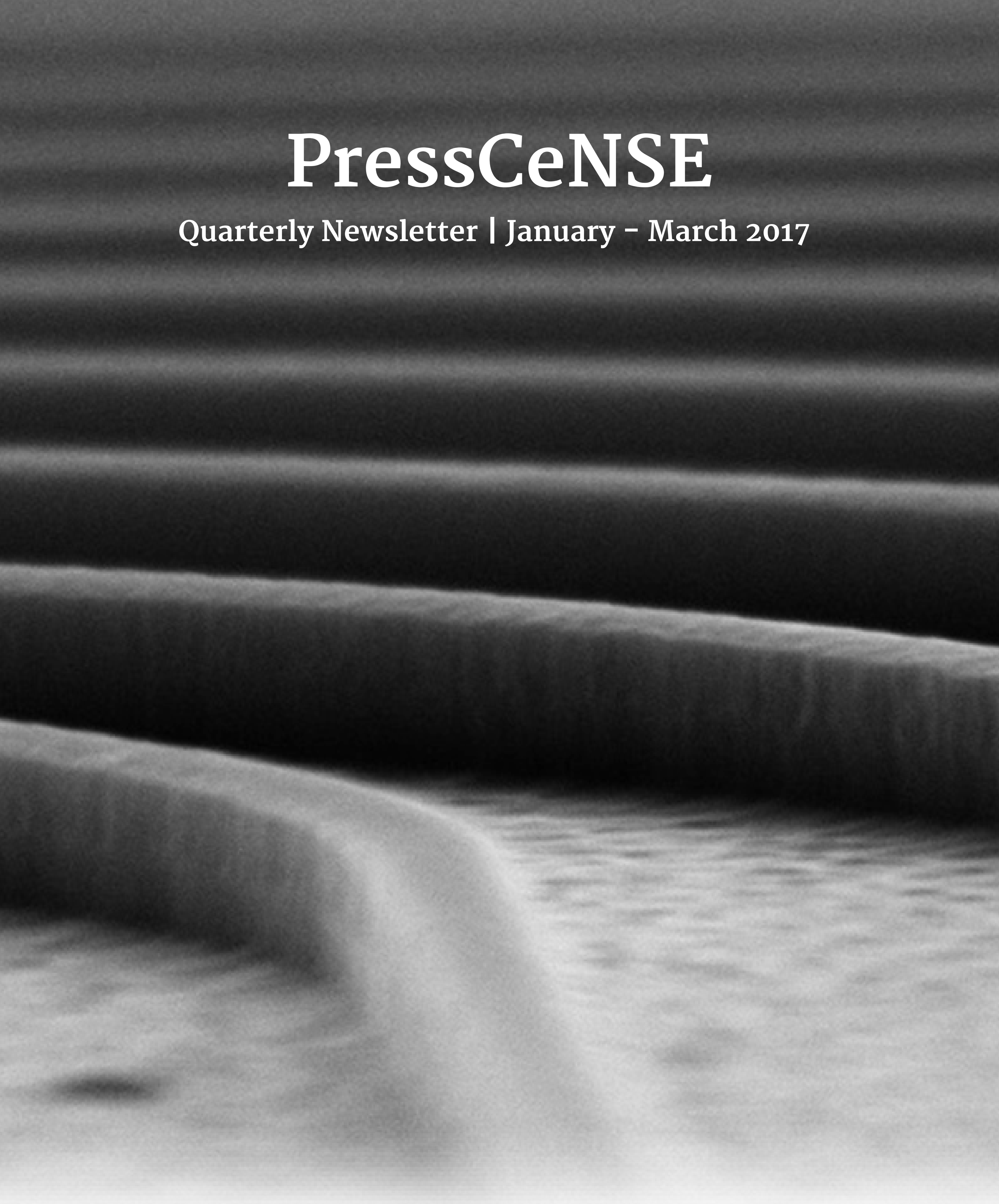
PressCeNSE

Quarterly Newsletter | January - March 2017



Centre for Nano Science and Engineering (CeNSE)

Indian Institute of Science

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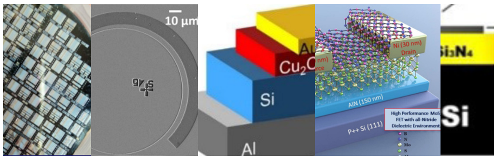

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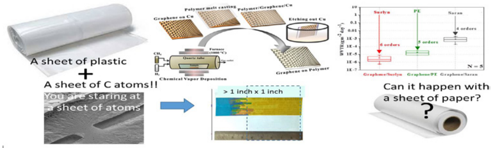

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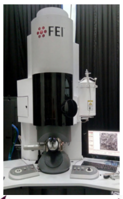

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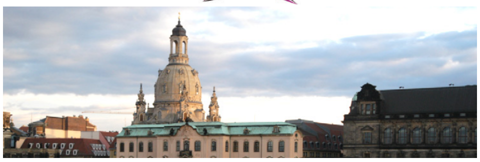


Cover photo: "Silicon Amphitheatre" by Viphretuo Mere

A WORD FROM THE CHAIR

Welcome to the Centre for Nano Science and Engineering (CeNSE) at the Indian Institute of Science. Established in 2010, and formally dedicated to the nation in 2015 by the Prime Minister of India, CeNSE has emerged as a melting pot of different disciplines in science and engineering. The interdisciplinary research in the centre is defining new horizons through scientific discovery and engineering innovation at the nano scale. The National Nanofabrication Centre (NNfC), anchored in CeNSE, is one of the best university foundries in the world. The Micro and Nano Characterization Facility (MNCF) is only one of its kind in an academic setting anywhere in the world. This unmatched physical infrastructure is complemented with the exceptional human capital of the Centre, consisting of faculty, students, technical, administrative, and support staff. The confluence of all these ingredients provides a unique platform to experiment and innovate with nanomaterials and nanodevices, with unprecedented precision. The research and education in the Centre is targeted towards diverse application areas, including electronics, sensors, photonics, defence, space, energy, healthcare, and agriculture. The underlying theme is to create societal impact by translating the academic research into useful products.

Our outreach programs are designed to ensure that the CeNSE family extends beyond its physical confines, thereby creating a larger pool of people and resources. This enables us to achieve our collective vision, as a "team", by leveraging complementary expertise. The Indian Nanoelectronics Users Program (INUP) has spread the awareness of nanotechnology to the remote corners of the country. A strong community of well-trained researchers, more than 2000 in number from about 200 institutions, is now accessible through INUP network. We are also engaged in research collaboration with several universities in India and abroad. The Industry Affiliate membership Program (IAP) bridges the gap between academia and industry through sustained scientific interactions and joint research project execution. Nanotechnology start-up incubation program has already created four start-up companies cofounded by faculty, students, and technical staff of the centre.

The future looks bright and clear. While we march forward to become one of the finest research centres in the world, we are equally determined to touch the lives of every citizen, by focusing on the bottom of the pyramid. We want to bring-in positive change in the society, through the intervention of nano science and engineering. Together, we can realize this dream. Come and join us; be part of this exciting journey...

CeNSE HAS A NEW LOGO!

Inspiration and thought of the designers for the logo: "CeNSE is committed to taking research in Nano Science and Engineering to new frontiers and making this matter known to the world. Our new logo is a visual expression of that commitment and has a dynamic hexagon soaring out of the letter N (symbolizing Nano). Nano particles coalesce to form one upward moving force that represents the power of collaboration, comprehensive strength, and path breaking science. The letter E is designed to indicate the focus on the cutting edge technology pursued in the centre. Pairing of an intense blue with an energetic red lends gravitas to the pioneering efforts of the Centre."

