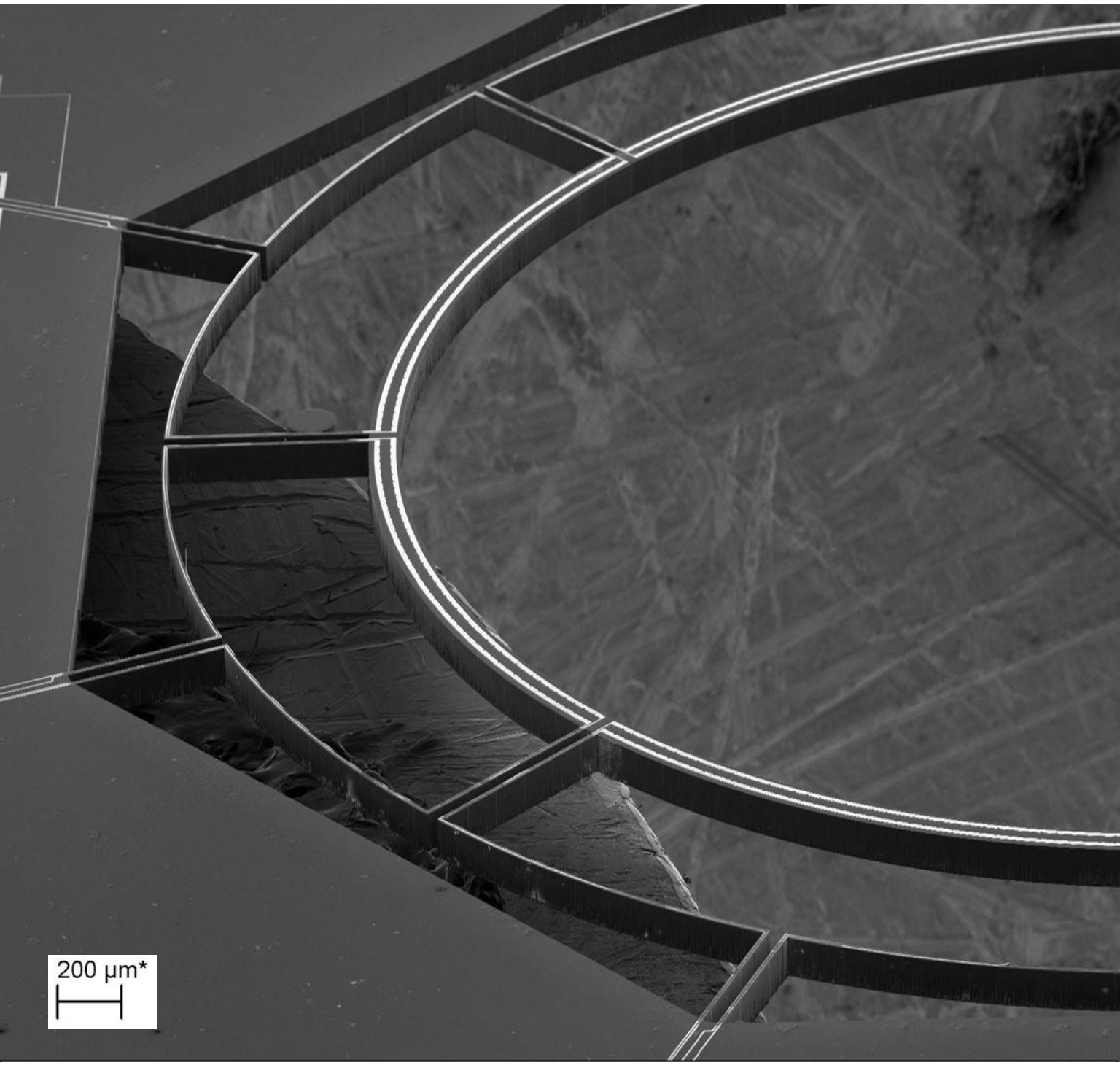
PressCeNSE

Newsletter | Issue 4, 2019



Centre for Nano Science and Engineering (CeNSE)

