Volume 23 February 2021

PHOTONICS NEWS

25 Years of ACADEMIC EXCELLENCE

International School of Photonics
Cochin University of Science and Technology

International Conference on Recent Trends in Photonics

International School of Photonics, established in 1995, has been conducting Annual Photonics Workshop, a national event which brings together leading scientists, academicians, industrialists and young researchers in the country for active discussions and fruitful interactions on various aspects of Photonics, for last several years. This annual event was conducted in the form of National Photonics Symposium (NPS) from 2017 onwards. This year, NPS will be conducted in all-virtual mode. The aim of NPS is to enlighten the budding scientists to find newer directions for research through active discussions and collaborative research. We hope to provide the best platform for all participants to exchange the latest and advanced research with other specialists and scholars in the field by bringing in the best scientists in India and abroad to deliver invited lectures and plenary talks apart from contributed papers. On 28th February, there will be a special session to celebrate National Science Day.

Speakers

Prof. Robert Bingham

STFC, RAL, UK

Prof. Antonello Andreone

University of Naples "Federico II"

Prof. Ebrahim Karimi

University of Ottawa

Dr. Arvinder Sandu

University of Arizona

Dr. Jana Jágerská

The Arctic University of Norway

Dr. Pravin Walke

Univesity of Mumbai

Dr. Deepa Kamath

Hiroshima University

Dr. Hrebesh Molly Subhash

Colgate-Palmolive Company, USA

Advisory Board

Prof. (Dr.) K N Madhusoodanan
Hon'ble Vice Chancellor, CUSAT
Prof. (Dr.) P G Sankaran
Hon'ble Pro-Vice Chancellor, CUSAT
Dr. V. Meera
Registrar, CUSAT
Prof. C P Girijavallabhan,
CUSAT
Prof. V P N Nampoori
CUSAT
Prof. P Radhakrishnan
CUSAT
Prof. V M Nandakumaran
Amrita University
Prof. (Dr.) Rajeev Pattathil
STFC, RAL, UK
Dr. Sony George
NTNU, Norway
Prof. (Dr,) Pramod Gopinath
(Director, ISP)
Dr. Priya Rose T
(Convener, NPS 2021)

Organizing Committee

Prof. Pramod Gopinath
(Chairman, NPS 2021)
Dr. Priya Rose T
(Convener, NPS 2021)
Prof. M Kailasnath
Prof. A Mujeeb
Prof. Sheenu Thomas
Dr. Saji K J
Dr. Manu Vaishakh
Mr. Muhammad Rishad K P
Dr. Praveen C S
Dr. Bini P Pathrose
Dr. Retheesh R
Dr. V Manickam
Dr. Kamal P. Mani
Dr. Md. Zaheer Ansari
Dr. Pradeep Chandran
Dr. Rehana P Ummer
Dr. Vineesh Kumar T V

A K Sooraj Vishwam
Alina C Kuriakose
Anitha Prakash
Arindam Sarkar
Cicily Rigi V J
Divya D Pai
Hajara P
Jayaprasad K V
Karthika Sankar
Lakshmi B
Pooja Gitty
Pradeep Kumar V
Praveen P
Priya Mary N J
Raj Sha M M
Remya R
Safna Saif
Shilpa S
Soumya S
Vijoy K V

Photonics News 2021

in Short...

Editorial

Dr. Manu Vaishakh

Dr. V Manickam

Harikrishnan P V

Anugop B

Titu Thomas

Sony U

Fathima R

Keerthana S H

Syammohan V

Sathe Mayur Anil

Inside...

Cover Image: Table salt (NaCl) imaged with polarization microscopy and a Wollaston or Nomarski prism.

Image Credit: Erik A. Rodriguez, The George Washington University, U.S.A. https://www.osa-opn.org/home/gallery/image_of_the_week/?page=2

Director's Message

Prof. Pramod Gopinath

International School of Photonics is on an exciting journey through times, as it has completed 25 glorious years of excellence in academic and research in the field of Photonics. Founded in 1995, as the Silver Jubilee initiative of Cochin University of Science and Technology, with 4 faculty members and 20 students, is now celebrating its Silver Jubilee and has grown into an Institution with a strength of 12 faculty members, 6 Post-doctoral fellows, 40 Doctoral Students and 140 Masters students. The silver jubilee celebrations has been inaugurated on February 25, 2021 by Prof. Donna Strickland, Professor, Department of Physics and Astronomy at the University of Waterloo and is one of the recipients of the Nobel Prize in Physics 2018 for developing chirped pulse amplification with Gérard Mourou, her PhD supervisor at the time. Due to the pandemic, the celebrations are currently limited to the conduct of an International Conference on Recent Trends in Photonics during February 27 - March 01, 2021 and a Webinar Series, through online mode. The webinar series was started on February 05, 2021 with a talk by Prof. Kyoko Nozaki from University of Tokyo, Japan. Five talks have already been conducted by Prof. Matjaz Valant, Materials Research Laboratory, Uni. of Nova Gorica, Slovenia, Prof. Michel Rerat, Université de Pau et des Pays de L'Adour, CNRS, Pau, France, Dr Ravi Kumar, CTO, Atomionics Pte Ltd, Singapore and by Prof. Chennupati Jagadish, Research School of Physics, The Australian National University, Canberra, Australia. The forthcoming talks in the webinar series will have Prof. Robert Boyd, University of Waterloo, Canada, Prof. John T Costello, Dublin City University, Ireland, Dr. Anil K Patnaik, US Air Force Institute, USA, among others.

The pandemic of COVID-19 has taught us new techniques to handle the taught programs and research undertaken in the School. Even during the pandemic, our students were able to continue the high quality research and were able to successfully complete their Doctoral/Master Projects without being affected too much. The outgoing students were also able to find positions and join research programs at various prestigious institutions around the world.

I am happy to see that the Photonics News, our annual publication since 1999 is being released in this Silver Jubilee Year also giving an account of the activities happening at International School of Photonics. The editorial team under leadership of Dr. Manu Vaishakh and Dr. V Manickam, have taken commendable effort to release it in time during the International Conference on Recent Trends in Photonics.

I wish all the best.

Pramod Gopinath

Faculty Members 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. Md. Rishad K P
Assistant Professor

Dr. Priya Rose T
Assistant Professor

Dr. C P Girijavallabhan
Visiting Professor

Dr. V P N Nampoori
Visiting Professor

Dr. P Radhakrishnan
Visiting Professor

Dr. Praveen C S
INSPIRE Faculty

Dr. Bini P Pathrose
Assistant Professor
[On Contract]

Dr. Retheesh R
Assistant Professor
[On Contract]

Dr. V Manickam
Assistant Professor
[On Contract]

Prof. A Varadarajan
Visiting Faculty

Dr. Reethama Thomas
Visiting Faculty

Dr. Anshad A
Visiting Faculty

Dr. Roopa Venkataraj
Visiting Faculty

Dr. Lalitha Mathew
Visiting Faculty

Administration


Siraj S
Section Officer


Ambika P N
Section Officer (T)


Aneesh P B
Assistant


Rajasree P S
Technical Assistant


Beema Begum A M
Store keeper


Gaseena K M
Computer Assistant


Manoj Kumar B S
Office Attendant


Mohammedali C B
Sweeper-cum-cleaner


Vishnupriya K V
Technical Assistant


Ashitha Beevi K A
Technical Assistant


Simimol M C
Professional Assistant


Yamuna P L
Sweeper-cum-cleaner

Achievements

Nideep T K
Assistant Professor
Govt. Polytechnic College
Mananthavady

Anjali A
Marie Curie Early Stage Researcher GANIL, France

Gopika Venugopal
Marie Curie Early Stage Researcher University of Kent, Canterbury, UK

Akhil Kuriakose
Marie Curie Fellow
University of Insurbia, Italy

Ajmal C J
Doctoral Researcher
KU Leuven Belgium

Athulya Thulaseedharan
Doctoral Researcher
University of Ottawa, Canada

Ben John
Doctoral Researcher
Fritz Haber Institute of the Max Planck society, Berlin, Germany

Aswan Kishore Das
Doctoral Researcher
European XFEL, Hamburg, Germany

Athulya Krishnan
Doctoral Researcher
École normale supérieure, Paris, France

Anees Mehaboob
Doctoral Researcher
Laval University, Quebec, Canada

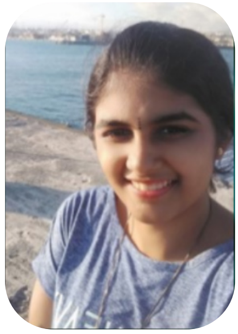
Vishnupriya P V
Doctoral Researcher
Institute of Electronic Structure and Laser-FORTH, Greece

Harsha Surendran
Doctoral Researcher
University of Konstanz, Germany

R Eruthuparna
Doctoral Researcher
University of Konstanz, Germany

Roy Philip George
Junior Project Assistant Indian Institute of Technology Jodhpur, India

Gayathri Reshma Sasidharan
Research Assistant
IISc Bangalore



Pramitha P Kamath
Charpak Master Scholarship Program
ENNSAT/RENNES 1, France

Awards

Alina C Kuriakose
Best Researcher Award

Anjali A
PSI Award
(Highest CGPA M.Tech)

Gayathri Reshma Sasidharan
Prof. Legget Award
Highest CGPA
M.Sc. Photonics

Pranjal Nobel Mukherji
Nalanda Award
Top Scorer
M Sc. First Semester
(GPA 9.60)

Ajmal C J
Sathish John
Memorial Award
Best Project thesis
M Tech. OE&LT

Shiju Prasad S R
C.V. Raman Award
Best Project thesis M.Sc.

Nideep T K
Best Paper Award
(NPS 2020)

Praveen P
Best Poster Award
(NPS 2020)

Nishanth N
Best Paper Award in
Fourth International
Conference on System,
Energy and Environment
(ICSEE2021)

New Doctorate from ISP

64 and continuing

Roopa Venkataraj

Development of optical sensors for detection and measurement of fluoride using organic dyes and some of their derivatives

Under the supervision of
Dr. M. Kailasnath and Prof. V.P.N. Nampoori

The objective of the research work was to develop highly sensitive, selective, low cost, easy to use optical sensors for the detection of fluoride in organic and organo-aqueous medium using both synthetic and natural organic dyes by investigating the optical changes of the dyes using spectro-photometric techniques and optical fibers. Other platforms like paper based sensing and coated capillary were also investigated.

FRET based fluoride detection using C540A- Rh6G dye pair was carried out to enable broad range detection in organic solvents. Hollow glass capillaries coated with C540A dye doped in PMMA matrix were also studied for dual channel (wavelength and intensity) detection of organic fluoride. Chemically tapered optical fiber probes were fabricated and combinations of uncladded-(untapered or tapered) optical fibers were assembled to detect the decreasing fluorescence of Curcumin in the presence of fluoride.

To enable aqueous based sensing of fluoride, irradiation of Curcumin and Curcumin-Aluminium complexes were studied. Curcumin irradiation in presence of fluoride led to decrease in absorption and fluorescence intensities of Curcumin owing to its enhanced degradation upon fluoride addition. in Aluminium complexes were found to respond to fluoride, acetate and phosphate with decrease in peak absorption-fluorescence intensity and blue shift in peak absorption wavelength.

Newcomers

PhD Scholar	Area of Research	Research Guide
Syammohan V	Laser Matter Interaction	Dr. M. Kailasnath
Sathe Mayur Anil	Fabrication and characterization of optical fiber based devices	Dr. M. Kailasnath
Chinthulal V S	Laser Matter Interaction	Dr. M. Kailasnath

Post Doctoral Researcher		Mentor
Dr. Shiju E	National Post Doctoral Fellow	Dr. Sheenu Thomas

Photons, Brain and Consciousness

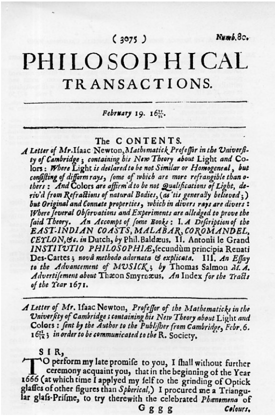
Prof. (Dr.) V P N Nampoori
Former Director
International School of Photonics
Cochin University of Science and Technology

Ever since Sir Issacc Newton published his work as a letter in Philosophical Transactions three hundred and fifty years ago ("*and made a small hole in my window-shuts, to let in a convenient quantity of Suns light, I placed my prisme at the entrance ,that it might be thereby refracted to the opposite wall……. To view the vivid and intense colours produced……..*"; **Philosophical Transactions, February 19, 1671/1672**) theory and experiments to understand the nature of light have evolved into pictures of different perspectives through Fraunhofffer, Kirchchoff, Rayleigh, Planck, Einstein, Niels Bohr, S N Bose, Louis deBrogle, C V Raman, Narinder Kapany, Shallow and Towns, Maiman, John Stuvert Bell, Roger Penrose, E C G Sudarshan, Stephen Hawking and others. Einstein's concept of photons and de Broglie's matter waves resulted into quantum mechanics questioning the nature of reality .