Success story: PathShodh Healthcare

We caught up with Vinay Kumar, one of the co-founders and CEO of PathShodh Healthcare, a medical device research and development company incubated in the Indian Institute of Science (IISc), Bangalore. The company is built on a very strong foundation of innovative research conducted at the Centre for Nano Science and Engineering.

How did it all begin?

At the beginning, we were clear that we would do something about diabetes. And it was going to be on the bio-sensing side of it and not the clinical side. When we think about biosensing as a means for pathology, multiple things can be done – managing the disease through point-of-care testing, or monitoring complications that arise out of diseases, or early detection to avoid complication and to reduce mortality. I first started working on kidney failure- that was the first project, which involved sensing components present in urine. Back then, we weren't planning on incubating a company. The idea was to just develop a sensing chemistry that could be used in an electrochemical framework. After working for a year, I enrolled as a Ph.D. student at CeNSE under Prof. Navakanta Bhat. By mid-2014, we had developed a proof-of-concept device and had applied for a few patents, etc. But even then we didn't have any idea of incubating a company.

When the Biosensors group at CeNSE went for a company visit, I felt that so much more could be done as far as biosensors are concerned. Prof. Navakanta always had a vision of converting innovative research into products that benefit society, which is also something that the Centre has prioritized. With this in mind, we decided not to just pass the technology to a third entity but to incubate our own company so that we have control over all aspects of the product, from design to pricing.

Can you please explain how the device works?

If you go inside a typical pathology lab, you observe that they use biochemical analyzers. These require trained professionals who perform different chemical tests that require large sample volumes and take relatively long durations of time. Point-of-care devices are different. The Glucometer was the first biosensor-based point-of-care device that was widely accepted. Such hand-held devices were very attractive to pathologists and clinicians because they were portable, did not need expert human analysis to analyze the signals and could output results instantly; so, they had clear cost and time advantage to them.

The advent of glucometers started a wave of research that set labs in search of biomarkers. This would enable a reliable and cost-effective way to detect proteins, albumin, urea, etc. in bodily fluids. Over the course of time, the electronics associated with biosensors – essentially electrochemical analyzers – have been miniaturized, along with electronics for data acquisition. The systems were now smaller, but the researchers were essentially working with the same concept – not much innovation had gone into improving the sensing and making the system self-contained. But a biosensor is so much more than just the control electronics. First, we needed a good interface between the electronic system and the human body, which was one of the biggest bottlenecks.

We defined the requirements for the sensor in a way very different from conventional systems in terms of functioning, the required skill set to operate, etc. Our system had to be portable and had to have a low cost per test while also trying to minimize the total cost of the module itself. The basic working of the device is

Vinay Kumar, co-founder and CEO of PathShodh Healthcare, alumnus of CeNSE

through the use of different sensing chemistries that work on different biomarkers, thereby generating electrical signals that are analyzed to get useful data.

How did the device evolve from the lab to the market? What did the first devices look like?

The device in its current form has gone through over 10 iterations. Earlier we used to use a bulky electrochemical setup. Now the same system has been miniaturized to fit in a handheld module. It uses a strip with a printed electrode, which we tried to manufacture. But now we import printed electrodes, which we then functionalize at PathShodh.

How much of a cost benefit are we talking about?

In a clinical lab, every test costs around ₹ 700. People with chronic diseases go through thousands of such tests. Also, these tests tend to take a few days, which varies from lab to lab. So, a one-time investment of about ₹50,000 for a hand-held device is a small cost. The advantage becomes more pronounced when we consider that multiple tests can be performed using a single system. This must be compared with the cost of about ₹300,000 for point-of-care devices which are used for many markers. Of course, there are savings in terms of time because we get results instantly.

How did you go about finding funding for the company? Who are your current funding sources?

The Department of Biotechnology currently funds us. We also have different government/angel funds for manufacturing. We have outsourced the PCB manufacturing and assembly and packaging. Strips come from the US, which are functionalized at PathShodh. We are looking at a large-scale production line. There was always a huge demand for such a device so, when we started talking about our product, there were many people who were interested. In fact, our bottleneck was the speed with which we could make these devices.

Multi-Analite Device manufactured by PathShodh. This instrument is capable of performing tests on multiple analytes.

What's new in research?

GaN Group

Prof. Srinivasan Raghavan, Prof. Digbijoy N. Nath

The demonstration of a power transistor based on Gallium Nitride (GaN) grown on silicon substrate, named iGaN540, has been one of the most remarkable achievements of the GaN team, which includes around eight faculty members and over twelve students, post docs and project staff in a multi-disciplinary research initiative at IISc. The material growth and device design, fabrication and packaging have been accomplished at CeNSE (S. Raghavan, D. Nath, N. Bhat, R. Muralidharan, K. N. Bhat, M. M. Nayak).

GaN-based power transistors, such as iGaN540, are poised to rival conventional silicon transistors for next-generation power electronics in terms of efficiency, heat management, footprint (hence size) and frequency of switching. Systems such as hybrid vehicles, laptop chargers, LED drivers, solar inverters, etc., where power conversion is required, will increasingly benefit from GaN power devices.

In iGaN540, the '540' refers to the fact that, in the ON state, the transistor is supposed to carry 5 Amperes (A) of current at very low drop of 0.1 V whereas, in the OFF state, it should block at least 40 V while allowing a leakage less than 100 µA. The requirement of 5 A of ON current necessitates devices with large peripheries with width running up to 50 mm, leading to challenges in process control and optimization.

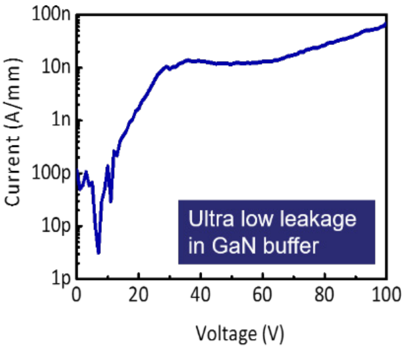
This device has been elusive for over two years primarily due to:

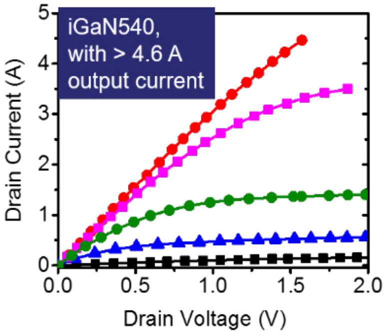
a) difficulties in achieving a superior quality GaN buffer layer, which results in high buffer leakage and

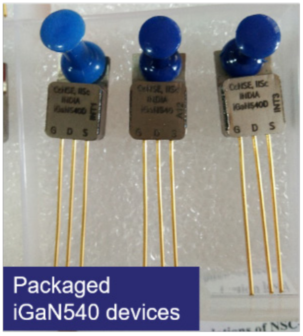
b) challenges in realizing the device, given that it involves a 7-mask/40-step process in a highly complicated fabrication sequence.

After rigorous epitaxy optimization which involved gaining deeper insights into GaN growth, material of excellent quality, which rivals or surpasses the state-of-the-art in terms of low background leakage, is now routinely grown.

On the device front, continual feedback and learning experiences have enabled understanding and controlling several process challenges and bottlenecks which eventually led to the realization of iGaN540.