Indian Institute of Science

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Cover photo: "Ring Gyroscope" by Jayaprakash Reddy

MESSAGE FROM THE CHAIR

I would like to dedicate this issue in memory of Rahul Singh Kotesa, Ph.D. student at CeNSE, who passed away on August 17, 2019. At the time of his sad and unexpected demise, Rahul had completed his 5 years tenure as Ph.D. student and was in the process of submitting his Ph.D. thesis. He was an outstanding student at CeNSE, who excelled in his research, and at the same time contributed to various outreach activities in the centre. He took lead in organizing "Think Nano" in CeNSE, an event conducted for the undergraduate students to enthuse them about Nano Science and Engineering. He was also very active in other voluntary services to the department. He was an avid photographer and an excellent communicator. In his memory, CeNSE will be conducting an annual competition titled "Art in Science" which will cover images produced during research including photographs, SEM images, microscopy images, computer generated visual art, drawings, simulation results, etc. Initially this event will be open to IISc community and later we plan to expand the reach. In this issue, you will be able to read a touching article on Rahul, written by his Ph.D. advisors Prof. Prosenjit Sen and Prof. G. K. Ananthasuresh.

We also present a very detailed account on our interactions with the two strategic departments, namely DRDO and ISRO. Through a memorandum of collaboration, we work very closely with DRDO and ISRO on a wide range of activities including training in nanotechnology provided by faculty and staff at CeNSE, providing access to use the nanofabrication and nanocharacterization facilities at CeNSE, defining and executing joint research and development projects.

We conducted a 2 weeks training program for Dentists from Rajiv Gandhi University of Health Sciences on Nano Science and Technology for Dental applications. In addition our Technology Business Incubator (InCeNSE) partnered with PATH Impact Lab (New Delhi) and TBI, CPDM (IISc) to organize a very unique workshop for start-ups in healthcare sector, with a theme "Medical Devices : Development, Testing, Regulation & Market Access."

We have a special feature on "Graduation day dinner" held on 12th September, the day of IISc Convocation 2019. This is an occasion for us to appreciate the contributions made by our graduating students, by inviting them with their family for an informal get together.

During the last quarter we also had the honour of hosting the visit of Dr Ramesh Pokhriyal "Nishank", the honourable minister of human resource development, Government of India and Mr. Walter J. Linder, the ambassador of Germany to India.

-Navakanta Bhat

What's new in research at CeNSE?

Record high efficiency in III-nitride deep-UV detectors

Anisha, Shashwat, S. Raghavan, R. Muralidharan and Digbijoy Nath

Several applications including wearable sensors for real-time ultra-violet (UV) radiation monitoring, space-borne imagers for UV astronomy and combustion monitoring in gas turbines necessitate the development of high-performance UV detectors. The direct, wide and tunable energy gap of Aluminum Gallium Nitride (AlGaN) offers substantial promise for such solar blind UV detectors. A vertical p-i-n geometry in particular can enable the realization of self-powered or battery-free UV detectors. However, AlGaN layers have to be grown on foreign substrates such as sapphire which lead to a high dislocation density, which in turn degrades the performance and reliability of AlGaN UV devices. Additionally, achieving reasonably low contact resistance for p-type layers in AlGaN has been a challenge. It is noteworthy that several groups around the world have reported extensively on the development of such battery-free UV detectors based on III-nitrides with rigorous optimization of the epitaxial layers to better the efficiency. At zero bias (i.e. in photovoltaic mode), the earlier record for efficiency of such AlGaN UV detectors was close to 80%, achieved with fairly complicated growth techniques such as a lateral epitaxial overgrowth (LEO). Recently, we demonstrated record high zero-bias efficiency in AlGaN-based deep-UV detectors. They employed a simple, scalable, template-free and mask-free growth technique to realize high crystalline quality AlN epi-layers on sapphire, which were then utilized as the buffer for the growth of the active detector stack.