If the twentieth century developed necessary theoretical and experimental treatments based on quantum mechanics, the twenty first century started to apply them in various fields of human activities. Latest in these fields is the quantum mechanical treatment of human brain. Attempts are being made with some positive results to apply Biophotonics together with nanoscience and nanotechnology to understand the structure of brain and human consciousness. One of the notable treatments in this direction is the seminal works by Roger Penrose which paved the way to arrive at the microscopic structure of neurons (the information processing system-network in brain to analyze and sort the data gathered by it through five windows). Experimental observations show that higher functions of human brain are due to its capacity to interact with higher wavelength radiations in the range of visible to near infrared part of the spectrum. It seems that the light of the mind is red unlike what the poet Sylvia Plath wrote "*This is the light of the mind, cold and planetary/The trees of the mind are black. The light is blue /Separated from my house by a row of headstones./ I simply cannot see where there is to get to*" ("The Moon and the New Tree" 1961).

There have been many suggestions (ranging from Schrodinger's treatment of quantum fluctuations producing mutations, to the conjecture of Hameroff and Penrose on quantum coherence in microtubules linking to consciousness) that quantum mechanics plays a key role in the origin and behavior of biological organisms, apart from merely providing the basis for the shapes and sizes of biological molecules and their chemical affinities. It seems that scientists are inching towards refuting the suggestion of Albert Einstein that "One can best feel in dealing with living things how primitive physics still is."

Stuart Hameroff and Penrose proposed in the mid 1990's that consciousness depends on biologically 'orchestrated' quantum computations in collections of microtubules within brain neurons and these quantum computations correlate with and regulate neuronal activity with the continuous Schrödinger evolution of each quantum


(3075) Numb. 80.

PHILOSOPHICAL TRANSACTIONS.

February 19. $16\frac{71}{72}$.

The CONTENTS.

A Letter of Mr. Isaac Newton, *Mathematick Professor in the University of Cambridge; containing his New Theory about* Light *and* Colors: *Where* Light *is declared to be not Similar or Homogeneal, but consisting of difform rays, some of which are more refrangible than others:* And Colors *are affirm'd to be not Qualifications of Light, deriv'd from Refractions of natural Bodies, (as 'tis generally believed;) but Original and Connate properties, which in divers rays are divers: Where several Observations and Experiments are alledged to prove the said Theory. An Accompt of some Books:* I. *A Description of the EAST-INDIAN COASTS, MALABAR, COROMANDEL, CEYLON, &c. in* Dutch, *by* Phil. Baldæus. II. Antonii le Grand *INSTITUTIO PHILOSOPHIÆ*, secundùm principia Renati Des-Cartes; *novâ methodo adornata & explicata.* III. *An Essay to the Advancement of MUSICK; by* Thomas Salmon *M.A. Advertisement about* Thæon Smyrnæus. *An* Index *for the Tracts of the Year* 1671.

A Letter of Mr. Isaac Newton, *Professor of the Mathematicks in the University of Cambridge; containing his New Theory about* Light *and* Colors: *sent by the Author to the Publisher from Cambridge, Febr.* 6. $16\frac{71}{72}$; *in order to be communicated to the* R. Society.

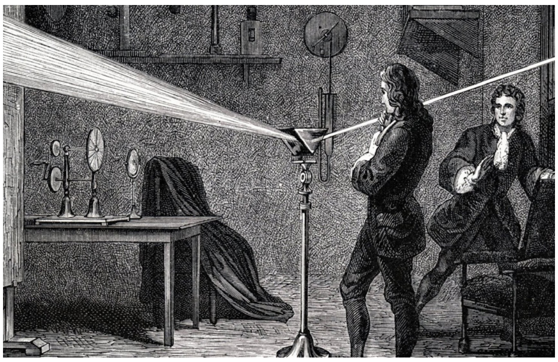
SIR,

To perform my late promise to you, I shall without further ceremony acquaint you, that in the beginning of the Year 1666 (at which time I applyed my self to the grinding of Optick glasses of other figures than *Spherical*,) I procured me a Triangular glass-Prisme, to try therewith the celebrated *Phænomena* of

Gggg *Colours*.

computation terminating in accordance with the specific scheme of 'objective reduction' of the quantum state (**OR**). This orchestrated **OR** activity (**Orch OR**) is taken to result in a moment of conscious awareness and free will. This particular form of **OR** is taken to be in the same line as a quantum-gravity process related to the fundamentals of space-time geometry, so that **Orch OR** suggests a connection between brain biomolecular processes and fine-scale structure of the universe. Reviewing and updating **Orch OR** in light of developments in quantum biology, neuroscience, physics and cosmology they conclude that consciousness plays an intrinsic role in the universe (*Consciousness in the universe: Neuroscience, quantum space –time geometry and orch OR theory, Penrose and Hameroff: Journal of Cosmology, 2011, Vol. 14 2011*).

With about one billion neurons and one trillion neural connections, human brain is one of the most complex systems in nature . In our daily life we make use of the brain capacity to about less than one percent and if we can increase it to say, to two percent the out come of human ability will increase to several orders. A neuron cell

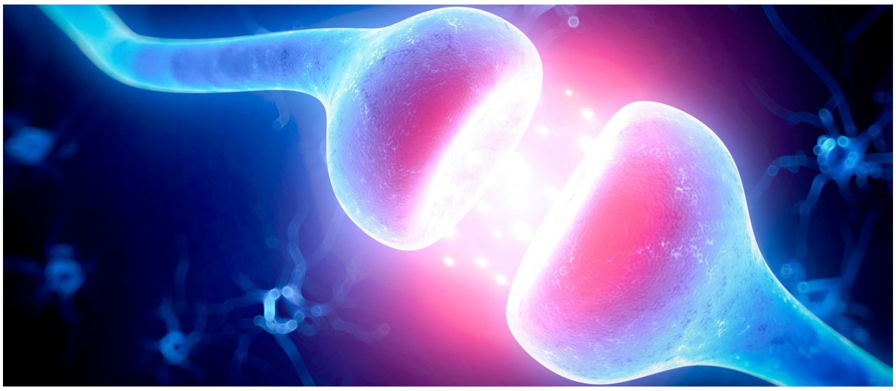


consists of the nucleus and several dendrites and a long neural axis ,called axon, ending with dendritic structures. Dendrites are used for connecting to other neurons to form a neural network . The connecting regions between two neurons are called synapses and the gap between the axon and dendrite is called synaptic cleft. At the tip of the axon there are channels through which special molecules called neuro transmitters entering into a dendrite of another neuron through the synaptic cleft so that the chemical energy carried by the neuro transmitters is converted into electrical signals to get conducted through the second neuron. In other words , the electrical signal generated in the cell nucleus will get conducted through the axon and will stimulate the encapsulated neuro transmitters which will pass through the synaptic cleft causing the electrical signal to get connected to another neuron. Neurons in different parts of the brain have special functions of gathering data from five sensory regions and analyze them for useful purposes . These data will be shared by different parts of the brain and whole brain will get stimulated to get appropriate out put signals. For example visual signal data gathered by the brain will stimulate auditory region of the brain and vice versa.

How does the brain produce consciousness? Most scientists and philosophers view consciousness as an emergent property of complex computation among 'integrate-and-fire' brain neurons which interconnect and switch at chemically-mediated synapses. Specific unexplained features of consciousness include questions like what is the nature of phenomenal experience, and what distinguishes conscious from non-conscious cognition? Perception and behavior may be accompanied or driven by phenomenal conscious awareness, experience, or subjective feelings, composed of what philosophers call 'qualia' . However perception and behavior may at other times be unaccompanied by consciousness. How and why do we have phenomenal consciousness, an 'inner life' of subjective experience?

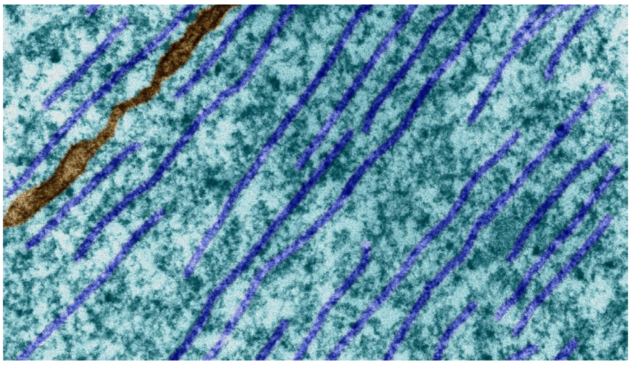
Sensory inputs are processed in different brain regions, at slightly different times, and yet are bound together into unified conscious content.

How is conscious content bound together? Polarization states of neuronal membrane may be precisely synchronized over large regions of brain , and also propagate through brain regions as synchronized zones . Some of the questions arise here are 1)Does precise synchrony require electrical synapses ('gap junctions') and/or quantum entanglement? And 2)Does synchrony reflect discrete, unified conscious moments?
As shown by Gödel's theorem, Penrose described how the mental quality of 'understanding' cannot be encapsulated by any computational system and must derive from some 'non-computable' effect. Moreover, the neuro-computational approach to volition, where algorithmic computation completely determines all thought processes, appears to preclude any possibility for independent causal agency, or free will. Something else is needed. What non-computable factor may occur in the brain?
Neurons have a rich and uniquely organized cytoskeleton, the major components being microtubules, well-positioned and uniquely arrayed (e.g. in dendrites and soma) to mediate consciousness and following along neighboring tubulin monomers repeat every 3 monomers, after winding twice around the MT (relating to the 13 protofilaments according to the Fibonacci sequence 3, 5, 8, 13).
Along with actin and other cytoskeletal structures, MTs self-assemble to establish cell shape, direct growth and organize functions including those of brain neurons. Various types of , microtubule-associated proteins (MAPs) bind at specific lattice sites, and bridge to other MTs, defining cell architecture like girders and beams in a building.. Three time-steps (e.g. at 10 megahertz) of a microtubule automaton. Tubulin subunit dipole states (yellow, blue) represent information. A general microtubule automata process . One of the MAPs include motor proteins (dynein, kinesin) that move rapidly along MTs, transporting cargo molecules to specific synapses and locations. Tau proteins bound to MTs apparently serve as traffic signals, determining where motor proteins deliver their cargo. Thus specific placement of tau on MT lattices appears to reflect encoded information governing synaptic plasticity. MTs



and regulate firing. Microtubules ('MTs') are cylindrical polymers 25 nanometers in diameter, and of variable length, from a few hundred nanometers, apparently up to meters in long nerve axons. MTs self-assemble from peanut-shaped 'tubulin' proteins, each tubulin being a dimer composed of alpha and beta monomers, with a dipole giving MTs ferroelectric properties. In MTs, tubulins are usually arranged in 13 longitudinal protofilaments whose lateral connections result in two types of hexagonal lattices (A-lattice and B-lattice), the proto filaments being shifted in relation to their neighbors, slightly differently in each direction, resulting in differing relationships between each tubulin and its six nearest neighbors.
Helical pathways following along neighboring tubulin dimers in the A-lattice repeat every 5 and 8 tubulins, respectively, down any proto-filament, are particularly prevalent in neurons (109 tubulins/neuron), and are uniquely stable. Non-neuronal cells undergo repeated cycles of cell division, or mitosis, for which MTs disassemble and re-assemble as mitotic spindles which separate chromosomes, establish cell polarity and architecture, then depolymerize for tubulins and MTs to be re-utilized for cell function. However neurons, once formed, don't divide, and so neuronal MTs can remain assembled indefinitely.