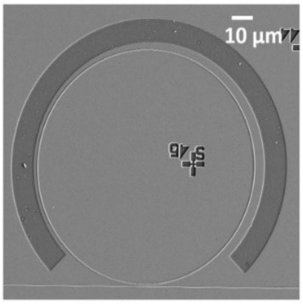


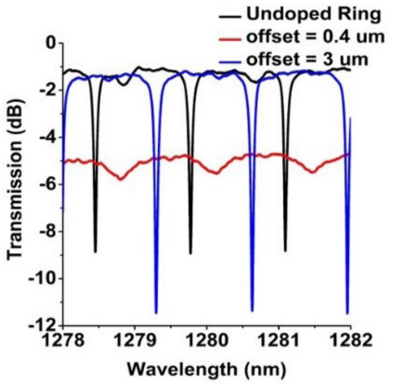
We acknowledge Prof. M. Shrivastava (DESE) and his group for their help with device simulation, reliability and high current measurements and Prof. G. Narayanan and Prof. V. John (EE) who enabled the integration of iGaN540 with power circuits for DC-DC converter.

Photonics Research Lab

Prof. Shankar Kumar Selvaraja

Over the past decade, CMOS-compatible silicon photonics has emerged as a potential candidate to replace copper interconnects with high-bandwidth optical interconnects, particularly in high-performance computing. To realise an optical interconnect, it should have a light source, a detector, wavelength filters, and a light modulator. Among these, the modulator is the key component that determines the data rate of the interconnect channel. In silicon, light modulation is achieved by the plasma dispersion effect, using p-n or p-i-n diode. To create the active junctions, implantation is typically used. In our work, we have explored thermal diffusion to realise such a modulator. Using a legacy process, we have achieved a figure-of-merit similar to the implantation process: $V_\pi.L_\pi$ of 0.325 V.cm. Furthermore, in a first, we have used an optical device to measure the lateral diffusion length of the dopants in silicon. We have reported a lateral diffuson length of 1600nm at a drive-in temperature of 1100 °C.

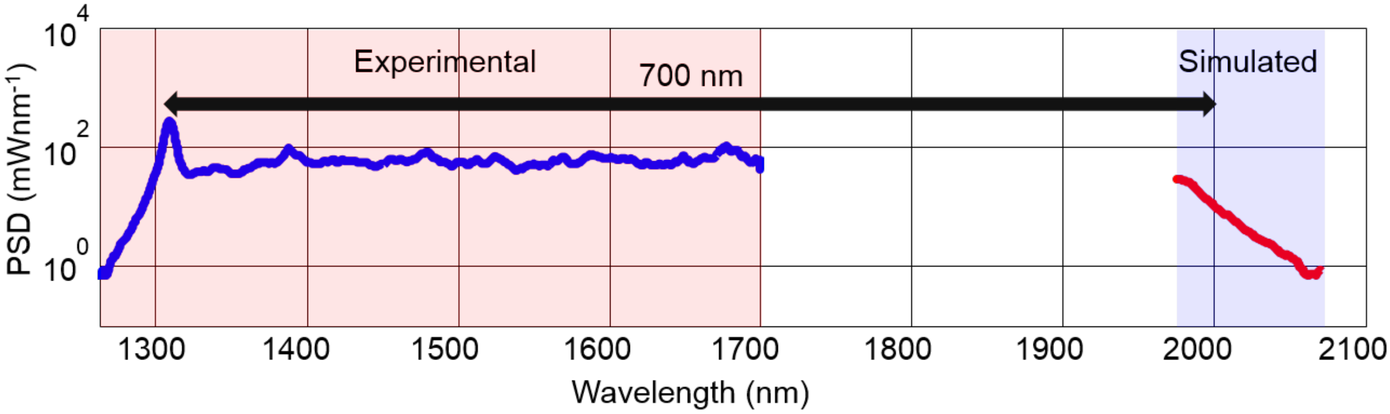




Nonlinear Photonics and High Power Lasers Group

Prof. V.R. Supradeepa

The requirement for laser sources varies substantially with applications, depending on the desired wavelength of operation and spectral emission properties. In our group, we have developed a simple, cost-effective, continuous wave supercontinuum laser that spans from 900 nm to 2500 nm by providing substantial spectral density throughout the wavelength range (minimum of several mW/nm). By performing optical signal processing using gratings and optical filters, any arbitrary wavelength output can be obtained from this laser source. We have achieved this goal by using conventional silica fibers, which are very cheap and easy to manufacture. The most difficult challenge in building the supercontinuum laser was to have an appropriate pump source at high power. With our expertise in the Raman laser technology, we have developed novel and efficient high-power laser sources that can meet our requirements for pumping the supercontinuum. This single laser platform can single handedly address diverse applications, such as tissue imaging at 900 nm, or free space communications at 1500 nm, or chemical sensing/detection beyond 2000 nm.

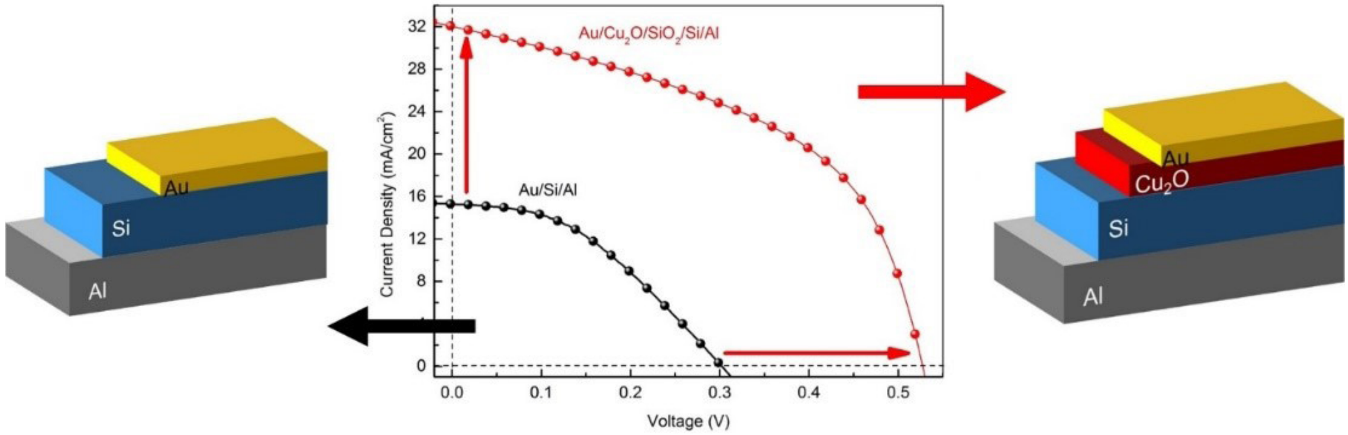


(Note: The spectrum is shown only up to 1700 nm because of the limit of our detection instruments. However, based on numerical simulations, the spectrum is expected to extend beyond 2000 nm.)