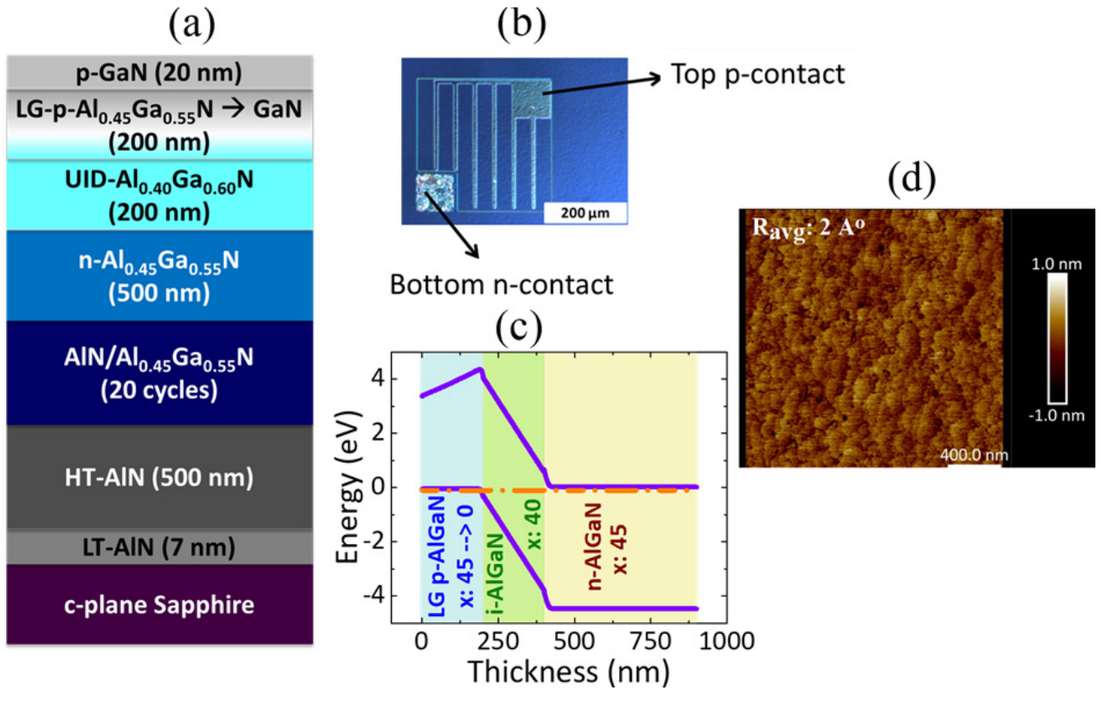


Fig. (a) Schematic of the UV detector epi-stack grown on sapphire by MOCVD (b) Optical micrograph of the fabricated detectors. (c) Equilibrium energy band-diagram of the active p-i-n stack simulated using a 1D Schrödinger-Poisson solver (d) AFM surface morphology of 500 nm thick AlN epi-layers for a 2 µm x 2 µm area

Additionally, the p-doped AlGaN layer was compositionally graded (i.e. polarization graded) to induce 'more' holes, and was utilized as the p-contact layer for the p-i-n stack. These modifications helped realize large-area (0.16 mm^2) solar-blind detectors with record-high zero-bias responsivity and external quantum efficiency of 211 mA/W and 92 % respectively, at 289 nm detection wavelength. In addition to a high zero-bias EQE, the detectors also demonstrated an impressive UV-to-visible rectification ratio exceeding six-orders of magnitude and a low reverse leakage current density of 1 nA/cm^2 at 10 V with rectification exceeding ten orders of magnitude. The thermal noise limited specific detectivity was estimated to be 6.1 x 10^{14} $cmHz^{1/2}W^{-1}$. These are some of the best numbers in the literature for AlGaN UV devices. The significant improvement in the zero-bias efficiency obtained in this work could be attributed cumulatively to an improvement in the electrical characteristics of the p-layer, attained through the use of a graded p-doped layer and to the use of a high crystalline quality AlN buffer layer which allowed for the growth of a low dislocation density absorbing layer and a crack-free, highly conducting n-AlGaN layer.

