guest of the function, Dr. R. Rajesh gave a talk on the role of laser based technology in nation's defence operations. The highlight of the celebration was the contribution of a collected amount towards the eye surgery of a deserving child undergoing treatment in Little Flower Hospital, Ernakulam. The official function was concluded with a vote of thanks by Dr. Sheenu Thomas, Professor, ISP.

Anti-drug & Anti-ragging Awareness Program

An antidrug & anti-ragging awareness program was organized by the Anti-ragging monitoring cell of Cochin University of Science & Technology on 29 July 2019. The venue of the program was Sir. C.V.Raman Auditorium, International School of Photonics.

Hands-on MATLAB Workshop

This Hands-on workshop on MATLAB was conducted in our School on a weekly basis on Tuesday afternoons throughout the year. The sessions were handled by senior PG students and OSA-SPIE members. MATLAB, a high-performance language for technical computing integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. This workshop has given the students a good opportunity to learn the basics of technical computing and hence the sessions were felt very productive.

Industrial Visit

The OSA-SPIE student chapters of our school conducted an industrial visit on 15 March 2019 to HHV Pumps Private Limited, Bangalore. Hind High Vacuum Company Pvt. Ltd. (HHV) is India's premier high vacuum and thin-film Technology Company. The students were taken to the manufacturing unit and the manufacturing process was demonstrated to the students by their staff.

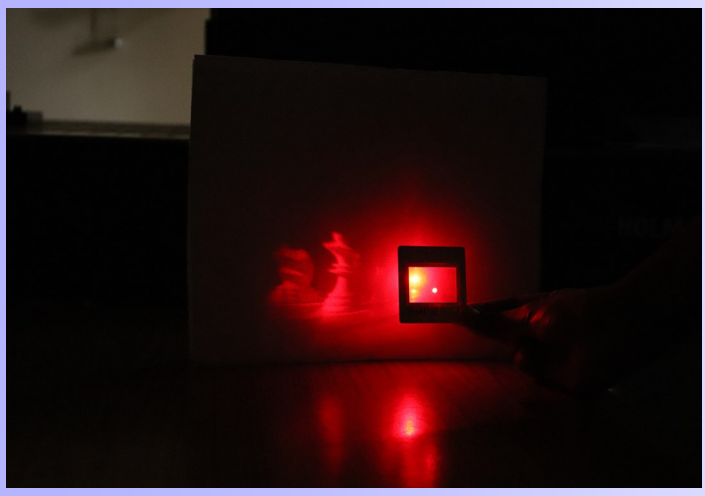
The visit was deemed successful as one of our students, Mr. Aswan Kishore Das (final year student, M.Sc. Photonics) bagged a chance to do a summer internship at HHV.

Augmented Reality Workshop

A two-day workshop on Augmented Reality was conducted on 27-28 August 2019 by the OSA-SPIE student chapters of International School of Photonics. The sessions were handled by Mr. Aadhil Khan, Chief Technology Officer of Infusory Future Tech Labs Private limited, a startup team of creative designers, developers and marketing consultants.

Augmented reality (AR) is an interactive experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information, sometimes across multiple sensory modalities. AR is defined as a system that fulfills three basic features: a combination of real and virtual worlds, real-time interaction, and accurate 3D registration of virtual and real objects. This experience is interwoven with the physical world such that it is perceived as an immersive aspect of the real environment. In this way, augmented reality alters one's ongoing perception of a real-world environment, whereas virtual reality completely replaces the user's real-world environment with a simulated one. The workshop trained the attendees to create their own augmented reality app for android. Some basic coding skill training was also provided. At the end of the day, everyone was happily playing with their custom made augmented reality app.

EtchNew



On 28th and 29th of January 2020, SPIE and OSA sponsored the optics fest ETCHNEW 2020, which was focused on enlightening the students of various schools about the world of photonics. The event was open to students of grade 8 to 12 and 836 students visited from over 21 schools. Moreover students from various colleges also showed their interest. The students of ISP put together optics kit containing different components useful for light experiments in schools. Four kits were given to government schools as a complement and three were sold to private schools.