Dendritic–somatic MTs are unique in other ways. MTs in axons (and non-neuronal cells) are arrayed radially, extending continuously (with the same polarity) from the centrosome near the nucleus, outward toward the cell membrane. However MTs in dendrites and cell bodies are interrupted, of mixed polarity , and arranged in local recur-



sive networks suitable for learning and information processing . Finally, MTs in other cells can assemble at one end and dis-assemble at the other or grow and then abruptly dis-assemble (‘dynamic instability’, or ‘MT catastrophes’) . Dendritic–somatic MTs are capped by special MAPs that prevent de-polymerization , and are thus stable and suitable for long term information encoding and memory .

Human beings hold higher intelligence than other animals on Earth; however, it is still unclear that which brain properties might explain the underlying mechanisms. The brain is a major energy consuming organ compared with other organs. Neural signal communications and information processing in neural circuits play an important role in the realization of various neural functions, whereas improvement in cognitive function is driven by the need for more effect Human high intelligence is involved in spectral redshift of biophotonic activities in the brain communication that requires less energy. Combining the ultraweak biophoton imaging system (UBIS) with the biophoton spectral analysis device (BSAD), researchers have found that glutamate-induced biophotonic activities and transmission in the brain, which has recently been demonstrated as a novel neural signal communication mechanism, present a spectral red shift from animals (in order of bullfrog, mouse, chicken, pig, and monkey) to humans, even up to a near-infrared wavelength (□865 nm) in the human brain . Spectral responses in various species are found to have spectral ranges Bullfrog (522.1 - 691.2 nm) ,Mouse (591.1 -711.8 nm), Chicken (607.4- 739.2 nm) Pig (604.9 - 777.7 nm) Monkey (696.9 - 609.8 nm) and Human (595.6 - 865.3 nm) as measured by Zhuo Wang et al. This brain property may be a key biophysical basis for explaining high intelligence in humans because biophoton - spectral redshift could be a more economical and effective measure of biophotonic signal communications and information processing.

Finally a few words on mind-body dualism and René Descartes. A debate has raged since Descartes said “I think therefore I am” in 1637 in his “Discourse on the Method…”.

To summarise the theory of consciousness we can say as Aravinda Korala puts it : “I model, therefore I am” (Aravind Korala “ From visual perception, and towards a theory of consciousness”)

Developments in Near Infrared Spectroscopy

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

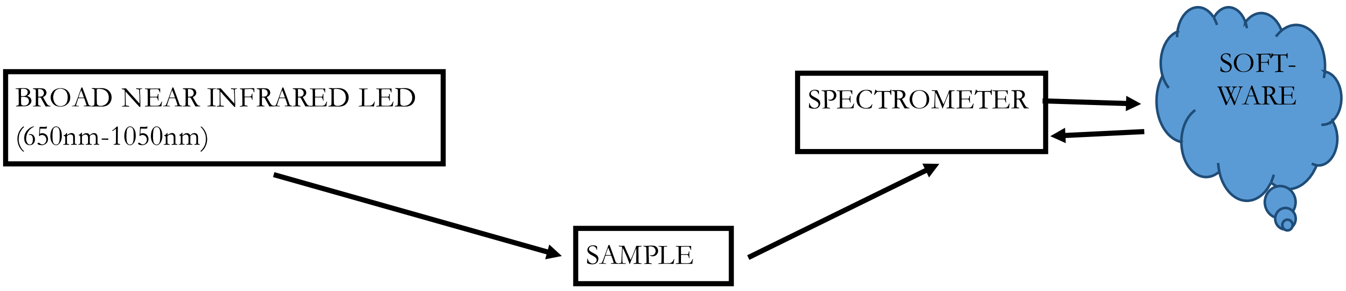
Consumers will soon be able to use their smartphones to check the freshness of supermarket food, fruits and vegetables , fat content in the cheese, measure the calories in restaurant meals and verify whether a medication is valid and contains its prescribed contents. This is made possible by near infrared (NIR) spectroscopy which uses the characteristic light absorption behaviour of certain molecular compounds in these samples. Here, directing a broad band source at the sample makes it possible to determine the presence and quantity of certain ingredients from the wavelength distribution of the reflected light. This method used in food and agriculture industries can measure water, fat, carbohydrate , sugar and protein content of the sample. This data also provides an indication of freshness, quality and calorie content.

The background principle of this method is that every molecule absorbs light at several specific wavelengths and this absorption spectrum is unique and acts as a fingerprint for a particular molecule. To classify an unknown material, spectroscopy can identify functional groups which enables to identify the raw materials and contaminants. Hence main aim of spectroscopic analysis is the determination of the chemical functional groups in the sample as different functional groups absorb their own characteristic frequencies of near infrared radiation.

A new generation of smartphone based devices have emerged that utilizes broadband near infrared emitters and compact spectrometers that can be connected to a knowledge database via cloud technology to compare the data with material and reference specifications for the analysis. By analyzing the absorption spectrum of an unknown material and matching the measurement with a database of known molecules, it is possible to determine the presence and quantity of the ingredients in the sample. A typical system developed by OSRAM Opto Semiconductors that can be added to a smartphone consists of 3 main parts viz an NIR LED emitter, a spectrometer

ter and a software for the analysis with access to a knowledge database that includes material and reference specifications. The system can be illustrated as shown below Also, an Israeli group has developed an NIR micro spectrometer that is smartphone operated and cloud connected for consumer products. The device having the shape and size of a match box can identify compounds such as fat, sugar, water and proteins in food. This leads to information about calorie content, freshness and food quality which helps consumers to monitor their health and reach fitness goals. Yet another attractive and emerging application of NIR spectroscopy is in the field of smart farming. One of the most important decisions farmers and vineyard owners have to make involves the timing of the harvest correctly in order to have the best possible taste for the produce and to save time and money. NIR spectroscopy can help the farmers to monitor the progress of their crops in real time and plan the ideal time of harvest by scanning fruits, vegetables or crops with the NIR LED and a spectrometer installed in a smartphone. This can lead to reliable information about the sugar, water and fat content of the samples. Farmers can carry NIR spectroscopy based devices in their pockets to get lab grade results in less than a minute. Everyday application of spectral analysis is transforming the way we think about food, fitness and medication.

Reference -Euro Photonics , 2019



Intellectual Property (IP)

Dr. Ranjini Dietsche
Alumnus
CELOS CUSAT

The success of any company is tied to the strength of its IP assets.

Here is a basic example.

Imagine company A develops product X spending billions of Indian rupees in R&D expenditure. Company A launches it in India, and X becomes an overnight success. 1 year later, company B launches product Y - a reverseengineered replica of X, and for half the selling price in the same market. A's profits start declining, while those of B increase.

Can A stop B here?

Case 1 - A had filed for Indian patent protection well before making X public, X was deemed to be revolutionary photonics technology by the patent office, and the patent is now granted.

Claim 1 of A's patent reads: Product X comprising features 1, 2 and 3.

A can easily prove that features 1, 2 and 3 have been copied in Y. This means A can legally stop B from manufacturing, offering to sell, using, selling or importing Y in India. A can also demand damages from B to compensate for its losses.

Case 2 – A did not have a claim to its IP. Hence, A can do nothing to stop B.

This is a remarkably simple example of how IP (patents, designs, trademarks, copyrights, geographical indications) can help secure a company's position in trade.

Possession of strong IP can not only provide market exclusivity, but also generate revenue, for example, by means of its licensing and selling to third parties. Furthermore, IP can act as an indicator to potential investors who can fund your start-up venture or university research project.

Profession

If the above has piqued your interest, it might be an idea to think of a career in IP.

Amongst other responsibilities, a patent attorney drafts a patent application, prosecutes it before the patent office, and represents parties in case of patent oppositions or litigations. A design/trademark attorney plays a similar role in design/trademark protection.

Different countries adopt different systems for qualification as an IP professional. While Europe opts for an attorney title, you can qualify as either an attorney or an agent in countries like US and India. To be called an attorney in the latter countries, you require an additional law degree. A technical degree and analytical skills are prerequisites in all cases. Your interpersonal and communicational skills play an important role in this profession.

Once qualified, you can either work in private practice or as an inhouse counsel. Private practice offers you the opportunity to represent clients across a diverse range of technologies, while as an inhouse counsel, you act as an IP legal advisor to your company. In both cases, you help shape the IP strategy of your client/company's assets and contribute to their development.

2D Janus sandwich of molybdenum, Sulfur and Selenium (MoSSe) for Surface Enhanced Raman Spectroscopy

Surface Enhanced Raman Scattering (SERS) has been widely investigated in the past several decades, for both fundamental studies of light-matter interaction and applications of microanalytical technique. SERS is well known for its superior selectivity and excellent sensitivity towards target molecules, which originate from the substances unique vibrational fingerprints of the substances and strong molecule-substrate or light-substrate interactions. SERS also provide several orders of magnitude higher sensitivity than inherently weak spontaneous Raman scattering. These merits grant SERS the capability to sense trace amount of molecules or even single molecule, rendering it a promising analytical technique for sensing, health monitoring and in-situ dynamic tracking of catalytic process.

The exact phenomenon behind SERS mechanism is still not fully understood. Generally, electromagnetic (EM) and chemical (CM) mechanisms are the two mostly accepted origins for Raman signal enhancement. For EM, the incident light generates localised surface plasmon and enhances local electromagnetic field around nanoscale metallic structures. On the other hand, CM is believed to involve charge transfer or dipole interactions between molecules and substrate.

Despite the huge enhancement factor usually observed for nanoscale metallic structure, metallic SERS media often cause side-reactions with analyte molecule and being catalysed. The drawback of these side-reactions is that they generate a strong spectra background noise, which restrict fabrication of practical SERS platform. In this context, exploring nonmetallic and SERS-active substrate is of critical importance for overcoming these disadvantages of nanometallic substrates.

Development of two-dimensional (2D) materials have attracted both academic and industrial interests in the past decade, because they exhibit novel electrical, mechanical, chemical, and thermal properties. Among the different rapidly growing 2D family, a diverse set of 2D materials have been reported to exhibit Raman enhancement effect, including graphene, hexagonal boron nitride(h-BN) and transition metal dichalcogenide (TMDs). Raman enhancement in these materials is attributed to different enhancement mechanisms. Raman enhancement effect in graphene depends on ground-state charge transfer interactions with adsorbates, while that of h-BN utilizes interface dipole-dipole interactions. Discovery of such new SERS media may provide additional insight to improve the understanding of SERS mechanism. However, the probe molecules that work with these nonmetallic substrate are limited to specific structures that possess large Raman scattering cross-section area in most cases. This limitation makes it challenging to detect small biomolecules that have significant value for health monitoring.

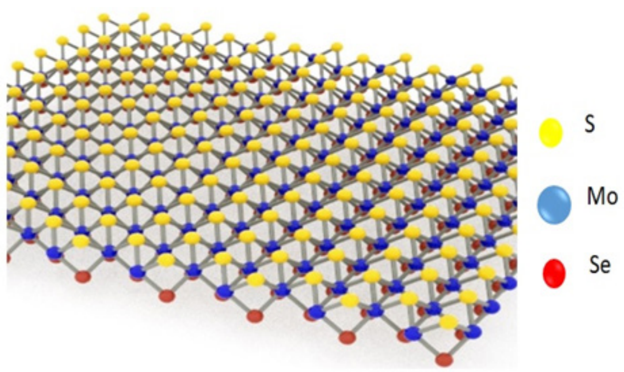


Figure. Schematic illustration of monolayer Janus MoSSe.

Recently, Jun lou and his colleagues from Rice University, USA fabricated 2D MoSSe produced by chemical vapour deposition method. Molybdenum sits in the middle with a layer of sulfur on one side and selenium on the other; hence form the two-faced Janus MoSSe. This work mainly addresses whether this platform can enhance the target molecules SERS signal strength and also avoids side reaction with analyte molecule.

SERS study on glucose and dopamine proved its ability to boost its Raman enhancement factor by more than 100,000 times, which the researchers say is comparable to the highest-reported enhancement factor for 2D substrates. So the substrate become adaptable to sense other molecules. The dipole created between the top sulfur and the bottom selenium lands out-of-plane, and this creates an electrical field a few nanometers beyond the MoSSe. This field interacts with the molecules at the vicinity and enhancing their vibrational intensity enough to be detected. Hence 2D Janus MoSSe compound is an effective and universal platform for improving the detection of biomolecules via surface-enhanced Raman spectroscopy (SERS).