Reference:

[1] Kalra, Anisha, et al. "Polarization-graded AlGaN Solar-blind pin Detector with 92% Zero-bias External Quantum Efficiency." IEEE Photonics Technology Letters, Vol. 31, Issue 15 (2019)

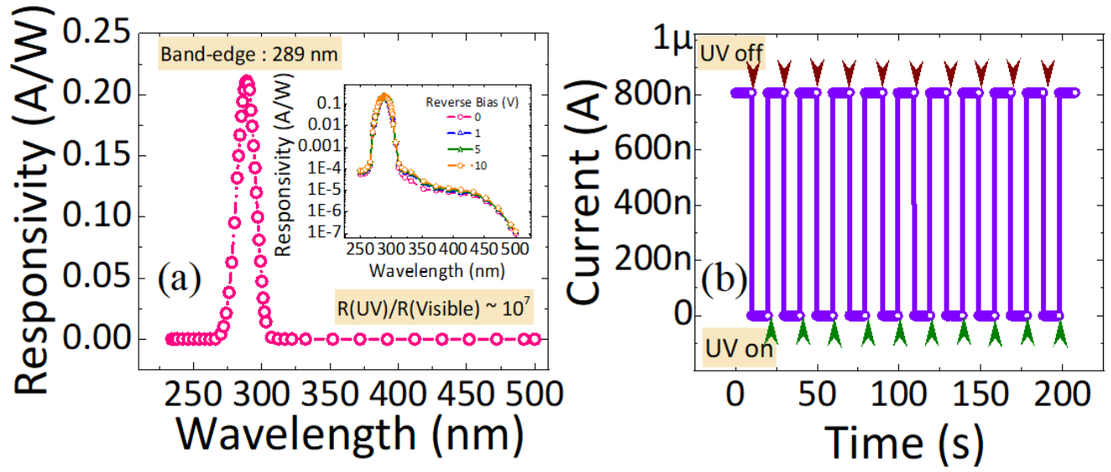


Fig. Zero-bias (a) responsivity variation for the 0.16 mm2 p-i-n detectors. Inset: Responsivity plot in the semi-log scale for 0 to 10 V reverse bias, showing a UV-to-visible rejection ratio ~ 107. (b) transient characteristics

Adaptive pulse shaping for enhanced spectral broadening of high repetition rate, electro-optic frequency combs

B.S. Vikram and V.R. Supradeepa

(Presented at CLEO EUROPE/EQEC2019)

Frequency combs are used in optical communications, arbitrary RF waveform generation and astronomical spectrograph calibration. Combs with tunable repetition rate can be generated by electro-optic modulation of lasers but are limited in bandwidth (BW). Wide band combs can be generated by cascaded four-wave mixing with two lasers in highly nonlinear fiber (HNLF), but the spectral spacing of the two pumps determines both bandwidth and repetition rate limiting the independent control of the two. Spectral broadening of electro-optic combs can achieve tunable repetition rate and wide bandwidth. However, the temporal and/or spectral profile is not suitable for spectral broadening. Different methods have been used such as pulse compression in single mode fiber (SMF) and pulse shaping prior to nonlinear broadening. However, such methods based on an open loop have resulted in poor flatness in the central region of comb and are not robust to varying operating and drive conditions of the modulators, initial spectral phases of electro-optic comb, modulator bias, length, dispersion profile of HNLF and power. In this work, we utilise an adaptive spectral phase optimization based on adaptive step size random search algorithm in a closed loop to optimize the spectral phases to obtain the broadest comb. We demonstrate bandwidth scaling by over 13 times of an initial 25GHz comb with 9lines (0.2THz) to 121 lines (3THz).Fig.1(a) shows the schematic where electro-optic modulators are driven at 25GHz to generate the comb shown in Fig.1(b) with 9 lines in 20dB BW. Spectral phases are controlled by wave-shaper before amplification and HNLF stages. Fig.1(c) shows the spectrally broadened output with 121 lines having output power of ~665mW with >14dB SNR limited only by instrument resolution. The optimized spectral phase profile is shown in Fig.1(d). It deviates from a strict polynomial function (primarily quadratic) anticipated from fibre-based dispersion compensation. The closed loop system is robust and adapts to varying operating conditions. The repetition rate and central wavelength agility allow the system to realise a wide variety of combs. Shaping the output spectrum to a predetermined profile is to be investigated.