Wide range of experiments were also set up and demonstrated, which included the topics covered in high school syllabus and other graduate level optics experiments. The research lab of ISP was open for college and higher secondary students.

On the first day, Dr. T R Ananthakrishnan, presented a physics stage show, after which the students where given an opportunity to set up their working model experiments and also explore the department and the various experiments set up by the students of International School of Photonics.

The afternoon session was headed by Dr. V P Nampoori, one of the founders of International School of Photonics. He gave a lecture and demonstration on wonder world of light. Kendriya Vidyalaya, NAD, Aluva won the first prize for the working model competition.

On second day , a quiz competition was held, 17 teams, each of two , participated and Bhavans Girinagar and Kendriya Vidyalaya, NAD, Aluva secured the first and second positions respectively. On this day students from various departments of the university were given an opportunity to visit and be a part of EtchNew 2020.

Optics to School

Optics to School is an outreach program aimed at school students, conducted annually by our department. The young minds are introduced to the wonders of optics and photonics through simple experiments demonstrated to them. This year, our team went to St. Mary's Public School, Thamarachal, Ernakulam. Some of the demonstrations include mini hologram, plasma globe, tyndall effect, total internal reflection, LED cube, UV light painting, motion sensing vehicle, etc. We were successful in piquing the students' curiosity probing them to research more about the subject.

Addendums to Lab

1. Monochromator

(Standard monochromator Model no: HO-SP-M035;

Holmarc Opto-Mechatronics Pvt. Ltd.)

Features

- Coating : Broadband Al-Coating
- Resolution : 0.05 nm @ 435.8 nm [1200 gr/mm grating, 10 µm slits]
- Accuracy : +/- 0.2 nm
- A fixed diverter mirror assembly for entrance side port.
- A exit selection diverter mirror assembly for exit ports.
- A micrometer controlled adjustable slit for entrance and exit ports.
- 0 to 3mm(10micrometer increment/decrement unit)

Monochromator consists of diffraction grating, slits and spherical mirrors, all held by precision opto-mechanical mounts. The input light source, which is always application dependent, typically emits a broad spectrum of radiations. Diffraction grating disperses light by diffracting different wavelengths at different angles. The angular position of the grating is adjusted by the use of rotary stage so that light with required wavelength is passed through the exit slit and all other wavelengths are blocked, without changing position of mirrors and slits.

Precision stepper motor controlled rotation stage is used for driving the grating. Very fine resolution for the grating stage is achieved by the micro-stepping feature of the stepper motor control. Wavelength selection is

2. High Precision Motorized Linear Translation Stage

(PI ; VT-80 linear stage)

Standard-class linear stage with recirculating ball bearings and precision leadscrew for smooth and even feed.

VT-80 Linear Stage features :

- Travel ranges from 25 to 300 mm (1 to12")
- Low profile
- Max. velocity to 20 mm/s
- Load capacity up to 5 kg
- Stress-relieved aluminum base for highest stability

3. Pico Ammeter

(Precision Pico ammeter- 6485-Keithley)

The 5½-digit Model 6485 Pico ammeter combines sensitive current measurement instrumentation with enhanced speed and a robust design. With eight current measurement ranges and high speed auto ranging, this cost effective instrument can measure currents from 20fAto 20mA, taking measurements at speeds up to 1000 readings per second. The Model 6485's 10fA resolution and superior sensitivity make it well suited for characterizing low current phenomena, while its 20mA range lets it measure currents high enough for applications such as measuring 4-20mA sensor loops.

4. Rotary Vacuum Evaporator

(Rotary vacuum evaporator cat no: 2199A)

The apparatus consists of an evaporating flask rotated by sparking induction motor in a heating water bath. Vacuum distillation of solvent at high and low temperature is achieved quickly and efficiently by use of a VARIABLE SPEED motor, which prevents foaming and bumping of the liquid (solvent) into the evaporating flask and also distillation under controlled atmosphere .