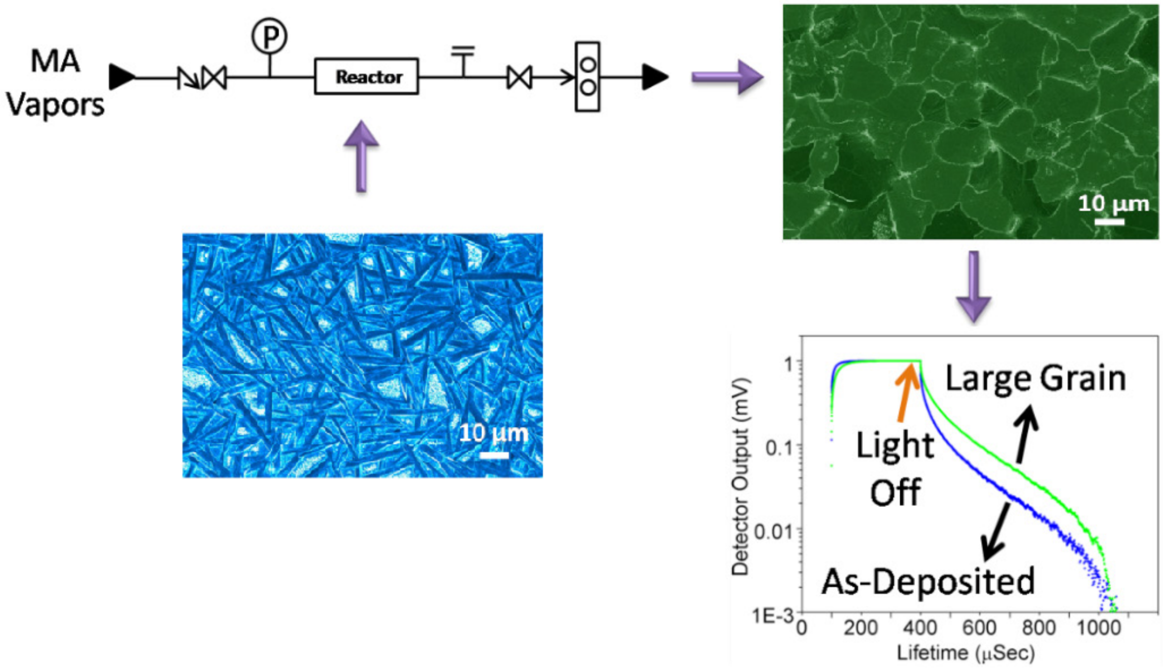
Heterojunction Lab

Prof. Sushobhan Avasthi

The lab has recently demonstrated that copper oxide (Cu_2O) can be used as an effective hole-selective contact for silicon solar cells. This is one of the very few p-type metal oxides with an appropriate band-alignment with silicon, which allows it to function as a hole-selective contact. While NiO-based hole-selective contacts have been reported, the highest open circuit voltage is only 328 mV and the corresponding value for Cu_2O based cells is only about 320 mV. A passivating tunnel oxide layer improves the interface quality by bringing down the number of recombination centres, which enabled us to achieve a high open-circuit voltage, which is a record for this class of devices.



In addition, we have successfully demonstrated a novel vapor-annealing method to consistently and reliably obtain high-quality perovskite ($CH_3NH_3PbI_3$) thin-films with large grains. Under optimized conditions, the annealing process yields films with >10 µm grains, and carrier recombination lifetime of up to 50 µs. This is one of the highest values of recombination lifetime ever reported for a perovskite thin-film. This increase in carrier lifetime substantially improves average current density (J_{sc}) and open-circuit voltage (V_{oc}) in large grain perovskite-based devices vis-à-vis small grains (as-deposited).

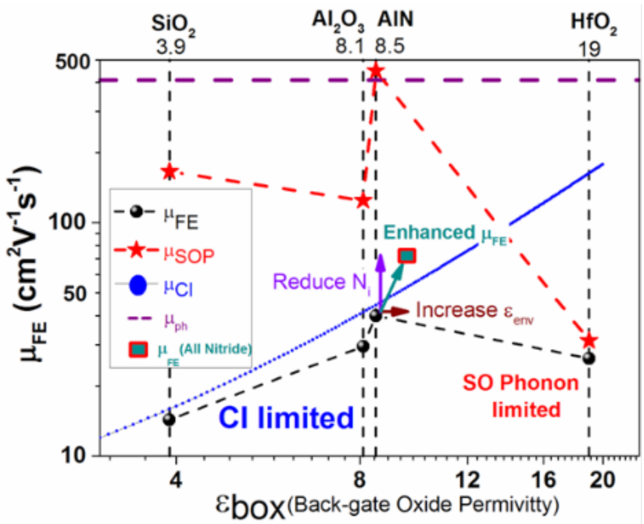


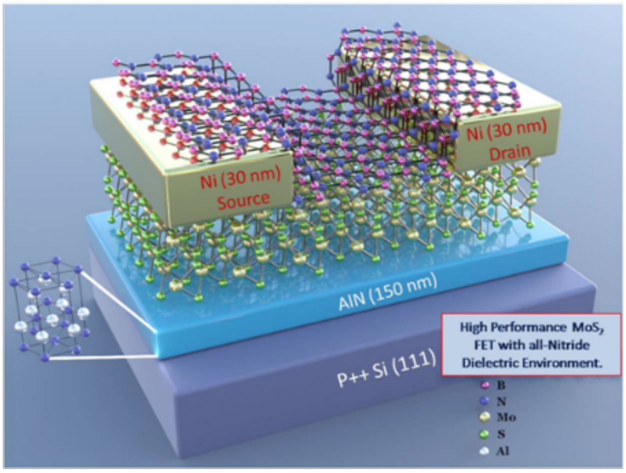
Nano-Devices and Sensors lab

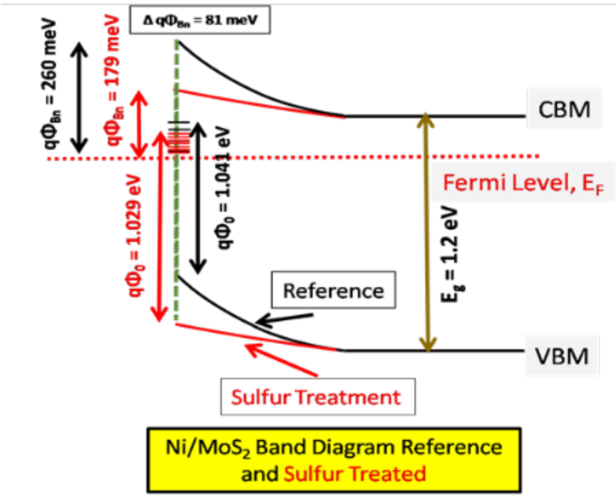
Prof. Navakanta Bhat

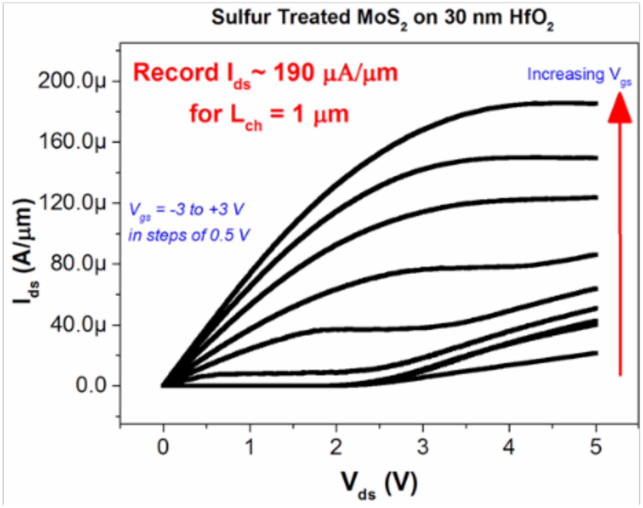
With dimensional scaling encountering fundamental limits with traditional silicon-based MOSFET technology, exploring new materials and device architectures has become crucial to sustaining the demands of the semiconductor industry. A new class of two-dimensional (2D) semiconductors, such as Transition Metal Dichalcogenides, which are just one atomic layer-thick (or thin!), provides excellent electrostatic control, enabling transistor channel lengths in the order of a few nanometers. Using the state-of-the-art cleanroom and characterization facilities at CeNSE, we aim to overcome some of the fundamental hurdles in realizing high-performance 2D nano-transistors.