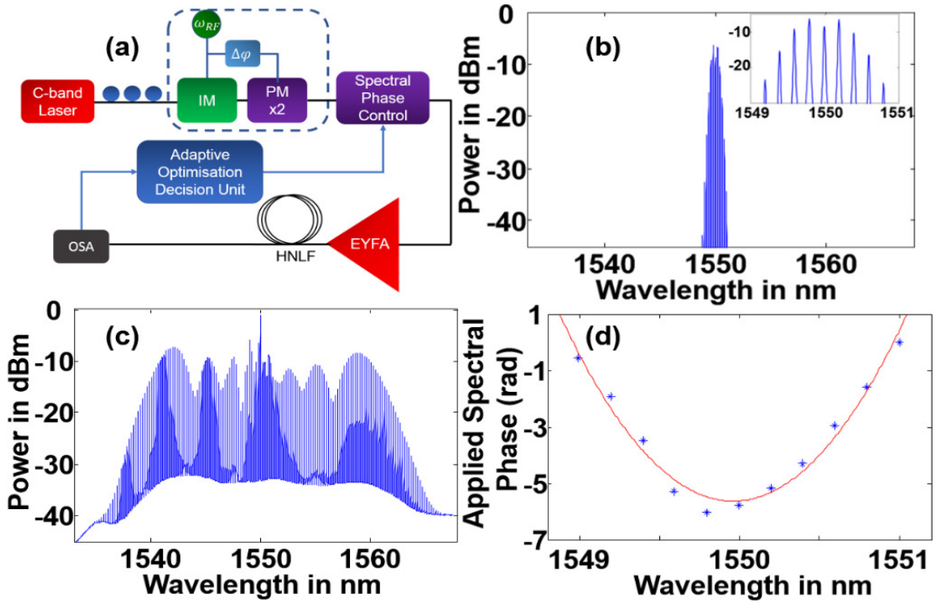


Fig. 1
(a) Adaptive optimization system Schematic; IM,PM-Intensity and phase modulators, EYFA-Erbium-Ytterbium codoped fiber amplifier
(b) Cascaded modulator generated comb with 9 lines (inset enlarged)
(c) Spectral broadening with optimization to 121 lines
(d) Optimised spectral phase profile (unwrapped) (blue dots), quadratic fit (red line)

FACILITY UPDATES

SYSTEMS ENGINEERING AT CeNSE

The facilities at Systems Engineering lab comprises of the following:

I. 2 Thermal chambers 270 x 230 x 290 mm (L x W x H) with programmable temperature (30°C to 100°C) and relative humidity (RH: 0% to 100%).

II. Qrera 3D Printer 300 x 290 x 150 mm (L x W x H) for prototype parts & mechanical housing.

III. 12 desk top work benches for design, development and testing.

IV. Temperature controlled soldering and desoldering stations for prototype PCB'S (1 unit Each).

V. Votsch VCL7003 temperature & humidity climatic chamber (350 x 300 x 310 mm) with programmable temperature (70°C to 180°C) and RH (0% to 100%).

VI. 4 units of Lab power supplies (GDS2303), 2 units of Keithley source monitor (2450), 2 units of signal generator (9Khz to 3Ghz-Rohde & Schwarz) and 2 units of digital storage oscilloscope (GDS1102A- 0 to 100Mhz).

VII. Fluke 975 Airmeter 1# & Particulate matter calibrator-Metone (1 unit).

VIII. Xilinx Zedboard for evaluation.

IX. HP Server running on Xenon 9 core processor with 32GB RAM & 1 TB HDD- hosting MNCF, SySEF, and biometric applications.