5. Volume Holographic Grating stabilized Laser Diode

(Thorlabs)

Features

- 785 nm Center Wavelength
- Wavelength-Stabilized Output
- Narrow 10 MHz Typical Linewidth (CW).
- SM Pigtail Package Contains an Integrated Optical Isolator to Protect Against Back Reflections

Thorlabs' Volume-Holographic-Grating- (VHG) Stabilized Lasers are laser diodes that use feedback from a volume holographic grating to provide narrow-linewidth, single-frequency operation. This allows the laser to achieve 10 MHz typical linewidths with an excellent side mode suppression ratio (40 dB typical).

6. Power meter & thermopile sensor

(Model PMKIT-21-01;New port)

Model PMKIT-21-01 can measure between 40 μW and 3 W optical power level in the 0.19 - 10.6 μm wavelength range.

The kit includes the following components:
• 843-R optical power meter with a tuning needle
• Model 919P-003-10 Thermopile detector, 40 μW -3 W

Features

- Spectral Range-190 to 10,600 nm
- Maximum Measurable Power-3 W
- Sensor Size-9.5 mm
- Minimum Detectable Power-40 uW

7. Helium- Neon Laser

(REO precise optical solutions ; 30991)

The 30991 Red He-Ne Laser generates a 500:1 linearly polarized output of 5.0mW (minimum) at 633 nm. Longitudinal mode frequency is approximately 441 MHz Utilizing enhanced designs and superior optical components these He-Ne lasers deliver unsurpassed operational stability and lifetimes. The mirror quality and performances are optimized to result in the highest quality He-Ne lasers available in the market. The red He-Ne laser product family offers TEM00 mode at 633 nm.

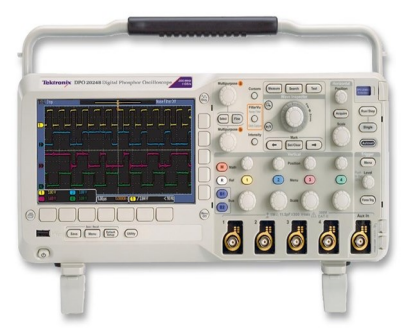
Features

- 633 nm wavelength power at 5.0mW
- 500:1 Polarized output
- Optimized cavity mirror performance and quality

8. Digital Storage Oscilloscope(4 - channel)

The DPO2024B is a 200 MHz, 4 channel digital oscilloscope from Tektronix. Measure voltage or current signals over time in an electronic circuit or component to display amplitude, frequency and rise times, etc.

Features:



- Bandwidth: 200 MHz
- 4 Channel
- 1 GS/s Sample Rate on All Channels
- 1 Mega point Record Length on All Channels
- 5,000 wfm/s Maximum Waveform Capture Rate

Connectivity

- USB 2.0 Host Port on the Front Panel for Quick and Easy Data Storage
- USB 2.0 Device Port on Rear Panel for Easy Connection to a PC
- Optional 10/100 Ethernet Port for Network Connection and Video Out Port to Export the Oscilloscope

9. Optical Dual Channel, Power and Energy meter

(Newport; 2936-R)

The 2936-R, RoHS compliant Dual Channel High Performance Optical Power and Energy Meter is one of the most sophisticated optical meters available in the market. These instruments combine the superb femtowatt level sensitivity.

10.Thermopile Sensor

(Newport)

The 919P-003-10 High Sensitivity Thermopile Sensor is designed for high sensitivity with very low noise and drift. It has an active diameter of 9.5 mm and can measure optical power from 40 µW to 3W and single shot energy from 20 µJ to 2J. It is spectrally flat and covers the wavelength range from 0.19 to 11 µm (BB type coating). It has a 1/4-20 tapped hole for post or plate mounting.

11. Fume Hood

(Modern Lab interior)

A fume hood is a type of local ventilation device that is designed to limit exposure to hazardous or noxious fumes, vapors or dusts. A fume hood is typically a large piece of equipment enclosing five sides of a work area, the bottom of which is most commonly located at a standing work height.