Due to their ultra-thin nature, charge transport in 2D semiconductors is heavily influenced by the surrounding dielectric environment. Through experimental data from devices fabricated on several substrates, coupled with extensive semi-classical modelling, we propose nitride-based environments as optimum candidates for gate and encapsulation dielectrics. As a result, high performance transistors with an all-nitride dielectric environment have been demonstrated on one of the promising 2D semiconductors, molybdenum disulfide (MoS_2). Furthermore, we have solved the large variability and poor nature at the metal/MoS_2 contact interface by employing a facile sulfur treatment technique, yielding record drive currents at 1 µm channel length, when supplemented with hafnia (HfO_2), a CMOS-compatible high- gate dielectric. Our current research is focused on leveraging the combined device and materials expertise to develop ultra-low power, highly scaled 2D FETs.





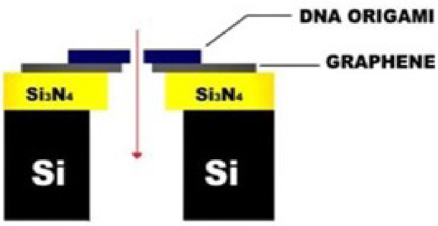




CoSMoS Group

Prof. Manoj M. Varma

Reliable, cost-effective, and fast DNA sequencing is the dream of our group. Nanopores are proving to be powerful tools for detection and identification of molecules. Here, a single DNA is threaded through a nanoscale pore in a membrane by applying electric field, thereby changing the ionic current. This could give information about the individual bases. The use of graphene as a material for solid-state nanopore sensing is being explored.



Scaffolded DNA origami is also a novel and unique technique to fabricate tailor-made nanostructures with a wide range of applications. The major advantage of DNA origami is the accurate control over the shape of the structure at the nanometer level. This is achieved by the ability to program DNA base pair interactions.

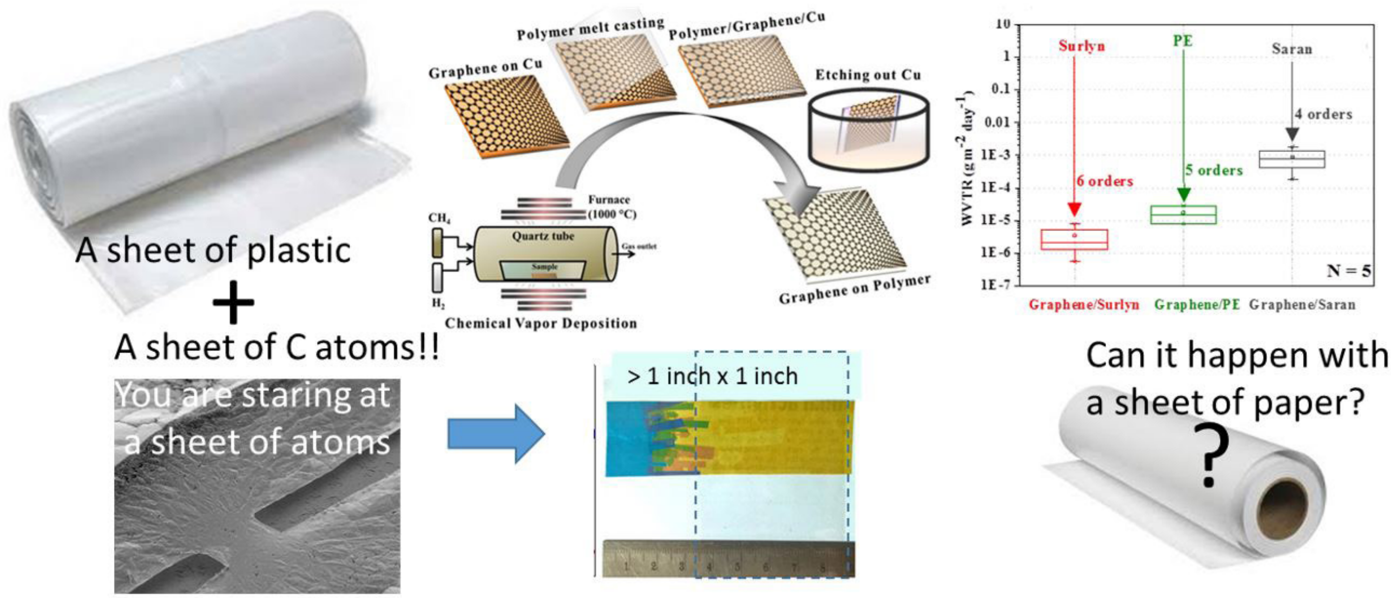
The specific interactions between programed nanopores of DNA origami and the translocating DNA strand might cause different residence times and ionic currents, based on various guest interactions. Graphene, on the other hand, with its atomic thinness, will be helpful in measuring the blockage currents due to single molecules. This hybrid nanopore will be helpful in single molecule detection and can have other biomolecule sensing applications, too.

Visitors to CeNSE

In August 2016, the Parliamentary Committee for Science and Technology visited CeNSE. The Committee of over 15 MPs was headed by **Mrs. Renuka Chowdhury**, a Rajya Sabha MP and a former Minister of State for Women and Child Development. The Committee serves the important function of monitoring the status of research and technology development in universities and making recommendations to the relevant ministries to be implemented in subsequent years. In addition to taking the MPs on a tour of the nanofabrication and the characterization facilities, several demos were put together for them in the cleanroom corridor showcasing recent research and technology developments at CeNSE. The response from the committee was overwhelmingly positive and the MPs asked the Centre to keep up the high level of work and to continue doing great things! Following their visit, at the lobby, CeNSE turned the tables on the MPs and "tested" them. A demo from PathShodh was setup and a quick screening of some diabetes markers was carried out on Mrs. Chowdhury and a few other MPs. A clean bill of health further sweetened (no pun intended) their visit to CeNSE.

Parliamentary Committee for Science and Technology visits CeNSE

GRAPHENE FOR FOOD PACKAGING



Plastics are supposed to be waterproof. However, for those working on organic electronics, the average plastic or polymers are not waterproof enough. The complicated composite packaging in which mango juices are packaged (Tetrapak) has a water vapor permeation rate of 0.0001 g/m² per day. Just the plastic alone in that composite, however, lets water through at a much higher rate of 1 g/m² per day. At this rate, the packaging used today for chips and juice would just not be sufficiently waterproof for electronics: it needs to be a million times lower in water vapor permeation.

A group of scientists at IISc have managed to develop exactly such packaging material. It is a novel moisture-impermeable polymer using the wonder material graphene. The new organic polymer is expected to address the challenge of permeation of atmospheric water vapor into flexible organic electronic devices, thereby increasing their active lifetime and improving performance. An interdisciplinary approach involving the groups of Prof. Srinivasan Raghavan from the Centre for Nano Science and Engineering and Prof. Praveen C. Ramamurthy from the Department of Materials Engineering resulted in the development of these materials, by combining experimental and molecular modeling approaches.

Organic electronics concerns the design, synthesis, characterization, and application of small organic molecules or polymers that show desirable electronic properties, such as conductivity and flexibility. Organic electronics is energy-efficient and eco-friendly, and easier to manufacture than the inorganic silicon counterparts. Scientists world over have already been developing devices like LEDs for displays, photovoltaic cells, transistors, and much more. A new flexible smartphone from Samsung, made from organic LEDs, is expected to be in the market very soon.

A major concern in the field of flexible organic electronics is the potential harm atmospheric moisture can cause to these devices. The development of moisture-impermeable polymer films that are simultaneously transparent and flexible is a crucial packaging requirement for such devices. To ensure at least a year of continuous operation, the packaging film should allow permeation of no more than 1 microgram of water vapor for every square meter of the film in a single day. Currently available polymer films fail drastically in this respect and are unsuitable for packaging organic electronics. Techniques available today to prevent moisture permeability require the deposition of inorganic oxide layers between polymer films, thus reducing its transparency and flexibility. Developing a flexible, transparent and moisture impermeable material has been the need of the hour.