Systems Engineering Capabilities:

We have the capability to understand and evaluate the user specifications, and then architect the complete system solution with accompanying hardware and software requirements. Our aim is to become one stop solution from concept to product.

Some representative focus areas and capabilities are listed below:

I. Customized systems engineering design of products involving hardware (PCB on Altium 18.1.7), mechanical housing design (including 3D modelling on NX-Unigraphics software).

II. Prototype design and development, testing & documentation for mass manufacturing & technology transfer.

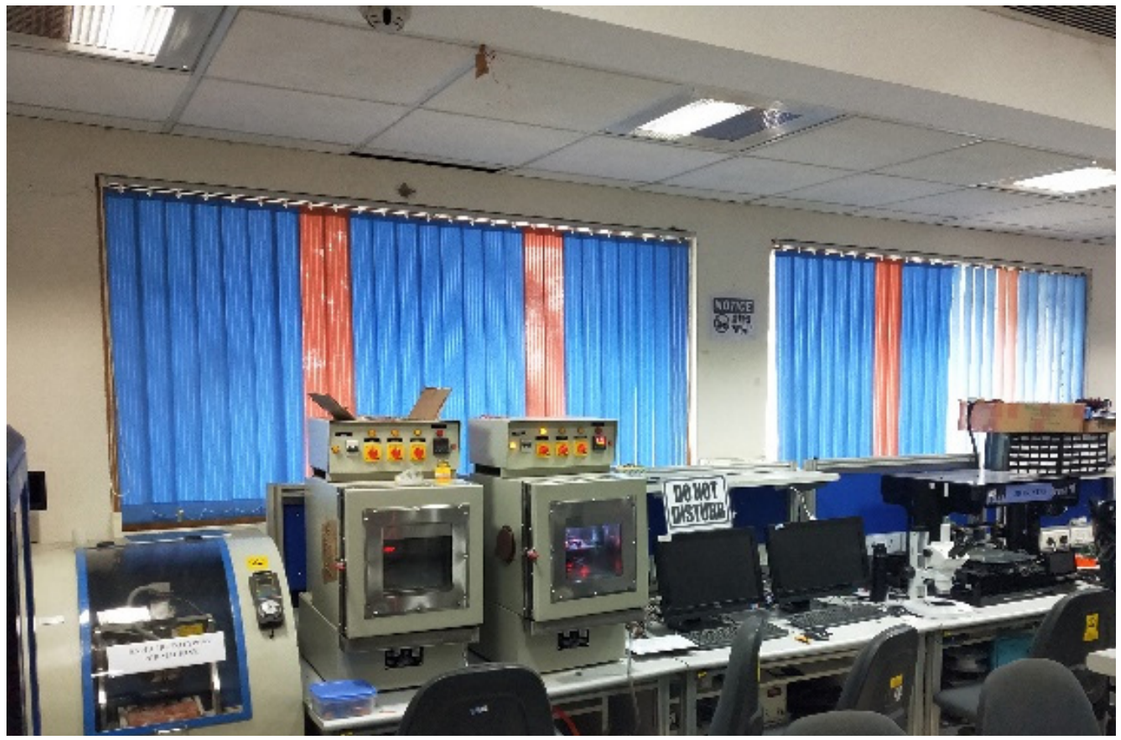
III. Analog and power management-hardware design for nano sensors.

IV. Digital and embedded board custom designs on ARM Cortex M3, STM32F411 ARM Cortex M4 for continuous real time data monitoring.

V. Raspberry PI, Arduino Uno interfaces for real time sensor and ambient parameters monitoring and logging as part of test and development.