Reference

Nanoscale, 2020, 12, 0723-10729

Nature communication (2020) 41467-020-18590-7

ACS Photonics, 2016, 3, 1164–1169

Dr. Vineeshkumar T V

UGC-DSK Post Doctoral Fellow

International School of Photonics

Cochin University of Science and Technology

Saving Abdul's life from toxic environment

Imagine a scenario. Year: 2035. Abdul's mobile phone has worn out and wishes to buy a new one. What would you do with the old one? Thinking about recycling? But wait till you read the next paragraph. Not surprisingly, Abdul removes an encapsulated sealing over his phone and dissolves the internal components in water or vinegar. As the electronic components breakdown, he simply throws it in his backyard. The soil takes care of disintegrated components to degrade safely without affecting the ecosystem. Another scenario. Due to a particular health condition, Abdul had to undergo regular health check at the hospital. But instead, he tattoos a thin flexible and wearable stick-on patch close to his heart or arm. The electronic sensors such as electrocardiograph (ECG), electromyograph (EMG), seismocardiograph (SCG) antenna, RF coil, RF diode, temperature sensor, are brilliantly concealed in the patch. These sensors powered by a smartphone capture heart-related data such as ECG, EMG, and SCG measurements and are transferred to the doctor's phone through the hospital. The tattoo wears off after several days before providing constant health monitoring. Abdul saves tiresome visits to the hospital, given his age and health condition. OK, one final scenario. Unfortunately, Abdul's health worsens. He takes a 'smart pill' – an ingestible capsule capable of measuring physiological data and ensures drug delivery at the point of need within the body. Abdul is not anxious as these devices are made of biocompatible and biodegradable materials and the body fluids are used as the battery's electrolyte which would power up the device. These devices dissolve and disintegrate in a month or two and end up as common compounds found in the human body. These scenarios turning into realities are not very far-fetched as the prototype of most of these devices has already been demonstrated. Thanks to the concerns of scientist and researchers on environment-friendly "green" sustainable electronics and biomedical devices. Modern materials science and off-the-book fabrication techniques are enabling diverse avenues for innovation in organic electronics and biomedical sensors that go beyond established basics.

We live in an Information age, which is marked by the development of the transistor that later transformed as a fundamental building block of digital electronics. In this era, we largely depend on electronics and photonics for hardware requirements to aid this technology. With the assistance of modern technology, electronic devices have become an indispensable tool in our everyday life. We live in an Information age, which is marked by the development of the transistor that later transformed as a fundamental building block of digital electronics. In this era, we largely depend on electronics and photonics for hardware requirements to aid this technology. With the assistance of modern technology, electronic devices have become an indispensable tool in our everyday life. These electronic devices are primarily based on the classical inorganic semiconductors which have been exploited for the on-growing demands of the digital revolution. The colossal and incessant demand for new technologically advanced products and the covetous marketing strategies have deliberately made these products obsolete in a short span and discard it in a few years of their inception. The rapid advancement in technology has created a huge electronic and plastic waste which presents a threat to the environment. A United Nations environment programme in 2019 reports that 53.6 million metric tons (Mt) of electronic waste is produced annually, which had increased 20% in the last two years and is expected to reach 120 Mt in 2050 [1]. Recycling is not a viable option. The process of extracting and purifying useful materials from electronic devices is expensive, hazardous, and cost-ineffective. Only 1-5% of the cost of original materials is retrieved. The hazardous environment of recycling workers demands better safety equipment which will further increase the overall cost of retrieved materials. It is not only the danger that it poses to the environment, but a complete energy imbalance embodied in them. The energy consumed by these inorganic materials in their processing or production phase is much more than the energy consumed by them as a product. To achieve sustainability, materials that have low embodied energy must be utilized. The depletion rate of scarce inorganic materials such as gallium and indium estimates that these materials will be exhausted completely in the next 15 years [2]. The outcome is the build-up of non-biodegradable solid toxic waste with adverse consequences to our environment and for the present and future generations.

is a big treasure-trove of successfully conducted experiments through natural selection. Inspired by its apparent simplicity and actual complexity, researchers are on the lookout for natural or synthetic materials mimicked from natural models, systems, or elements

Today we live in a world with a pile of electronic garbage because our parent generation did not foresee the dangers, introduced by exploiting inorganic semiconductors. It is, therefore, our responsibility to set up an environment that is safe for our future generations. Our society must address this problem by choosing environmentally sustainable pathways for the design, production, and disposal of such electronic devices. One approach is to make electronics biodegradable [3] (transient electronics) so that the environmental issues can be assuaged. With the dangers posed by inorganic materials and the promise of delivering low-cost and energy-efficient materials, synthetic organic materials such as conjugated polymers and small molecules have opened new avenues for research. Despite the effort by scientists and researchers, the performance and airstability of organic devices have taken a back seat [4,5]. In a race to match the efficiencies of inorganic devices, the issue of biodegradability and biocompatibility of the materials employed in organic electronics were neglected. Nevertheless, the true biocompatibility of organic materials is of paramount importance, not only for the development of biomedical devices and applications involving interfacing with living tissues but also for human and environment-friendly electronics, in general. With no immediate replacement of inorganic materials, we turn to nature for help. Nature is a big treasure-trove of successfully conducted experiments through natural selection. Inspired by its apparent simplicity and actual complexity, researchers are on the lookout for natural or synthetic materials mimicked from natural models, systems, or elements. Bio-inspired technology uses natural design as an inspiration to solve human problems and channel these solutions in new directions. It is promising that natural and nature-inspired materials can achieve the ambitious goal of 'green' technology for a sustainable future. The idea is to study the systems in nature and re-engineer them with synthetic materials or use those natural materials to solve our complex problems. Such studies are already on the research table providing a plethora of unexplored phenomena [2]. Transient electronics is based on devices made of fully biodegradable materials that can completely or partially dissolve, resorb, or self-destruct after their lifetime. These materials are used in temporary implants such as biodegradable sutures and cardiovascular stents, which can be safely metabolized by the body eliminating the need for retrieval surgeries to recover the implants and avoid the risk of infection. Extending the transient behaviour to consumer electronics can alleviate environmental issues caused by electronic wastes and eliminate the costs of recycling it.

An organic electronic device is composed of several building blocks: substrates, smoothening agents, encapsulating layers, contact electrodes, organic semiconductors, and dielectrics. It is necessary that the interest of the scientific community should turn towards natural biodegradable materials.

Figure 1: Representation of natural materials for biodegradable consumer electronic products

Natural biodegradable polymers (biopolymers) obtained from renewable resources have attracted much attention in recent years. Biopolymers are available in nature during the growth cycles of all living organisms. They are broadly classified as polysaccharides (carbohydrates), polypeptides (proteins), and polynucleotides (nucleic acids). Research on molecular and organic electronics is focussed on identifying and exploring exotic materials. Mihai Irimia Vladu, Johannes Kepler University, Austria in a series of papers [2,6,7] has summarized a list of such materials classified based on the various building layers of organic electronic devices. This article intends to provide a few examples of such materials. Any exclusions by the author do not necessarily devalue the properties or performance of those materials.

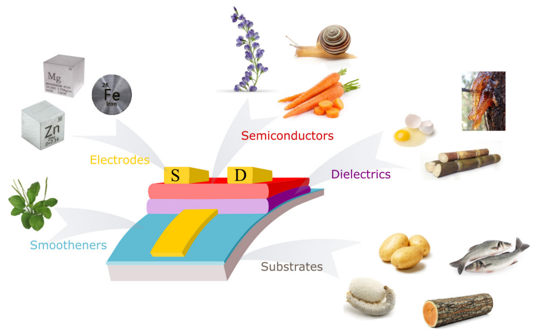


Figure 2: A partial list of natural materials for various building blocks of electronics

Paper extracted from wood pulp contains cellulose fibers. However, commercial paper is coated with polymers that pose certain disadvantages. For device substrate applications, cellulose fibers is developed into cellulose nanofibrils or cellulose nanocrystals which have improved properties such as high transparency, reduced porosity, tunable optical haze including dielectric constant and resistivity. Starch from potatoes and corn is an excellent source for biodegradable plastic foil substrates. Expensive silk fibroin protein from silkworms and gelatin from cost-effective inedible wastes viz. pork skin, fish scales are suitable choice as green substrates. Other naturally occurring biodegradable substrates include collagen, chitin, chitosan, alginate, dextran, shellac, leather, vinyl, fabric, etc. The surface roughness in biodegradable substrates can be mitigated by coating smoothening layer like aurin extracted from the roots of the wild medicinal plant, Plantago Asiatica L. Most substrates mentioned above are also good dielectrics. Their dielectric constant can be improved by incorporating plant-based nanofillers containing cellulose and lignin such as fibers from cotton, jute, bamboo and banana. Contribution by Christopher Bettinger, Carnegie Mellon University, Pennsylvania and Zhenan Bao, Stanford University, California has stirred a lot of interest in this field. Polysaccharides e.g., caramelised glucose, sucrose, lactose; tree gum, natural waxes such as beeswax, honey; polypeptides including natural chicken albumen; nucleic acids namely DNA, RNA and its nucleobases adenine, guanine, thymine, cytosine, uracil have been explored as a dielectric material. Hydrogen-bonded molecules are being revisited since indigo, a dye produced from plants and tyrian purple, extracted from the secretion of Murex sea snails showed promising results as a natural semiconductor. Melanin, a natural compound that pigments skin, hair and eyes of humans and animals exhibited ionic conductivity and ushered a whole new era of melanin bioelectronics. Natural pigments, in particular plant-based chlorophyll, terpenoids including beta-carotene, hemin from human blood, phenazine sourced from bacteria have been investigated. As for the conductive electrodes, the minerals present in a healthy human diet such as iron, zinc, manganese, magnesium, copper, and melanin have been exploited.

Extending the transient behaviour to consumer electronics can alleviate environmental issues caused by electronic wastes and eliminate the costs of recycling it.

These biodegradable materials and devices are expected to disappear into the surrounding environment without leaving its footprint. Their transience behaviour can be triggered by an external stimulus, usually water or light acidic solvents [8], temperature, humidity, oxygen, or by micro-organisms [9,10]. The timeframes for disintegration or dissolution can be tuned from few days to many years by selecting the physical dimensions, chemical architecture, morphology, film thickness, configurations of materials, or by encapsulating the devices with suitable materials [9]. Biodegradation takes place in two steps [11]: fragmentation of macromolecular chains to oligomers and monomers; and their mineralisation by microorganisms to form carbon-di-oxide (CO_2), methane, water, and biomass. The CO_2 emission and percentage of weight loss can be measured upon exposure to the external stimulus to evaluate the rate of biodegradation and degradation profiles of these materials and devices. We could positively hope that the rapid advances in materials, inventions, and discoveries would help Abdul's life better and the environment he lives in, a much better haven for his children and their children and their children and...

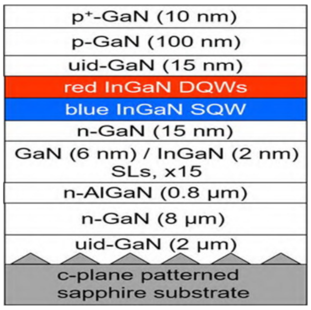
Author: Pradeep Chandran is a post-doctoral researcher at the International School of Photonics, Cochin University of Science and Technology, India. His research interest stems from the threat of the growing ecological problem and strives to focus on environmental friendly natural materials for organic electronics. The author can be contacted at chandran@cusat.ac.in

Sources:
[1] Garam Bel, et al, 'A New Circular Vision for Electronics – Time for a Global Reboot'. World Economic Forum, 24 January 2019.
[2] M Irimia-Vladu, '"Green" electronics: biodegradable and biocompatible materials and devices for sustainable future', Chem. Soc. Rev., 2014, 43,
588.
[3] Suk-Won Hwang, et al, 'A Physically Transient Form of Silicon Electronics', Science, 2012, 337:6102, 1640-1644.
[4] René A. J. Janssen, et al, 'Factors Limiting Device Efficiency in Organic Photovoltaics', Adv. Mater., 2013, 25:13, 1847-1858.
[5] Mikkel Jørgensen, et al, 'Stability of Polymer Solar Cells', Adv. Mater., 2012, 24:5, 580-612.
[6] M Irimia-Vladu, 'Exotic materials for bio-organic electronics', J. Mater. Chem., 2011, 21, 1350-1361.
[7] M Irimia-Vladu, 'Environmentally sustainable organic field effect transistors', Org. Electron., 2010, 11, 1974-1190.
[8] Kun Kelvin Fu, et al, 'Transient Electronics: Materials and Devices', Chem. Mater., 2016, 28:11, 3527-3539.
[9] Vivian R. Feig, et al, 'Biodegradable Polymeric Materials in Degradable Electronic Devices', ACS Cent. Sci., 2018, 4, 337-348.
[10] Yei Hwan Jung, et al, 'High-performance green flexible electronics based on biodegradable cellulose nanofibril paper, Nat. Commun., 2015, 6,
7170.
[11] Seema Agarwal, 'Biodegradable Polymers: Present Opportunities and Challenges in Providing a Microplastic-Free Environment', Macromol.
Chem. Phys., 2020, 2000017.