Surface Enhanced Raman Scattering for Forensic and Bio Sensing Applications

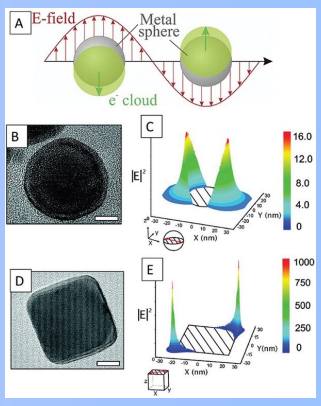
New psychoactive substances (NPS), also known as illicit drug or designer drug poses a substantial problem all over the world. The major issue is that it is very challenging to detect abuse of these designer drugs, since the present technology to identify these drugs is highly expensive. The biochemical content such as lactate, urea, Glutamate etc. are largely controlled by metabolic activity that fluctuate regularly based on age, sex and activity level. This can provide valuable information in criminal investigations, forensic sciences and health disorders.

Although methods such as mass spectrometry, NMR, IR and Raman spectroscopy provide a high level of qualitative and quantitative analysis, their inability to be operated by a non-specialist, high sample costs and lack of portability severely limit their application to in-field analysis of NPS. In this circumstance, surface enhanced Raman scattering (SERS) based sensors received great attention in recent times due to their simplicity, low costs, ultra-high detection sensitivity and portability.

SERS arises from two distinct Physical mechanisms: the electromagnetic and chemical enhancement contribution. The electromagnetic contribution is dominant with enhancement factor values typically ranging from 10^4 to 10^8. Far field radiation can excite the oscillation of electrons on metal nanostructures, and the localized surface plasmon resonance (LSPR), leads to amplified local electromagnetic fields. Molecules at or near the surface of the metal experience the amplified field, and Raman scattering is correspondingly increased. Fabrication of hot spot size and morphology play an important role in the localized surface enhancement of Raman scattering. For example, enhancement factors for silver nanospheres are between 10^3 and 10^4, while for silver nano cubes of similar dimensions it is found to be about 100 times larger as shown in the figure.

This technique mainly focuses on the trace detection of drugs, explosives, food contaminants, biological entities and environmentally hazardous gases. There are different categories of SERS substrates: solution-phase, solid-supported, tip-enhanced Raman scattering (TERS) substrates and substrates for single molecule detection using SERS.

Some of the Novel biosensing strategies based on SERS to be noted here are, a study by Kang Mao who could detect illicit drugs using silver nanopartcles. Farquharson et al presented a portable Raman analyzer based on a solid phase extraction and SERS-active capillary using gold/silver colloids. This set-up allows for measurement of drugs in saliva in minutes and can be rapidly matched with a spectral database of more than 150 illicit anprescription drugs. Shizhuang Weng reported an Au based SERS for fast detection and intelligent identification of methamphetamine and 3, 4-Methylenedioxy methamphetamine in human urine for drug sensing. Many of the current research in this area focus on the development of portable and bio combatable SERS based systems which will enable the real time monitoring of various NPS drugs.



(A) Schematic diagram of the localized surface plasmon resonance oscillation; (B) TEM of a spherical silver nanosphere. (C) Field enhancement around a symmetrical silver nanosphere (D) TEM of a silver nano cube. (E) Field enhancement around a nano cube

Dr. Vineeshkumar T V
Kothari Post Doctoral Fellow
International School of Photonics
Cochin University of Science and Technology

References:

Analyst, 2018, 143, 3990

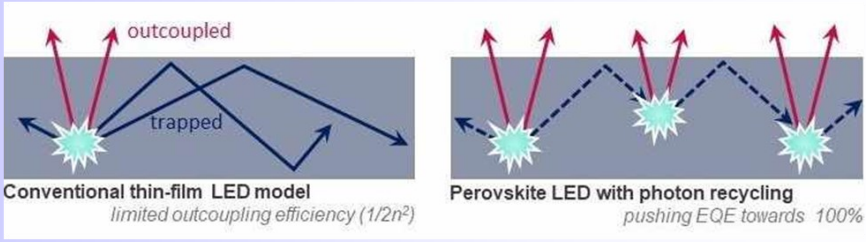
Anal. Chem. 2016, 88, 1, 152-169

Anal. Chem. 2013, 85, 2, 923-931

Photon Recycling in Perovskite Light-Emitting Diodes

Perovskite light-emitting diodes (PeLEDs) have gained tremendous attention in the past several years because of their high efficiency, low fabrication cost, highly pure and widely tunable light emission etc. With modifications in the perovskite compositions and device structures, the external quantum efficiency of PeLEDs has been dramatically improved to more than 20%, which is comparable to those of organic LEDs (OLEDs). However, the poor operational stability, including the spectral instability in pure-blue (emission wavelength, 450–470 nm) and pure-red (emission wavelength, 620–650 nm) PeLEDs and short operational lifetime under electrical bias, still hinders their possible practical applications.