VI. Firmware, Middleware and User Interface software on Windows/ Linux/Lab View/Andriod platforms.

VII. Cloud server & GSM real time data collection and analysis on Grafna Influx data base.



OUTREACH

CENSE OUTREACH PROGRAM TO DEFENCE AND SPACE LABORATORIES

Realising the importance of connecting itself to industries and strategic sectors, Center for Nano Science and Engineering (CeNSE) organized the "First Annual Meeting with Industries, Strategic Sectors & Government funding agencies on Micro and Nano Sensors, Systems and Structure" during 20-21 March'2013. About 150 participants attended this meet to know about the cutting edge research in the areas of micro and nano technologies that is being carried out in CeNSE. More than 80 participants were from Government agencies such as CMTI, ONGC, BEL, DRDO, DAE and ISRO.

Following the success of this meet, it was decided to organize an exclusive meeting for Defence sector to understand the requirements of "Micro and Nanotechnology Devices for Defence Applications", In this regard, a meeting chaired by Dr. BhujangaRao, DG was organized between 16-17 Apr'2014. This meet was attended by about 40 Scientists from various DRDO Labs. Post inauguration and facility tour, CeNSE faculty presented their areas of research on the first day. On the second day, various DRDO scientists projected their requirement in brainstorming session.

Dr. BhujangaRao, DG addressing the gathering during the Inaugural Session

It was in this meet that all DRDO scientists recognized CeNSE as a state-of-the-art National Micro and Nano Fabrication and Characterization Facility for strategic and defence R&D applications and felt the need for it to be maintained, nurtured, so that it can become anodal point to get their devices fabricated.

Participants of the CeNSE-DRDO Meet held during 16-17 Apr'2014

Simultaneously DRDO headquarters appreciated the concept of shared central facilities to be used by all DRDO labs.

When every one felt that it is only a continuous hand holding between IISc faculty and DRDO scientists by having brain storming sessions and facility utilization at CeNSE by DRDO scientists will result in the fabrication of the devices required by Defence.

Based on the outcome of the above two meets, and multiple meetings at DRDO headquarters, CeNSE signed a Memorandum of Collaboration with DRDO on 13-December-2016.

Similar kind of interactions happened with Space Sector and after serious deliberations, anMoU on the same lines was signed with ISRO on 21-April-2017.

Objective of the MoU's:

The MoUs signed with DRDO and ISRO cover a wide range of research & development (R&D) activities pertaining to Nano Science & Technology. The proposed R&D activities would incur expenditure towards utilization of fabrication and characterization facilities for nanomaterials/ nanodevices/ nanosystems and training modules for DRDO and ISRO Scientists.

Scope of Services:

1. Utilisation of CeNSE Facilities in IISc :

Utilisation of fabrication and characterisation facilities by DRDO and ISRO scientists at IISc as part of their R & D activities.

2. Training

Imparting training to the ISRO and DRDO personnel in the areas of MEMS/NEMS fabrication technologies, Nano electronics, Photovoltaics, Biosensors, Gas sensor and Nano photonics.

3. R&D Projects

The relevant R&D projects to be initiated by different centers of DRDO and ISRO or proposed by IISc to cater to their future needs.

Training:

The main goals of the training modules are :

1. To promote research in the field of Nanotechnology, with expert lectures from IISc.

2. To provide hands-on-training in Nanotechnology research to DRDO and ISRO Labs.

3. To provide access to sophisticated facilities for carrying out research projects of current interest.

4. To provide a platform for researchers to benefit from complementary expertise.

5. To motivate DRDO and ISRO Labs to establish/enhance new research programs in their home institutions.

ISRO MoU Signing Ceremony Dt: 21-April-2017
(From L to R: Mr. S. Mohan, Emeritus Professor, CeNSE, Dr. Rajarajan, Registrar, IISc, Prof. NavakantaBhat, Chairperson, CeNSE, Dr. P G Diwakar, Scientific Secretary

Each training module is tailor made to meet the requirement of a specific lab covering the basics of nanoscience and technology and about the essential research methods and practice in Nanofabrication and Characterization. This includes lectures by faculty members providing an overview of various aspects of nano science and technology. During lab visits, the participants will be provided with practical training in the National Nano Fabrication Facility (NNFC) and the Micro and Nano Characterisation Facility (MNCF) at CeNSE.Experienced technologists and domain experts at CeNSEassist them, making it possible for participants to be engaged in current R&D.