Now, scientists at IISc have addressed this challenge and developed a flexible, transparent and moisture-impermeable polymer by embedding a monolayer of graphene in a Surlyn film. Graphene is an allotrope of carbon with a honeycomb lattice structure and used in semiconductor and electronics industry. One key step is to obtain a uniform graphene monolayer over large-area copper foils, which was done by chemical vapor deposition in Prof. Raghavan's lab. Then polymers were melt-casted on the graphene/copper foil substrates and the copper foils were etched away, thus obtaining the polymer/graphene composite films in Prof. Ramamurthy's lab. The research team believes that this 'direct-transfer' method can be easily scaled up while greatly reducing mechanical damage to the graphene layers.

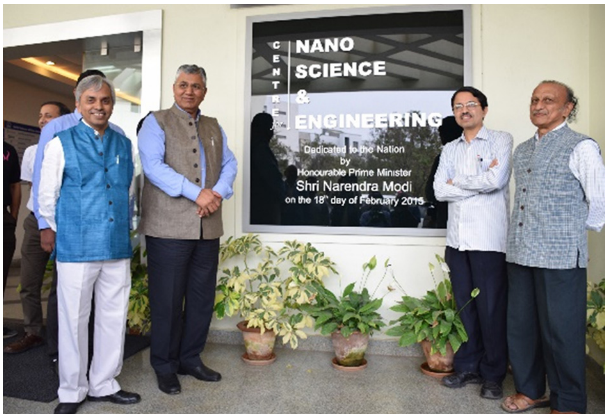
With the new polymer composite, the researchers were able to obtain large-area composite films with almost negligible water permeation. "From molecular modeling studies, we established that a graphene monolayer on the polymer would be impervious to water due to the high energy required by the water molecules to overcome the potential field of the membrane. We found that this would result in a million-fold lower moisture impermeability than 'neat' polymer films", says Prof. Ramamurthy.

The researchers performed transparency and flexibility tests on the new graphene/polymer composite films and found that they were almost as transparent as other available polymer films. The addition of the graphene monolayers did not compromise the flexibility of the polymer films. The team also demonstrated the ability of the films to protect encapsulated devices like organic photovoltaic (OPV) devices and tested for their power conversion efficiencies (PCE). It was found that the OPV devices encapsulated with the graphene/Surlyn films retained 50% of their efficiency after 1000 minutes, in comparison with their non-encapsulated counterpart. The studies suggested that the devices packed with the composite films would have ambient operating lifetimes of almost 1 million minutes (almost 1.9 years) – highly desirable for most organic devices. The stress tests on the encapsulated OPV devices also did not affect their performance, indicating the robust nature of the packaging films.

Prof. Srinivasan Raghavan, the co-inventor, believes that, if paper could be made impermeable by forming a composite with graphene, we could rid the world of the evils of plastic packaging. He feels that, if realized, it could be an invention that parallels the invention of plastics themselves, at least as far as packaging goes.

Visitors to CeNSE

In January 2017, CeNSE had the privilege of a visit by Shri PP Choudhary, Union Minister of State, Ministry of Electronics and Information Technology and Ministry of Law and Social Justice. After a tour of the facilities and demos, a lunch was organized for the minister and his team in the outdoor section of the 2nd floor. Shri Choudhary then gave a talk at the Workshop organized in CeNSE, Women in Science and Engineering (WiSE). He was very pleased with what he saw at CeNSE and praised the Centre for being exceptional in the kind of things being done. Before he left, he expressed his desire to visit CeNSE again to spend more time at the Centre and learn about the R&D efforts in greater detail. Though this has not happened yet due to scheduling difficulties, the Centre looks forward to the honourable minister's visit again.



Union Minister Shri P.P. Choudhary visits CeNSE

Annual Student Symposium 2017

CeNSE organized its 5th annual student research symposium on the 3rd and 4th of February, 2017. The main objective of the two-day event was to bring together young researchers working in nanoscience and technology for a mutual exchange of ideas, and to facilitate interaction among the student researchers, faculty members, and industry affiliate members.

Prof. Navakanta Bhat, Chair, CeNSE, welcomed the audience and noted that the motivation behind the Symposium is to provide students with an opportunity to showcase their research work over the past year, and to bridge the gap between student researchers and industry professionals so as to complement each other in tackling complex problems through cutting-edge research and the technologies emerging from nanoscience and engineering.

The event was inaugurated by eminent scientist, Padma Vibhushan **Dr. V. K. Aatre**, who also released the Symposium handbook. Dr. Aatre, who has served as the chief of the Defence Research and Development Organisation (DRDO), and also as Scientific Advisor to the Defence Minister, shared his vision of making India a knowledge power, with science and technology driving progress.He highlighted the importance of three 'I's towards realizing this vision: **I**nvent, **I**nnovate and **I**ndustrialize, and emphasized the need for building well equipped academic institutions that have the power to steer this technological drive.

Dr. V.K. Aatre addressing the students and releasing the symposium handbook

By sharing his experiences, he urged the young researchers to come back to academia and contribute not only to research and development, but also to policy making at the national level. Setting the tone for the event, Dr. Aatre stressed upon the importance of academia-industry interaction in building a technologically advanced India.

Of the 60 abstracts submitted by the research scholars, 15 were chosen for oral presentation and the remaining for poster presentation. Students presenting posters were given an opportunity to pitch for their posters through a 2-min **pitch talk**. The sessions in the two-day symposium comprised of presentations by scholars, interspersed with talks by the Industry Affiliate members. Expert speakers from Phillips, Larsen & Toubro Technology Services, Lam Research, Centum Electronics, ASM Technologies, Analog Devices and Bharat Electronics Limited highlighted the relevance of research-industry knowledge transfer and the opportunities available for research students to work in collaboration with them. The event also served as a platform for an active interaction between the research scholars and members from the industry affiliates, thus opening new avenues for collaborative work.

A total of nine awards were presented in three categories: research excellence (best oral presentation), best poster presentation, and best pitch talk. **Research Excellence Award** was given to Vadivukkarasi Jeyaselvan, Shashwat Rathkanthiwar, Pramod R. and Hreedish Kakoty.

Vadivukkarasi Jeyaselvan, working with Prof. S.K. Selvaraja, presented her work on the application of micro-ring resonators in measuring lateral diffusion length of dopants in silicon. Her work can aid in accurate definition of dopant boundaries, which is essential to any effective electro-optic design. Shashwat Rathkanthiwar, who works with Prof. Srinivasan Raghavan and Prof. Digbijoy Nath, spoke about the record-high responsivity achieved in III-nitrides-based photodetectors operating in the deep-ultraviolet regime. The work provides significant insights into the correlation between crystal quality and device performance. Pramod Ravindra, a student with Prof. Sushobhan Avasthi, presented his work on the use of copper oxide as a hole-selective contact for silicon solar cells. Metal-oxide thin films are stable and can be deposited at low temperature using simple and scalable processes, thus making them viable. Hreedish Kakoty, working with Prof. Ambarish Ghosh, was recognized for his work on the role of entropy in self-purification of colloidal clusters in an optical trap.

Shubhadeep Bhattacharjee, Anisha Kalra and Pallavi Dasgupta shared the award in the Best Poster category. Shubhadeep, of Prof. Navakanta Bhat's group, presented his work on the utilization of nitride-based environments, rather than conventional oxide-based dielectrics, for realizing high-performance FETs. Anisha, working with Prof. Digbijoy Nath and Prof. Srinivasan Raghavan, presented her poster on carrier transport mechanisms responsible for leakage across Schottky contacts made to heteroepitaxially grown Al-rich AlGaN. Pallavi, who works with Prof. Navakanta Bhat, discussed in her poster the development of a biosensor for detecting Serum Creatinine, which can aid in providing an early signature of Chronic Kidney Disease. A new category was introduced this year to recognize well-presented pitch talks and Parmeshwar Prasad, Rahul Singh and Santosh Aparanji shared the Award in this category.