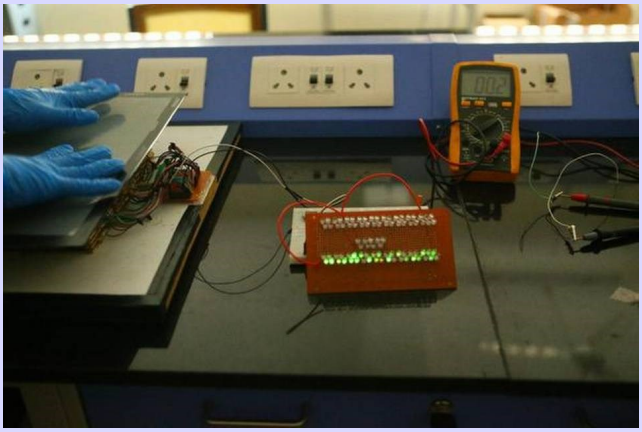
Generally, it's not easy to get light out of a large-area LED. The problem is refraction – only a small cone of emission inside the emissive semiconductor can escape; the rest of the light experiences total internal reflection and bounces sideways inside the device. The higher the refractive index of the emitter the worse the problem, and usually no more than 20% of the light is in the escape cone. No one wants to lose 80% of the light, so the LED community has developed various tricks to improve the situation. One approach used in organic LEDs is to carefully control the position and orientation of the emissive molecules so they preferentially emit light into the escape cone. Another strategy is to pattern the device to scatter out the sideways-going light. But none of this comes for free, so when a new LED technology suddenly demonstrates high external efficiencies without deliberately trying to optimize the optical outcoupling, it comes as a big surprise.



The process of **Photon Recycling** (PR) is playing an important role in coupling out the light, to enhance the externally outcoupled photoluminescence of perovskite films and to improve the voltage characteristics of photovoltaics (PVs). Also Perovskite semiconductors have relatively small Stokes shifts, which lead to significant levels of re-absorption of emitted photons. Although re-absorption has been typically considered as a loss mechanism in LEDs, with sufficient luminescence efficiency, the process of photon recycling can assist with optical outcoupling by randomising the direction of photon propagation and redirecting photons from trapped to outcoupled modes. The repetitive re-absorption and reemission of photons trapped in substrate and waveguide modes significantly enhance light extraction when the radiation efficiency is sufficiently high. In this manner, PR can contribute more than 70% to the overall emission. The process is a simple one – the sideways-propagating light is reabsorbed in the emissive material, which then has a second chance to emit. Since the new emission is randomised in direction, there's another chance to find the escape cone, and the emission that misses the escape cone can go through the cycle again. Unlike organic semiconductors, perovskites have enough overlap between the emission and absorption spectra for recycling to occur, and in the latest perovskite LED materials the emission efficiency is high enough that 30-70% of the electroluminescence could be coming from photon recycling. If we can reduce parasitic absorption by non-emissive electrode materials in the device, it could be possible to couple out all the light, pushing external efficiencies towards 100%.

Reference:
Nature Commun. 2020 Jan 30;11(1):611.

Dr. Kamal P Mani
Kothari Post Doctoral Fellow
International School of Photonics
Cochin University of Science and Technology



Electricity at Fingertip

A group of nanotechnology researchers from the Inter University Centre for Nanomaterials and Devices of Cochin University of Science and Technology (CUSAT) developed a novel triboelectric material based on the composites of a rubber like polymer with nanomaterials which can harvest Static electrical energy generated from vibrations, body movements, and frictional impulses or by a simple touch. A lot of energy which is burned up during walking, running and physical exercises can be effectively converted to electricity. The research group claims that this novel approach of generating electricity from the finger-tap can be a solution to the development of self-powered devices. This technology has been developed by Nano Energy and Device Group of Inter University Centre for Nanomaterials and Devices (IUCND) of CUSAT led by Prof. Honey John, the director of IUCND and the Head of Department of Polymer Science and Rubber Technology.