Pradeep Chandran C
University Post-Doctoral Fellow
International School of Photonics
CUSAT

Towards Natural White Light - A Phosphor-Free Monolithic White LED

The Nobel Prize-winning invention of the blue LED in 1992 sparked a lighting revolution by allowing for the creation of white LED bulbs. Commercial white LEDs use a phosphor conversion layer in combination with a blue LED to achieve white-light emission. However, the conversion process results in efficiency losses, and phosphor also degrades over time, which limits the lifetime of the bulb. In a new study, the researchers have demonstrated a phosphor-free white LED that can be tuned from warm white to cool white emission. While its efficiency remains limited and more work is still needed, the device represents a step toward the development of practical, phosphor-free white-light sources. Traditional phosphor converted white LEDs (pcWLEDs) are fabricated by coating a blue LED with a phosphor. A proportion of the blue light is absorbed by the phosphor and converted to another color. The mixture of different colors results in what our eyes perceive as white light. There are several previous works, which attempted to create white LEDs without phosphor by growing layers of compound semiconductors with different emission wavelengths to form a single structure. These devices have been plagued by a poor color rendering index (CRI), which indicates how naturally the colors of objects appear with a given light source, due to a lack of red emission. The recently developed new technology, based on integrated InGaN quantum wells, would have more widespread uses than its red counterpart. To develop this researchers employed metal-organic vapor-phase epitaxy in a single-wafer horizontal reactor to grow the LED structures, this contained a blue single-quantum well (SQW) and red double-quantum wells, on a sapphire substrate. To improve the lightextraction efficiency, c-plane sapphire substrates with a cone-shaped patterned structure. The red-emitting QW structure consisted of AlN/AlGaN barrier layers to compensate for strain and, thereby, improve the crystal quality.



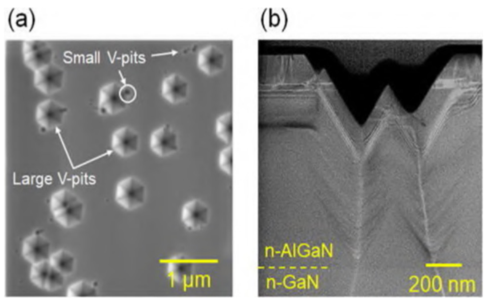


Fig (1) a) Schematic of the cross-sectional view of the epi-structure of monolithic InGaN-based white LEDs,
b) (a) Planview SEM and
(b) cross-sectional STEM images of white LEDs

Fig (1) shows a schematic cross-sectional view of the white LED structure. Scanning electron microscopy image Fig (1b) shows several material defects—pits with a V-shaped cross-section-on the LED surface, which actually serve to significantly improve hole injection into the blue and red quantum wells. For testing the WLED, the electroluminescent (EL) spectra for a current injection ranging from 5 to 100 mA with the emission over a wide range for all current levels were studied. The emission is dominated by two components, blue and red, which is due to the dichromatic QWs. Both the blue and red emission peaks blue shifted as the current injection increases from 5 to 100 mA. These large blue shifts are typical and are attributed to the screening by the QCSE (quantum-confined Stark effect). The localized emissions are distributed in the LED chips, which

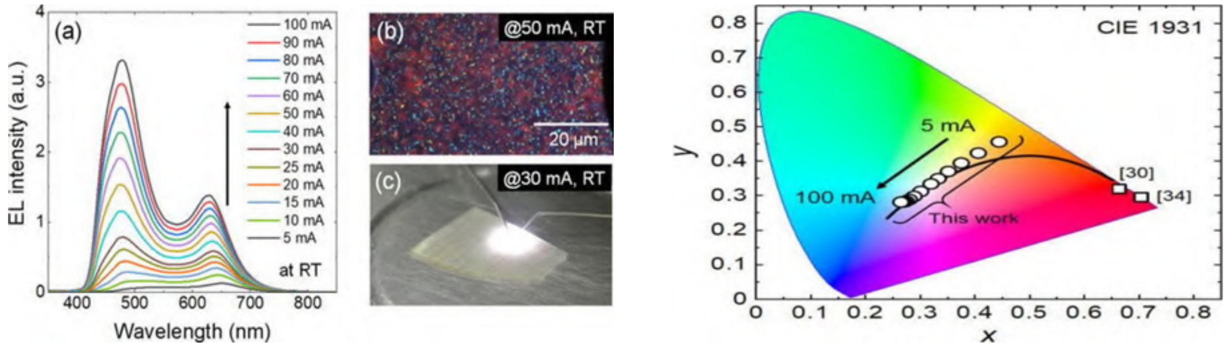


Fig 2 a). (a) EL spectra at different current injections from 5 to 100 mA. (b) Microscopic EL image under 50 mA current injection. (c) Photograph of on-wafer LEDs acquired during the EL measurement at a current injection of 30 mA,

b) CIE 1931 chromaticity diagram indicating the color coordinates. The circles indicate the color coordinates reported herein for the white LEDs at current injection of 5–100 mA. The squares correspond to LEDs without large V-pits at a current injection of 20 mA. The black curve shows the Planckian locus.

contributes to broadening the EL emission. The high-In-content InGaN LEDs have localized states due to phase separation. Also, the localized blue emission comes from the QWs in the semi-polar sidewalls of the V-pits, and the mixing of these localized emissions improves the CRI value for a natural white emission. In contrast, LEDs without the large V-pits only produce red emission; therefore, V-pits contribute significantly to the injection current into the blue SQW.

These monolithic white LEDs produce a CRI as high as 88 at an injection current of 10 mA (2.8 V). They also emit high-quality white light with CIE (x, y) chromaticity coordinates of (0.320, 0.334), a CRI of 78, and a CCT of 6110 K at 30 mA (3.2 V). By varying the current injection, the LED emission color is tunable from warm white to cool white. Typically, lights with a measured CRI greater than 80 are considered acceptable for most applications. In summary, these white LEDs emit in the range from 410 nm to 770 nm, which is almost identical to human eye sensitivity range. Also, the range is the widest one compared to other monolithic white LEDs and most of the white LEDs with phosphor. Even though there is lot to be done to improve the efficiency of such white LEDs, they are promising devices for the development of phosphor-free white-light sources.

References

K. Ohkawa, T. Watanabe, M. Sakamoto, A. Hirako, and M. Deura, J. Cryst. Growth 343, 13 (2012).
D. Iida, Z. Zhuang, P. Kirilenko, M. Velazquez-Rizo, M. A. Najmi, and K. Ohkawa, Appl. Phys. Lett. 116, 162101 (2020).
J.-I. Hwang, R. Hashimoto, S. Saito, and S. Nunoue, Appl. Phys. Express 7, 071003 (2014).

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

Recent Publications

1. Alina C. Kuriakose, V. P. N. Nampoori, and Sheenu Thomas. “Influence of laser ablated Ag core on the thermo-optic and photocatalytic characteristics of CdS nanocolloids.” Materials Chemistry and Physics 258 (2021): 123911.
2. Alina C. Kuriakose, U. Sony, V. P. N. Nampoori, and Sheenu Thomas. “Modulation of nonlinear optical properties in CdS based core shell nanocolloids fostered by metal nanoparticles.” Optics & Laser Technology 134 (2021): 106626.
3. Sony Udayan, D. Sherin, S. Vijaykumar, T. Manojkumar, V. Nampoori, S. Thomas, “Exploring the LDS 821 dye as a potential NIR probe for the two photon imaging of amyloid fibrils”. Biomaterials, Science (2020) 6082.
4. Sony Udayan, R. Lakshmi, B. Anugop, P. P. Saipriya, Ajith Vengellur, M.Kailasnath, V.P.N.Nampoori, Sheenu Thomas, “Role of bio-nanotemplates on the lasing behavior of LDS 821 dye”. Optics and Laser Technology 139(2021) 106973.
5. N. Nishanth and A. Mujeeb, “Modeling and Detection of Flooding Based Denial-of-Service Attack in Wireless Ad Hoc Network Using Bayesian Inference,” in IEEE Systems Journal, May (2020). doi: 10.1109/JSYST.2020.2984797.
6. N. Nishanth and A. Mujeeb, “Modeling and Detection of Flooding based Denial of Service Attacks in Wireless Ad Hoc Networks using Uncertain Reasoning,” in IEEE Transactions on Cognitive Communications and Networking, doi: 10.1109/TCCN.(2021).3055503.
7. Anitha Prakash, Bini P. Pathrose, P. Radhakrishnan, and A. Mujeeb. “Nonlinear optical properties of neutral red dye: Enhancement using laser ablated gold nanoparticles.” Optics & Laser Technology 130 (2020): 106338.
8. Jessy Simon, Sony Udayan, E.S. Bindiya, Sarita G. Bhat, V.P.N. Nampoori, M. Kailasnath, “Optical characterization and tunable antibacterial properties of gold nanoparticles with common proteins”, Analytical Biochemistry 612 (2021) 113975.
9. Jessy Simon, Sony Udayan, V.P.N. Nampoori, M. Kailasnath, “Investigations on nonlinear optical properties and thermal diffusivity of gold nanoparticle embedded proteincomplex”, Optics and LaserTechnology 138 (2021)106859.
10. Jessy Simon, Anugop B, V.P.N. Nampoori, M. Kailasnath, “Effect of pulsed laser irradiation on the thermal diffusivity of bimetallic Au/Ag nanoparticles”, Optics and Laser Technology 139 (2021) 106954.
11. Jessy Simon, V.P.N. Nampoori, M. Kailasnath, “Concentration dependent thermo-optical properties and nonlinear optical switching behavior of bimetallic Au-Ag nanoparticles synthesized by femtosecond laser ablation”, Optics and Laser Technology (inpress).
12. Fathima, R., and A. Mujeeb. “Tailoring thermo-optical properties of eosin B dye using surfactant-free gold-silver alloy nanoparticles.” Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy 228 (2020): 117713.

13. V.J. Cicily Rigi, M. K. Jayaraj, and K. J. Saji."Envisaging radio frequency magnetron sputtering as an efficient method for large scale deposition of homogeneous two dimensional MoS2." Applied Surface Science 529 (2020): 147158.
14. Rehana P Ummer, Sreekanth Perumbilavil, Jiya Jose, Pramod Gopinath, Sabu Thomas, Nandakumar Kalarikkal, "Exploring the Optical limiting, Photo catalytic and antibacterial properties of BiFeO3-NaNbO3 Nano Composite System" RSC Advances Article IDRA-ART-11-2020-009776.R1(accepted for publication)
15. Ramya M, Nideep T K, V P N Nampoori, and Kailasnath M "The impact of ZnO nanoparticle size on the performance of photoanodes in DSSC and QDSSC: a comparative study", Mater Sci: Mater Electron, (2021) 1.
16. Nideep T K, Ramya M and Kailasnath M, "An investigation on the photovoltaic performance of quantum dot solar cells sensitized by CdTe, CdSe and CdS having comparable size", Superlattices and Microstructures 141 (2020) 106477.
17. Shaji, M., Markose, K.K., Saji, K.J. et al. "Investigation on the improved electrical and optical properties of trivalent boron-doped Cu2O thin film and fabrication of Cu2O:B/c-Si heterojunction diode". J Mater Sci: Mater Electron 31, (2020) 10724.
18. Kurias K. Markose, Manu Shaji, Swasti Bhatia, Pradeep R. Nair, Kachirayil J. Saji, Aldrin Antony, and Madambi K. Jayaraj. "Novel Boron-Doped p-Type Cu2O Thin Films as a Hole-Selective Contact in c-Si Solar Cells", ACS Applied Materials & Interfaces (2020) 12 (11), 12972.
19. C.S Praveen and Aleix Comas Vives, "Design of an Accurate Machine Learning Algorithm to Predict the Binding Energies of Several Adsorbates on Multiple Sites of Metal Surfaces", ChemCatChem, 12 46111, (2020)
20. C.S Praveen, AP Borosy, Christophe Copéret, Aleix Comas Vives, "Strain in Silica-Supported Ga(III) Sites: Neither Too Much nor Too Little for Propane Dehydrogenation Catalytic Activity", ChemRxiv, (2020)
21. Kumar, P., Mathew, S., Anand, V. R., Radhakrishnan, P., Nampoori, V. P. N., & Mujeeb, A. (2021). Defect level dependent visible emission of nickel oxide nanoparticles through controlled calcination temperature. Optik, 166388.