A Photography Competition was organised by CeNSE in which submissions could be made under two major categories: Technical and In and Around CeNSE. Viphretuo Mere's image of a "Silicon Amphitheatre" and Neha Somalwar's beautiful capture of the "cafeteria terrace" were chosen the best images under the two categories, respectively.

The event culminated with an address by the CeNSE Chair and an interactive feedback session between faculty members and students. Prof. Bhat informed the gathering that CeNSE will have its own incubation center in a few months, which can serve as the backbone for nucleating nanotechnology-based start-ups. Prof. Vasu suggested an intriguing idea for next year's student symposium: the formation of teams with researchers at CeNSE and management students from IIM-Bangalore, an amalgamation of tech and management, aimed at the incubation of new ideas.

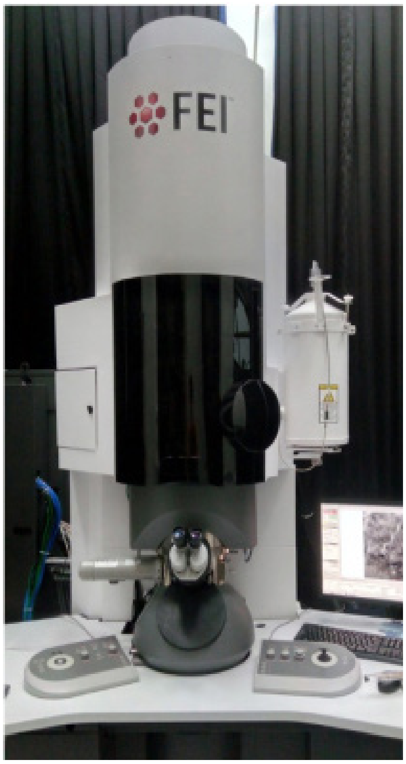
Highlights of the CeNSE Annual Symposium

Transmission Electron Microscope (TEM)

The Micro and Nano Characterization Facility (MNCF) is a centralized facility for the characterization of Micro and Nano devices. The MNCF is a 5000 sq. ft. precision-controlled environment housing four distinct laboratories for Electrical, Mechanical, Optical, and Material Characterization. This national facility boasts a wide range of high-end equipment, rarely found under a single roof, catering to the multiple disciplines of nano science and engineering. The mission of MNCF is to support research and educational objectives of researchers at IISc and other academic and research institutions, Indian Nanoelectronics Users Programme (INUP) participants, Industries and National Laboratories.

In this article, we introduce the new, advanced transmission electron microscope (TEM – FEI TITAN Themis), as part of MNCF's material characterization suite. The Titan Themis was installed and commissioned in November, 2016. It was opened to IISc and INUP users in January, 2017. Beginning April, 2017, samples from industry and national laboratories will also be accepted.

The FEI Titan Themis S/TEM is one of the most advanced electron microscopy platforms today, capable of imaging and spectroscopy at the atomic level. The FEI Titan Themis 80-300 is an ultra-high-resolution transmission electron microscope enabling chemical and structural investigation of complex materials in the nanometric (billionths of a meter and less!) regime. The resolution of the Titan Themis is 1 Å in the TEM and STEM modes.



TITAN Themis TEM housed in MNCF, CeNSE

Features of TITAN Themis :

•Operates with the Ultra-bright XFEG gun.

•Voltage tunable from 60-300 kV, suitable for beam-sensitive samples.

•4K x 4K CMOS camera for fast and large-area imaging.

•Operates in the transmission electron microscopy (TEM) and scanning transmission electron microscopy (STEM) modes.

•HAADF (High-angle annular dark-field imaging) and triple Dark field (DF) / Bright Field (BF) detectors for simultaneous imaging in the STEM mode.

•Super-X quad EDS detector for super-fast elemental analysis (meaning that four EDS detectors are placed to work simultaneously for faster elemental analysis).

•Energy resolution: ≤ 136 eV for Mn-K and 10 kcps (output) and ≤ 140 eV for Mn-K and 100 kcps (output).

•The new piezo stage allows for movements as fine as 20 pm (x, y, and z) for centering the feature of interest in the field of view.

•Equipped with single-tilt and double-tilt specimen holders.

All this delivers a highly flexible and stable platform to routinely extract chemical and spatial information at the atomic level from complex materials.

How to access the TEM for your analysis:

All IISc users can register with the Facility Online Manager (FOM) to book and use the TEM. External users from the academia and industry can contact us through mail : abi@cense.iisc.ernet.in for information.

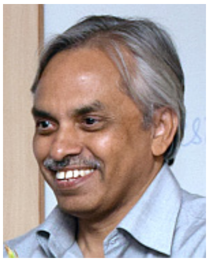
Women In Science and Engineering (2017)

A two-day National Workshop, WiSE 2017, was organized by the student chapters of IEEE Nanotechnology Council and Sensors Council on 12th & 13th January, 2017 at CeNSE. The event drew participation from 80 women scientists, academicians, corporate professionals and students. The two-day event comprised some very informative talks on a multitude of subjects, all delivered by women eminent in their respective professions, and followed by panel discussions. The event also featured a tour of the state-of-the-art, world-class cleanroom facilities at CeNSE, and a "pitch competition" in which prospective women entrepreneurs presented their ideas before a jury and won prizes. WiSE 2017 concluded with a panel discussion on Leadership & Skill Development.

The Chair of CeNSE and faculty advisor to the IEEE NC-SC Student chapter, Prof. Navakanta Bhat, welcomed the participants and stated emphatically that CeNSE had adopted the gender-neutral designation of "Chairperson" instead of "Chairman". He highlighted how important it is to have women in leadership roles and that people like Prof. Mildred Dresselhaus from MIT, who is the only woman recipient of the IEEE Medal of Honor, are helping the cause. He stated further that CeNSE already has women comprising a third of its student strength and is seeking female faculty members actively.

Shri. P. P. Chaudhary, the honorable Union Minister of State, Ministry of Law and Justice and Ministry of Electronics and Information Technology, kindly graced the event. He expressed his happiness at the extraordinary quality of research at CeNSE and underscored the importance of having women in all roles of society, especially science and engineering. "The time has come for us to embrace technology. The youth of this country have the capability to do great things, and I and my ministry promise to provide full support to the youngsters", concluded the honourable Minister with an optimistic message to the young scholars and researchers gathered.

Prof. Jayant Modak, Deputy Director, IISc, addressed the attendees and gave an overview of IISc and spelt out what lies ahead for the Institute. "In today's age of digital platforms, we have realized that the old method of research, where the faculty members sits in their individual labs and tries to finish research by themselves, is not sufficient. We have thus set up various interdisciplinary centres like the Robert Bosch Centre for Cyber Physical Systems and Interdisciplinary Centre for Water Research. CeNSE is an excellent example of such an interdisciplinary space for researchers to come together and collaborate", remarked Prof. Modak.



Prof. Rudra Pratap, the founding chair of CeNSE, appreciated the culture at CeNSE, highlighting the fact that the ratio of women to men at CeNSE is higher than in most educational institutions and that all women students at CeNSE are amazingly capable and, hence, they need not compete with anybody but rather believe in their own identity.

Prof E. Shankaran, Senior Member, IEEE Bangalore Section, was very happy to see a WiSE Workshop being conducted in India. He noted how WiSE had started in the USA and has now spread to developing countries where it is imperative that large scale efforts be invested in promoting women in science and engineering.