The material has the prolonged ability to provide electricity for wearable devices and body implanted sensors for medical research. The future plan of Nano energy and Device Group is to develop self –powered tiny sensors and transistors from these cost-effective nanogenerators which can function at very low current. The material developed using eco-friendly and cost effective raw materials and its large scale production is simple and economical. A scaled up model of it was prepared and using it, illuminated 100 LED bulbs, charged smart phone, powered calculators and digital watches. The group has demonstrated how the human body movements like walking, stepping, and even pulses of blood vessels can be used to harvest electricity. When connected to a battery it can store energy and can be used for charging portable devices. Further, this invention can lead to the development of security and biomedical sensors, wearable devices etc.

Prof. Honey John, Head of Department of Polymer Science and Rubber Technology and director of IUCND, Dr. Saji K J, Asst. Professor of International School of Photonics, Prof. Manoj N, Department of Applied Chemistry and Prof. M. K. Jayaraj, Department of Physics, together with Ph.D. students Mrs. Divya Jose (Polymer Science), Mr. Vijoy K V (International School of Photonics), and post doctoral fellow Dr. Jelmy E J (Polymer Science) are the lead personals of this invention. About 3 patents have been already filed based on this development. The next pace of the research group is to begin a start-up company at CUSAT for the development of devices using this technology, with the complete back-up and support of Dr. K N Madhusoodhanan, Vice-Chancellor of CUSAT.

INVITED TALKS BY OUR FACULTIES

Prof. Pramod Gopinath

- A Talk on " Dynamics of laser produced plasma through time resolved imaging ", International Conference on Optics and Optoelectronics (ICOL-2019), IRDE, Dehradun, Uttarakhand, India, on October 21, 2019.

Prof. A Mujeeb

- Lecture on " Laser assisted non-destructive testing and synthesis of materials ", UGC Human Resource Development of University of Kerala, Trivandrum, on November 28, 2019

Prof. M Kailasnath

- Invited Talk " Microcavities for Biophotonic applications ", University of Gothenburg, Sweden, Department of Physics, on September 25, 2019
- A Talk on " Microring embedded hollow optical fibres ", University of Gothenburg, Sweden, Department of Physics , on September 27 2019
- " Random lasing in metal nanoparticle doped polymer optical fibres ", Department of Applied Physics, KTH Royal Institute, Stockholm, Sweden, September 30,2019
- A Talk on Recent Trends in Fibre optic sensors. Faculty Development program, IHRD College of Engineering, Chengannur, December 10,2019
- Lecture on Polymer micro lasers for sensing applications, Indian Science Congress, University of Agricultural Sciences, GKVK, Bangalore, January 6,2019
- Attended " Building Strategic Partnerships towards Collaborative International Learning ", International Conference - organized by the Association of Indian Universities in collaboration with Symbiosis International University, Pune, 04-04-2019 to 06-04-2019.

Dr. Saji K J

- Lecture on " Electrical characterization ", workshop on material characterisation, conducted by Govt Victoria college on October 15, 2019

Dr. Praveen C S

- Resource Person at " Two-day national workshop on Quantum ESPRESSO-a DFT based code " held at PG and Research Department of Physics, Govt. Women's College, Kumbakonam, Tamil Nadu, India from 29-30 July 2019.
- Coordinator and Resource Person at " Winter School on Materials and Molecular Simulations Using Open Source Softwares: From Theory to Practice " conducted by Department of Physics, Bishop Moore College, Mavelikkara, Kerala, India from 16-22 September 2019.
- Resource Person at " 5-day workshop on Computational Materials Science " at Cochin university of Science and Technology, Ernakulam, India from 29 September- 2 October, 2019

Cherishing Moments….

Industrial visit

ISPians


കുസാറ്റിൽ ദേശീയ ഫോട്ടോണിക്സ് സിംപോസിയം

NPS 2019

Onam Celebration

Our members at International Conference , Dehradun

IDL 2019

Entering to Newly Constructed Academic Space

EtchNew

Christmas Celebration