FEBRUARY 2021

Books Published/Edited

1. Mohammad Zaheer Ansari, Hilda C. Grassi, Humberto Cabrera, Ana Velásquez, Efrén D. J. Andrades, and A. Mujeeb "Application of Biospeckle Laser Method for Drug Testing on parasites", (Chapter: 9) in Advanced studies in experimental and clinical medicine Modern Trends and Latest Approaches; First Edition; Apple Academic Press (CRC, Taylor & Francis Group) March 2021
2. A.K. Sooraj Viswam; Basics of 8085 Microprocessor, First edition; Authentic Books, Thiruvananthapuram, Kerala. ISBN 978-81-89125-70-7.

Conference Proceedings

1. Alina C Kuriakose, Sony Udayan, V P N Nampoori, Sheenu Thomas.” Plasmon Enhanced Fluorescence in Styryl 7: Gold Nanostar Composites.” 33rd Kerala Science Congress Proceedings January (2021):54
2. Alina C Kuriakose, V. P. N. Nampoori and Sheenu Thomas.” Heat Transfer Characteristics in CdS: Basic Fuchsin Binary Hybrids Using Laser Induced Thermal Lens Technique.” ROWS Proceedings (2020): 53
3. Sony Udayan, Alina C Kuriakose, VPV Nampoori, Sheenu Thomas. “Lasing studies of LDS 821 dye in different solvents”. 33rd Kerala Science Congress
4. N. Nishanth and A. Mujeeb, “ Application of Adaptive Threshold Algorithm with selected modified parameters for the Detection of flooding based Denial-of-Service (DoS) attack in Mobile Ad Hoc Network” in International Conference on System, Energy and Environment (ICSEE 2021) at Govt Engineering College, Kannur.
5. N. Nishanth and A. Mujeeb, “Route Request Flooding based Denial of Service Attack in Wireless Ad Hoc Networks and Selected Defending Measures: A Review “, in International Conference on Emerging Trends in Engineering, Science and Technology held at Govt Engineering College, Thrissur.
6. Arindam, Sarkar, Rajeevan Neelima, and Madanan Kailasnath. “Silver nanoparticles-dye filled hollow polymer optical fibre laser with enhanced Q-factor.” AIP Conference Proceedings. Vol. 2244. No. 1. (2020).
7. Ramya M, Nideep T K, V P N nampoori and Kailasnath. “Synthesis and nonlinear optical characterization of ZnO nanoplates and its PVA composite film.” AIP Conference Proceedings. Vol. 2244. No. 1. (2020)
8. Nideep T K, Ramya M, and Kailasnath. “ Amplified spontaneous emission from MSA capped CdTe QD synthesized using colloidal method” AIP Conference Proceedings. Vol. 2244. No. 1. (2020).
9. A. P. Sunitha, P. Praveen, P. Hajara, K. J. Saji, “MoS2 quantum dots for photovoltaic device applications”, AIP Conference Proceedings 2287, 020001 (2020).
10. A.P. Sunitha, K. Sandeep, P. Praveen, K.J. Saji, “Upconverting carbon quantum dots: An eco-friendly material for light energy harvesting and bio-imaging”, Materials Today: Proceedings 33, 1298-1300 (2020).
11. Shilpa S., Divya D. Pai and Pramod Gopinath, “Fast imaging and spectroscopic study on colliding laser produced aluminium plasmas.” 13th International Conference on Plasma Science and Applications (ICPSA-2020) December 26-28, 2020.
12. S Soumya, Sheenu Thomas, “Preparation and characterization studies on ternary Se rich chalcogenide glasses with Ga content for infrared photonics”, AIP Conference Proceedings 2244 (1) (2020) 100007.

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
Modeling and detection of flooding based DoS attack in wireless AdHoc networks using Bayesian Interface	Nisanth N
Optical Band gap of semiconductors-Review of different Methods	Lakshmi B
Large scale aqueous synthesis of fluorescent and biocompatible silicon nanoparticle and their use of highly photostable biological probes	Raj Shah M M
Terbium doped hydroxyapatite nanoparticles	Pooja Gitty
High performance, High index contrast chalcogenide glass photonics on silicon and unconventional non-planar substrates	Soumya S
Influences of Detection Pinhole on Thermal Lens Detection in Microfluidic Systems	Priya Mary N.J
Dye-Sensitized Photodetector: A new method of improving the photoresponsivity of semiconductor	Pradeep Kumar V
Utilizing formation of dye aggregates with aggregationinduced emission characteristics for enhancement of two-photon absorption	Anitha Prakash

Some selected applications of plasmonics	Arindam Sarkar
Forming van der Waals metal contacts to two-dimensional semiconductors Approaching the Schottky Mott limit	Cicily Rigi
Ultrafast Laser Filament Produced Plasmas	Divya D Pai
Fourier transforms for fast and quantitative Laser Speckle Imaging	Keerthana S.H

Special Talks by Experts

TOPIC	PRESENTED BY
Synthesis and properties of Heterohelicenes	Prof.Kyoko Nozaki, University of Tokyo,Japan
General Trends in Chemical Interaction of Metals and Bi2Se3 Topological Insulator	Prof. Matjaz Valant, Materials Research Laboratory, Uni. of Nova Gorica, Slovenia
Refractive index of Materials and Nonlinear optical effects	Prof. Michel Rerat, Université de Pau et des Pays de L'Adour, CNRS, Pau, France
Cold atom interferometry and its applications	Dr. Ravi Kumar, CTO, Atmionics Pte Ltd, Singapore
Semiconductor Nanostructures for Optoelectronics Applications	Prof. Chennupati Jagadish, Research School of Physics, The Australian National University, Canberra, Australia

Silver Jubilee Celebrations
Inaugural Lecture by
Nobel Laureate
Prof. DONNA STRICKLAND
Held on 25th February 2021

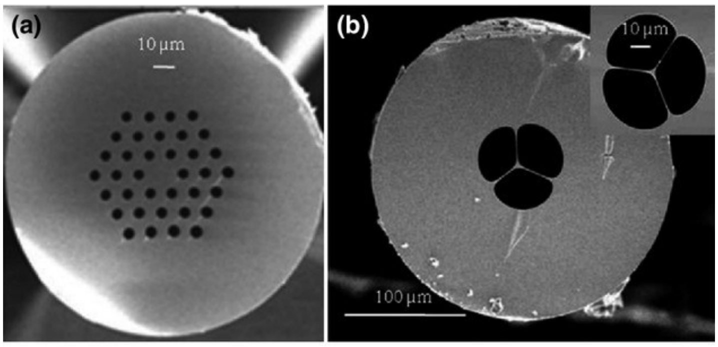
From Nonlinear Optics to High Intensity Laser

This year, the International School of Photonics, is all set to celebrate the completion of its silver jubilee with full vigour and enthusiasm. In connection with this, the department has decided to organize a webinar series featuring eminent scientists from around the globe who hold distinguished positions in different areas of photonics research. The silver jubilee celebrations were inaugurated on 25 th of February by Nobel Laureate, Prof. Donna Strickland who delivered a lecture on the topic 'From nonlinear optics to high intensity laser physics' at 7.30 pm. Donna Strickland who is a professor in the Department of Physics and Astronomy at the University of Waterloo, Canada had been awarded the Nobel prize in Physics, in the year 2018, alongwith Dr. Gérard Mourou for the ground-breaking invention of chirped pulse amplification technology in the year 1985. The inauguration of the Silver Jubilee Celebrations also witnessed the presence of Hon. Vice Chancellor of Cochin University of Science and Technology, Prof Dr. K. N. Madhusoodanan, who introduced the speaker. The talk was extremely motivating for the young generation of researchers since it provided a fabulous opportunity to listen to the origin of Chirped Pulse Amplification Technology from the very scientist who introduced this remarkable concept to the scientific community.The webinar series was continuing with the talks of various experts including **Prof. Kyoko Nozaki**, University of Tokyo, Japan, **Prof. Matjaz Valant**, Materials Research Laboratory, Uni. of Nova Gorica, Slovenia, **Prof. Michel Rerat**, Université de Pau et des Pays de L'Adour, CNRS, Pau, France, **Prof. Chennupati Jagadish**, Research School of Physics, The Australian National University, Canberra, Australia and being proceeded by the lectures of the leading scientists in the field.

Research Inside

A Glimpse into Chalcogenide Glass Photonics

Chalcogenide glasses (ChGs) are amorphous semiconductors with group-16 elements as major constituents (sulphur, selenium, and tellurium, excluding oxygen and polonium) covalently bonded to network formers such as arsenic, germanium, gallium, antimony etc. ChGs are promising materials in the field of Photonics because of its notable physical, optical, thermal and electrical properties. ChGs have high transmission in the IR region of the spectrum (IR cut-off is near to 2-12 Xm for sulphides, 2-15 Xm for selenides and 2-20 Xm for tellurides) which makes them a good candidate for the fabrication of active and passive IR devices especially for biochemical MIR sensor applications and in the field of fiber optics. The high refractive index (in the order of 2-3) of ChGs can be put to use for optical trapping when it comes to optical resonators. The high photosensitivity including photo-darkening, photo-crystallization and photo-expansion/contraction of ChG permits the direct writing of optical waveguides and photonic integrated circuits (PICs). In addition to this, ChGs offer attractive properties like high nonlinearity, low band gap (1-3eV) and good rare earth solubility which can be exploited for making amplifiers and lasers especially in IR regime. Research in this realmhas been consistently and continually progressing, opening a way to the more compact integration of photonic circuits with high optical quality. Our research group led by Prof. (Dr.) Sheenu Thomas, mainly focus on ChGs for IR photonic applications. In particular, ChG based MIR biosensors, polymer photonic crystal fiber (PCF) with infiltrated ChG films, ChG microresonators, ChG nanophotonics and nonlinear optics (NLO) are our core exploring areas. We synthesis ChG using conventional melt-quenching technique and have an excellent Photonics research laboratory to carry out the research. Recently, we have developed novel amorphous nanowires from solution processed ChG and also



realized a hybrid metal-ChG substrate for surface-enhanced infrared spectroscopy.

CITATION:
Adam, J.-L., Calvez, L., Trolès, J. and Nazabal, V. (2015), Chalcogenide Glasses for Infrared Photonics. Int J Appl Glass Sci, 6: 287-294. https://doi.org/10.1111/ijag.12136

Integrating Magnetism and Plasmonics

Magnetoplasmonics is an exciting field of research, that combines the fields of magnetism and plasmonics in the nanoscale. The main objective of research in this field is to manipulate magnetic and magneto-optic properties of nanostructures by incorporating plasmonics components. There have been numerous reports where magneto-optic effects of thin films of magnetic material have been enhanced and/or modified when plasmonic components such as gold or silver nanoparticles are introduced. Various interesting nanostructures such as bimetallic and core shell nanoparticles offer platforms for investigating magnetoplasmonic effects. Another potential area of research in this field is related to manipulating the optical properties of nanostructures using magnetic field. Magnetic field based modifications of surface plasmon polariton wavevectors in magnetoplasmonic waveguides offer desirable applications in developing all-optical circuits for communication. Due to the inherent ultrafast nature of magnetic field based responses, one may explore novel phenomena related to the interaction between light and magnetism in the nanoregime, which can be enthralling from a basic scientific point of view as well as offer explicit applications that can change the face of communication pathways for the coming generations.