Dr. Savitha and Dr. Deepalakshmi, senior technical managers at CeNSE, presented the capabilities of the fabrication and characterization facilities at CeNSE (the NNfC and the MNCF, respectively) and noted that women comprise 50% of the technical staff in-charge of both these facilities.


WiSE-2017 hosted eight talks by eminent women professionals from different walks of life

Ms. Supria Dhandha, Senior Director HR, San Disk India, delineated the mantras for success at different levels of the corporate ladder - the entry, middle and senior levels. She noted that women have as much capability for success as men but limit themselves because of lack of confidence, and that women must be a part of decision-making at all levels. She quoted - “Lead by rule is passé, lead by influence is the new leadership”. Communication skills and a good dressing sense go a long way towards success in all spheres of life - she backed these pearls of wisdom with her life experiences. Mrs. Pamela, Vice President, Cloud Computing Innovation Council of India, highlighted that success starts with self at home and then at profession, and spoke about how being a mother made her understand the need for inner strength to take pride in what one does, and the need for women to speak up and venture out of their comfort zone. She also talked about the Cloud Computing industry and the importance of being passionate about work - backed by her personal life experiences.


Mrs. N. Valarmathi, Programme Director of MWRS, ISRO, took the audience on a starry voyage, as she detailed the space program of ISRO and humorously said that satellites are like her friends. She pointed out that ISRO offers an equal opportunity work environment – one of the reasons many women lead space missions. Mrs. Aruna M. Katara, President of I^{2}IT Pune, delivered a very informative talk on the skills women require to shine in STEM (Science, Technology, Engineering, & Mathematics) fields. She started with a history of women in STEM, and went on to describe the journeys of present-day role models. She concluded with a brief on the variety of opportunities available to women today in STEM fields.


Dr. Y.V.S. Lakshmi, Head-IPR & Marketing, C-DOT Bangalore, delivered a talk titled “Innovation and Inventions in Telecom”, in which she highlighted the work of C-DOT, namely Shared GSM SG-RAN, Gigabit Passive Optical Network, and C-DOT WiFi terminals for last-mile connectivity. Mrs. Sandhya Thyagarajan, GM-Ops-SEBU at Centum Electronics focused on women in manufacturing operations. She began with an introduction to Centum Electronics and noted that Centum employs 540 women. She highlighted the importance of women in manufacturing and talked about her personal journey in this exciting field.

Mrs. T.K. Anuradha, Programme Director of GEOSAT, ISRO delivered an exciting talk on the multi-faceted space programs of ISRO, and highlighted the achievements of the indigenous organization, particularly the Chandrayaan-I and the Mars Orbiter missions. The focus was on satellite-based communication and its applications.

Hans-Georg Braun, Associate Professor, Leibniz Institute of Polymer Research and a Visiting Faculty Member, CeNSE, highlighted the gender imbalance prevailing in the education system and spoke about gender equality laws in Germany.

An interactive panel discussion titled "Towards Entrepreneurship" concluded the first day of WiSE 2017. It was one of the most interesting and fruitful parts of the event, in which two women entrepreneurs (Dr. Neha Satak, CEO, Astrome Technologies and Ms. Uma Reddy, CEO, Hi-Tech Magnetics) shared their views, along with Mrs. N. Valarmathi. The discussion was moderated by Prof. Rudra Pratap.

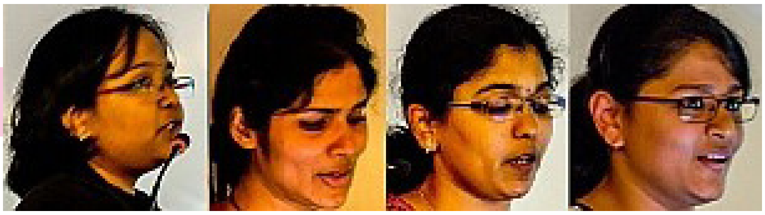
Another highlight of WiSE 2017 was the second panel discussion titled "Leadership and Skill Development" and it aptly featured Ms. Supria Dhandha, Mrs. Renu Rajni (VP at Capegemini) and Mrs. Sandhya Thyagarajan. Prof. Rudra Pratap was the moderator. Delegates actively participated in the discussion.

"Research at CeNSE by women students" was a much awaited feature that had 11 female students describing research at CeNSE - both their own work and the work progressing at their respective labs. They broadly covered research in the areas of bio-sensors, gas sensors, microfluidics, MEMS, NEMS, 3D integration, optical interconnects, high power LASERs, and GaN devices. Their presentations showcased the phenomenal inter-disciplinary nature of work at CeNSE and the outstanding contribution of women students to it.

A pitch competition was conducted to bring forth the budding entrepreneur in the audience, and two interesting ideas were presented by their innovators to the jury - one on taking science to rural areas and schools, and the other on remote health monitoring.

Last but not the least, WiSE provided the opportunity to participants to visit the state-of-the-art facilities at CeNSE. A tour of the MNCF and NNfC (Micro Nano Characterization Facility and the National Nano Fabrication Centre) was conducted for the participants, who were delighted to see the one-of-its-kind, world class facility in India.

The participants applauded WiSE 2017 and found the two-day event refreshing and inspiring. The delegates were impressed by the highly successful research at CeNSE and were delighted to have a first-hand experience of it.



THE DRESDEN CONCEPT AND PERSPECTIVES FOR FUTURE COLLABORATION

Prof Hans-Georg Braun

Dresden is a medium-sized (540,000 population) city in Germany. It is located in the eastern part, almost midway between Berlin (200 km) and Prague (140 km). For scientists, it is for sure a place to take note of, as the city has the largest density of researchers and research institutes in Germany. Dresden has successfully transformed itself into an internationally recognized hub, both in the life sciences and in the engineering and materials sciences.

After reunification of West and East Germany in 1992, research efforts in the country were completely reorganized, and the basic idea of establishing a strong research focus at the interface of life sciences and materials sciences became a guideline. Twelve research institutions belonging to the four governmental scientific societies in Germany, namely, Max-Planck (3), Leibniz (3), Fraunhofer (5) and Helmoltz, have been established in Dresden which, together with the Technical University Dresden (TUD), constitute a loose but effective organizational concept of cooperation – The Dresden Concept. Based on this interaction and the resulting joint initiatives between the institutes and TUD, the TUD succeeded in the so-called Excellence Initiative of German higher education entities. In 2006, TUD received the Excellent University Award in a highly competitive process among German universities. Research in these institutions is focused on three priority areas:

• Microelectronics, Information, and Communication Technology
• New Materials, Nanotechnology, and Energy Research
• Biotechnology and Life Sciences

The strength of the effort in life and materials sciences is mainly due to the fact that each institute contributes to research at this interface, even if the main focus of an institute is either hardcore life sciences (Max Planck Institute of Molecular Cell Biology and Genetics) or materials sciences (IPF or IFW).

A number of common research interests between the Centre for Nano Science and Engineering (CeNSE) and the research institutes cooperating within the Dresden Concept can be recognized, and will be discussed in a joint workshop planned in Dresden in the near future. In a long-term perspective, institutional cooperation within a common area of interest can follow different programs which could include funding by DFG (German Forschungsgemeinschaft) which keeps its focus on high-level fundamental research. International initiatives can focus on joint PhD research and training groups, both of which combine a set of bilateral research projects embedded in a PhD training program.

Other options involving individual researchers can include funding for PhD students to conduct research within a joint German / Indian research project, in a so-called "Sandwich PhD thesis", which would be completed and evaluated by the Indian Institute of Science.

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