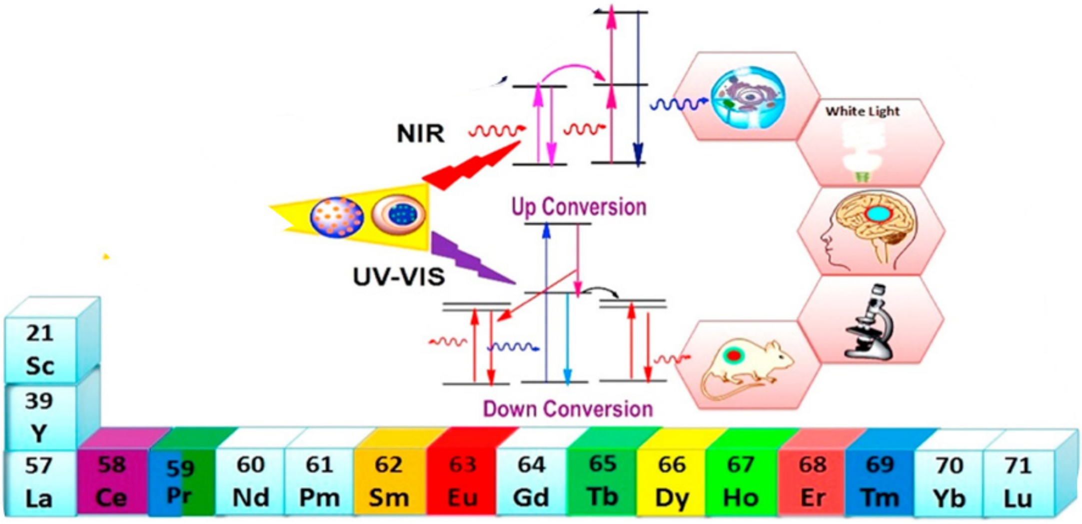
Electronic Laser Speckle Imaging : Laser as a non-destructive probe

The coherent monochromatic light from a laser source can be used to measure minute details of a system of interest. This can be done with the help of a technique known as Laser Speckle Imaging. A laser is made to fall on an optically rough surface from where we collect the scattered light using an imaging system. What we will observe is an Intensity pattern, of a ‘speckled’ appearance, which is produced by the mutual interference of a set of wave-fronts from the laser source and the optically rough surface. The distance travelled by these wave-fronts differ by multiple wavelengths. The interference of these wavelets results in a granular intensity pattern called specklegram.

In laser speckle imaging technique, laser light is used, together with video detection, recording and processing to visualise static and dynamic displacements of components with optically rough surfaces. It can also be used as a non-destructive method of testing. Speckle imaging can display correlation fringes in real time on a screen and many methods have been developed for measuring displacement components, their derivatives, surface roughness, shapes and slope contours of surfaces. The speckle phenomenon which was initially considered to be noise in imaging systems later was identified to be the signature of the object surface by the scientist Leendertz in 1970. With the advancement in computational technology and better recording equipment the field continued to grow. 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, shelf time of medicines, fruits etc. An extension of this method is the addition of a reference laser beam along with the probe beam and digital subtraction of the images resulting in interference rings. The addition of a reference beam helps us to record the phase information of the activity under observation. The resulting images are later processed using image processing algorithms and analysed to obtain qualitative and quantitative data.

Rare Earth Doped Nanoparticles-Future in Lighting and Imaging

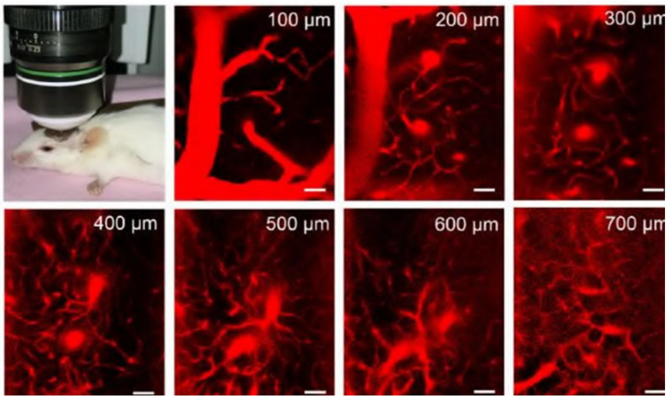
Rare earth elements (REE) include the lanthanide series elements (La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu) plus Sc and Y. Rare Earth based luminescent nanoparticles have numerous advantages compared with the other materials due to their lower toxicity, photostability, high thermal and chemical stability, high luminescence quantum yield, and sharp emission bands. The nanocrystals of rare-earth compounds, such as oxides, phosphates, fluorides, vanadates, and sulfides, have gained more importance due to their unique properties regarding the 4f electron configuration and the way they can be applied in ultraviolet absorbents, solid-state lasers, optical amplifiers, lighting and displays,bioimaging and biolabeling. A typical rare earth nanoparticle structure comprises of a host lattice and activator and sensitizer ions. The host lattice provides structure for both the activator and sensitizer ions and acts as a medium that conducts energy transfer. The emission wavelengths are fine tuned by the properties and crystal structure of the host lattice.The final characteristic properties of the nanophosphors are highly influenced by both the inorganic matrix and the dopant. Fluoride matri-



ces are used due to their low vibrational energies, which minimize the quenching of the exited state of the Ln cations and result in a higher quantum efficiency of luminescence. Phosphate-based matrices attract interest for their high biocompatibility and good biodegradability and are used more in imaging and drug delivery applications . Other matrices such as vanadates, molybdates, and wolframates are used to enhance the luminescence and hence used in light emitting diodes and some silicate-based matrices are appropriat for the production of persistent luminescent NPs. When the lanthanide ion is excited to a certain energy level, part of the excitation energy will be dissipated via nonradiative processes until a resonance level is reached for the generation of luminescence. Lanthanide dopants have multiple 4f excitation levels and completely filled 5s and 5p shells, which shield their characteristic 4f electrons, thus producing sharp f-f transition bands. These transitions provide substantially longer lasting excited states, since they are Laporte forbidden. Rare earth based nanoparticles absorb light of a specific wavelength and reemit light of a different wavelength having a Stokes or an Anti-Stokes shift with an energy corresponding to the energy difference between the excited state and the ground state. Light emitting materials based on inorganic matrices doped with rare earth ions show excellent photoemission with good thermal and chemical stability as they are based on electronic transitions rather than chemical bonds as in organic fluorophores. Regardless of the recent advances in the field of rare earth nanophoshors, challenges persist in making their applications affordable, having good quantum efficiency and compatibility.

Biophotonics

All over the history of the world, human beings have always been fascinated by the power and importance of light. This fascination appears in their religious writings and rituals, in art and literary works ranging from ancient to modern, in lights for vehicles and buildings, wide variety of displays devices for computing and communication devices, and in the dramatic visualization effects of cinematography and other entertainment settings. Similar to the use of electrons in the electronics, photons are the key entities in the world of light-based technology or photonics.



Photonics is the discipline that involves the generation, detection, and control of photons for enabling functions such as transferring or processing information, sensing or measuring changes in physical parameters, and physically modifying material characteristics. Thus, photonics technology also has become an indispensable tool for basic life sciences research and for biomedical diagnosis, therapy, monitoring, imaging, and surgery. This category of photonics deals with the interaction between light and biological material and is referred to as biophotonics. From a global viewpoint, biophotonics refers to a branch of science where the interaction between biological substances as well as light is used for probing, manipulating and imaging cells and tissues. Some of the applications of biophotonics are (a) 2D and 3D imaging of cells, tissues, and organs and second harmonic imaging is an efficient method for imaging since it offers higher resolution of nonlinear optical microscopy and also prevents photo-toxicity and photo-bleaching (b) measurements of biometric parameters such as blood oxygen and glucose levels, (c) therapeutic photonic treatment of injured, diseased, or unwanted cells and tissues without harming the surrounding cells and organs, (d) detection of injured or diseased cells and tissue, (e) monitoring of wound healing and progress of therapeutic treatments, and (f) surgical procedures such as laser cutting, tissue ablation, and removal of cells and tissue.

References

[1] G. Keiser. Biophotonics 2016.
[2]www.news-medical.net/life-sciences/Biophotonics-in-Cell-Biology-Studies.aspx
[3]https://medium.com/biotech-ly/biophotonics-to-cure-cancer-redefining-medical-treatments-552991bcaa2

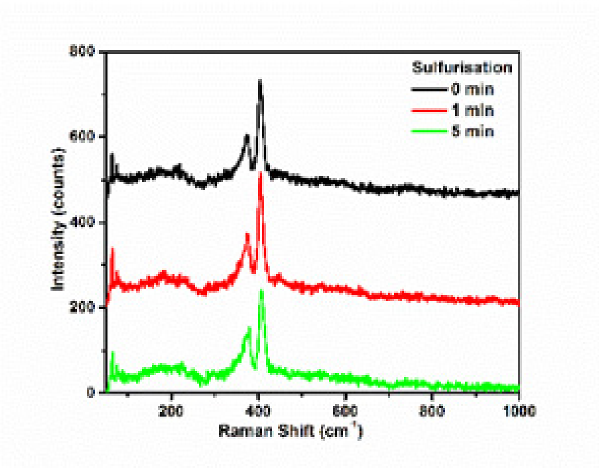
Optical fibers; A plethora of exciting applications

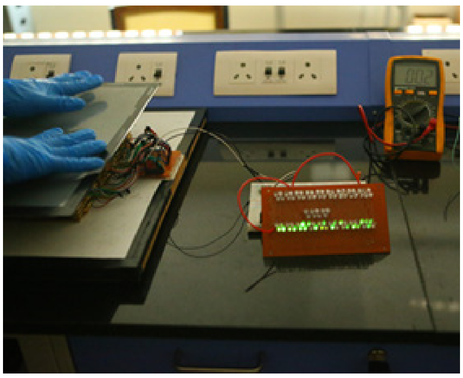
Polymer Optical Fibre (POF) has achieved a remarkable stance in various important fields such as short-distance communication, lasing, and sensing. Compared to silica, the polymer-based optical fibres have many advantages including mechanical flexibility, ease of fabrication, low manufacturing temperature and cost-effectiveness. The low manufacturing temperature enable researchers the incorporation of various active materials in such fibres. Depending on the application one can go for various types of POFs such as step-index multimode(SI-MM), graded-index multimode(GIMM), Single-mode (SM)POF, Electro-optic(EO)POF, segmented cladding POF, Scintillating POF, Dye doped

POF, Photorefractive POF, Photosensitive POF, and Microstructured POF. International School of Photonics (ISP), CUSAT is one among the pioneering institutes in the country which has been contributing to the field of optical fiber research. In ISP, researchers are mainly interested in the development of PMMA based Polymer optical fibers for various photonic applications such as amplification, sensing and lasing. Here, dye doped-step index, graded index, hollow and micro ring embedded polymer optical fibers have been used for lasing as well as sensing applications. Dyemetal nanoparticle combination when doped in POF finds applications in spectral tuning, amplified spontaneous emission as well as random lasing. Metal nanoparticle-dye combination is also found to be effective in enhancing the photostability of the dye doped fibres. Silver nanoparticle filled hollow polymer fiber laser with enhanced photostability has been reported. WGM lasing from Rh6G doped hollow polymer optical fiber exhibits a blue shift in the lasing spectra under tensile strain yielding a strain sensitivity of 0.235 pm/με. Using a microring embedded hollow polymer fiber sensor, a refractive index sensitivity of 188 nm/RIU has been achieved. This class of hollow fibers is also known for the single mode selection out of whispering gallery mode laser emission at very low pump powers. Tunable amplified spontaneous emission from dye doped hollow polymer optical fiber was also reported. from ISP. Currently, researchers are also seeking combinations of several dopedand undoped hollow-core optical fibers in the perspective of microstructured waveguide devices.

Thin film fabrication for opto-electronic applications

Physical vapor deposited thin films have potential application in various optoelectronics devices, in which a thin layer of material (between a few nanometers to about 100 micrometers) is deposited on a substrate in a vacuum chamber. Radiofrequency magnetron sputtering and vacuum thermal evaporation are the common methods used in our lab for high quality, large area thin film deposition. Various oxides and sulfide films are deposited for different devices like solar cells, thin film transistor, memristor, and nanogenerators. 2D transition metal Dichalcogenides (TMDC) such as MoS2 and WS2 has successfully synthesized using sputtering techniques which has intense applications in Thin film transistors and memristors. Studies in 2D TMDCs could lead to manufacturing of low cost, fast switching, and



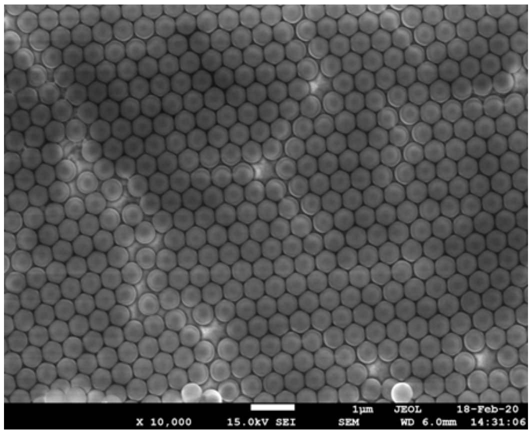


low power consuming field effect transistors owing to high mobility tunable band gap and other features of monolayer TMDCs.

The memristor (a contraction of "memory-resistors") is a 2-terminal electronic element and is considered as the fourth fundamental passive element. Memristors are nanoscale resistive switching devices whose memristance depends on the amount of charge passed through it. Due to the nanoscale structure, low-power consumption, intrinsic non-volatile memory characteristics, compatibility with CMOS technology and synapse-like behaviour, they can be used in highdensity memory and Artificial Neural Networks. Nowadays 2D materials are found high applications in energy production. Sputter deposited Sulfides (CZTS, CdS), CdTe and Oxides (ZnO) etc are using in solar cells. Drastic rise of number sensors in internet of Things (IoT) devices, automobile industry, and medical field demand for self-powered technology. Triboelectric nanogenerators are fast developing technology to harvest energy from mechanical motion and also work as sensor. Metal, semiconductor and polymer films are highly employed in fabricating triboelectric nanogenerators. The technology is based on triboelectrification and electromagnetic induction.

Photonic Crystals-the way to all-optical circuit

Photonic crystal (PC) based structures is an active research area due to its wide and interesting applications. PCs are periodic structures with periodicity of the order of wavelength of light. Due to this structural periodicity, incident light flow can be controlled and manipulated. If there is good refractive index contrast between the constituent media, Bragg scattering off the dielectric interfaces can result in a complete photonic bandgap- a range of frequencies for which light is forbidden to propagate through the structure. PCs can be classified into one-dimensional, two-dimensional and three-dimensional, based on the directions along which the structural periodicity exists.



Semiconductor technology plays the major role in everyday lives. But we know miniaturization of electronic circuits beyond a certain limit results in circuits with increased resistance and higher levels of power dissipation. What we now have are optoelectronic circuits. For further high performance, research is progressing towards photons as information carriers instead of electrons. Photons have many advantages over electrons like high speed and increased bandwidth. Also, photons are not strongly interacting as electrons which helps in minimizing energy losses. In short, all-optical circuits is the solution and PCs pave way to realize an all-optical circuit.

Areas of interest of the PC research group include 1D PCs, Self assembled 3D PCs, hetero structures (1D-3D combinations), Metallo-Dielectric Photonic Crystals (MDPC) and Inverse Opals. Spin coating technique is utilized for the fabrication of one dimensional photonic crystals. Theoretical analysis of 1DPCs are carried out using transfer matrix method, which is a technique used in optics and acoustics to analyze the propagation of electromagnetic or acoustic waves through a stratified medium. 3D PCs and Inverse Opals are fabricated via colloidal self assembly. MDPCs have been shown to possess complete photonic bandgap in the visible region. Also due to the incorporation of metal nano particles, they can exhibit both localized and propagating surface plasmon modes. Enhanced surface area and photonic properties of inverse opals coupled with the in-

teresting properties of metal nanoparticles can have many applications as catalysts, SERS substrate etc. We are working towards PC based sensors. Integrated optical biosensors have advantages of direct, real-time and label-free detection. So PC based biosensors, especially inverse opals (due to its enhanced surface area) are appropriate candidates for detecting bacteria and viruses.. General applications of PCs include chemical and biological sensing, tunable color displays, anti-counterfeiting and as optically active components.

Plasma, the mysterious and powerful fourth phase of matter...

Plasma is a collection of positively charged ions and negatively charged free moving electrons with charge neutrality, referred to as fourth state of matter. When high powered laser pulses are focused on to a solid target for a short duration, a hot plume is generated over the surface of the target which is known as Laser Produced Plasma. Laser produced plasma has been studied extensively for past 60 years since the advent of laser in 1960's. Colliding laser pulsated plasma were first investigated in 1970s. The collisional plasma is produced as a result of collision of two rapidly expanding laser ablated plasmas. When two plasmas collide, the outcome usually lies between two extreme scenarios where the plasma can either completely interpenetrate or decelerate rapidly at the collision front, thereby they can stagnate. In the case of hard stagnation, rapid accumulation of plasma material at the collision front leads to the formation of a dense layer of material between the two plasmas, the so called stagnation layer. Outside these conditions the colliding plasmas undergo interpenetration where the plasma passes through each other without stagnation. The degree of interpenetration is determined by the relative velocity and density of plasmas. Laser produced plasmas finds many applications such as in Laser Induced Breakdown Spectroscopy (LIBS), pulsed laser deposition (PLD), rocket propulsion, EUV lithography, space applications etc.

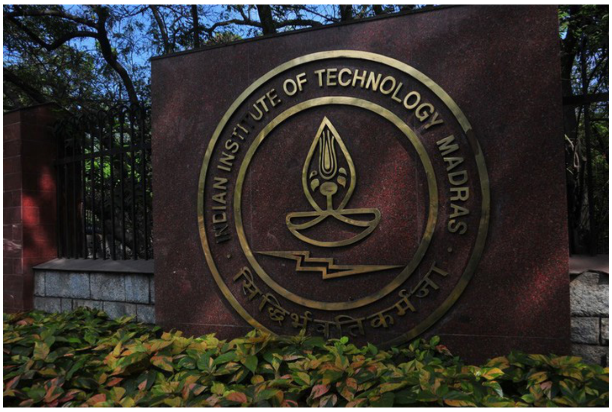
Laser produced plasma experiments are conducted mostly with solid samples followed by liquids and gases. Target samples like metals, semiconductors, and insulators have been studied in various experimental configurations. The study of laser produced plasma in the presence of external magnetic field were triggered with the purpose of trapping plasmas for thermonuclear device applications. Laser produced plasma in the presence of an external magnetic field shows complex hydrodynamic expansion features such as plasma oscillations/bounce, plume confinement, formation of a diamagnetic cavity, plume splitting, formation of lobes, plasma instabilities as well as diffusion across the magnetic field into a non-diamagnetic regime. Due to the underlying complexity involved in the interaction of laser plasma with the applied magnetic field great deal of research towards the theoretical understanding of fundamental physical process and extensive modelling databases and software like FLYCHK, PrismSpect, and ADAS can be used.

Memorandum of Understanding

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

Gothenburg University, Sweden

University de Rennes 1, France



Indian Institute of Technology, Madras

NPS 2020

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 includes seminars by professors from the remier institutes across the country and abroad & oral and poster presentations by researchers. NPS-2020 was conducted from 27 February 2020 to 29 February 2020. The event was inaugurated by the then Vice Chancellor of Cochin University of Science & Technology, Prof. (Dr.) K. N. Madhusoodhanan. Prof. (Dr.) Pramod Gopinath, Director, ISP welcomed the gathering. Prof. M. Krishnamurthy, from TIFR Hyderabad gave an overview on the current trends in photonics and felicitated the event.

A souvenir named "Photonics News" comprehending the activities of the International School of Photonics for the year 2019, articles briefing the developments in several fields in Photonics by the research scholars and faculty members, and the details of NPS-2020, was released by Prof. M. Krishnamurthy by handing it over to the Hon'ble Vice Chancellor. Several merit awards were distributed to students and research scholars for their outstanding contribution to research and academic excellence for the year 2019. The inauguration ceremony was concluded by a vote of thanks delivered by Dr. Praveen C. S. There were 82 registered

participants and 20 of whom were outstation participants. All the research scholars, M. Tech students, Project students, and Integrated M.Sc.(Photonics) students from ISP were also attended and actively participated in discussions of the sessions lead by eminent scientists from different parts of the country. 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. M. Krishnamurthy, TIFR, Hyderabad

Dr. K. N. Narayanan Unni, NIIST, Trivandrum

Dr. Bharath B. Kale, Director, C-MET, Pune

Prof. P Ravindran, Central University of Tamil Nadu, Thiruvarur

Dr. V. K. Praveen, CSIR-NIIST, Trivandrum

Dr. Deepa Venkitesh from IIT, Madras

Dr. Sudheesh Chethil from IIST

INVITED TALKS BY OUR FACULTY MEMBERS

Prof. M Kailasnath

• Micro cavity based Optical Devices- One Week Online Faculty Development Program (FDP) on Photonics, Rajarshi Shahu Mahavidyalaya , Latur, Maharashtra, 7-11-2020

• Current trends in optical sensors - AICTE – ATAL FDP on Recent Trends in Photonics, Model Engineering College, Trikkakara, 20-10-2020

Dr. Saji K J

• "Transparent Electronics", 16 May 2020, Summer School on "Advanced Functional Materials for Energy Harvesting, Storage and Biomedical Applications" organized by the Department of Physics, Bishop Moore College, Mavelikara.

• Triboelectric Nanogenerators for Mechanical Energy Harvesting, 18 Feb 2021, Annual Physics Symposium, St. Teresa's College Ernakulam.

Prof. A. Mujeeb

• Prof. (Dr.) A.Mujeeb as a resource person in the Online Faculty Development Program organized by LBS Institute of Science and Technology for Women, Poojappura, delivered a talk on "Photonics-Technology using Light: Thrust areas of Research and Prospects on 9/11/2020

• Prof. (Dr.) A.Mujeeb as a session chair for "Lasers and Nonlinear Optics", Raman Optronics Webinar Series (ROWS 2020), Virtual International Conference organized by Department of Optoelectronics, University of Kerala on 28/11/2020

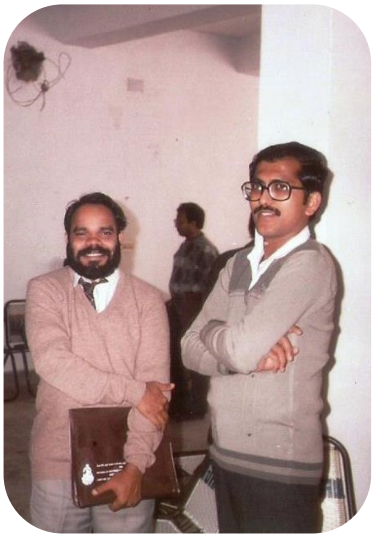
Dr. Priya Rose T

• Dr. Priya Rose, as a resource person in the MEET THE SCIENTIST Program organized by the Post Graduate Department of Chemistry, Vimala College (Autonomous) Thrissur on 9thNovember 2020.

• Invited lecture on "Photonic Bandgap Materials" in ATAL sponsored Faculty Development Program on Recent Trends in Photonics held at Model Engineering College, Thrikkakara on 23/10/2020


FLIR

Cherishing Moments....



INTERNATIONAL SCHOOL OF PHOTONICS

DIRECTORS

Name	From	To
Dr C P GIRIJAVALLABHAN	20.03.1995	20.09.2000
Dr V M NANDAKUMARAN	21.09.2000	31.07.2003
Dr P RADHAKRISHNAN	01.08.2003	31.07.2006
Dr V P N NAMPOORI	01.08.2006	30.04.2010
Dr P RADHAKRISHNAN	01.05.2010	06.06.2012
Dr M KAILASNATH	07.06.2012	24.08.2013
Dr P RADHAKRISHNAN	25.08.2013	30.04.2014
Dr SHEENU THOMAS	01.05.2014	06.10.2014
Dr M KAILASNATH	07.10.2014	25.07.2016
Dr A MUJEEB	25.07.2016	25.07.2019
Dr PRAMOD GOPINATH	25.07.2019	

Email: photonicsdirector@cusat.ac.in
Website: www.photonics.cusat.ac.in

Published by
International School of Photonics
Cochin University of Science and Technology
Cochin - 682022
Kerala, India
Phone: +91-484-2575848