Depending on the requirement of each lab, CeNSE also brings experts from other R&D institutions and industries. The Scientists are allowed to have a brainstorming session which helps them in getting their problems solved. This has also led to formation of several clusters according to the domain.

Following training programs were offered:

Sl No	Title of the Program	Participating Lab
1	*Advanced Micro / Nano Fabrication and Characterization Techniques*	DMRL, DRDO
2	*Pressure Sensor Fabrication and Characterization and Overview of PiezoMicromachined Ultrasound Transducer (PMUT)*	NPOL, DRDO RIC, DRDO
3	*Micro and Nano Fabrication Technologies with emphasis on Gas Sensors*	DEBEL, DRDO
4	*Advanced Micro / Nano Fabrication and Characterization Techniques*	GTRE, DRDO
5	*Advanced Micro / Nano Fabrication and Characterization Techniques*	VSSC, ISRO LEOS, ISRO
6	*Advanced Micro / Nano Fabrication and Characterization Techniques*	DLJ, DRDO

During the workshop, the Scientists were also exposed to technological aspects involved in fabrication and characterization for the realization of a MEMS device namely: simulation for designing a device, cleaning of wafers, various process steps, packaging of devices and finally the characterization / testing of the prototypes developed.

By this way, the scientists are motivated in visualizing / ascertaining the requirement of their own labs and use this knowledge in scaling up of their existing technologies to the next level.Some scientists have already fabricated the devices for their requirement. CeNSE has been handholding them throughout this process.

Highlights of this Program:

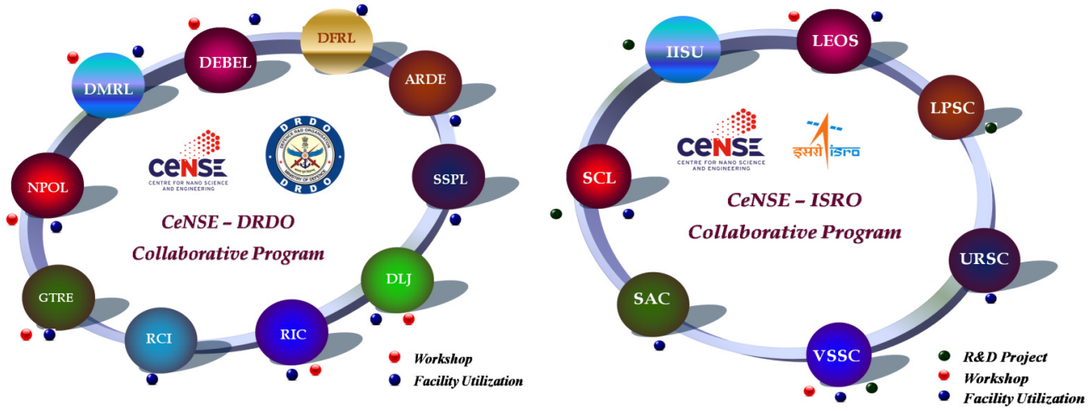
1. ISRO has funded 9 R&D projects worth Rs.17 Crores

2. Over 1500 hours of facility utilization by DRDO scientists

3. 5 workshops have been successfully completed for DRDO Labs

4. 10 DRDO labs and 6 ISRO labs have been utilizing the CeNSE facilities extensively

5. Handholding the DRDO and ISRO scientists in developing MEMS / Nano devices to meet their In-House requirement - "MAKE IN INDIA"



Participating DRDO and ISRO Labs under this MoU

Other Activities:

Dr. Poornendu Chaturvedi, Scientist 'F', Solid State Physics Laboratory,DRDO has been identified by SSPL to spearhead the establishment of Cleanroom at SSPL. In this connection, he has visited CeNSE several times and also regularly interacting with facultyand staff at CeNSE to have a thorough understanding on "establishment, operation and maintenance of cleanroom". During one such visit of Dr. Poornendu, CeNSE had also arranged for brainstorming session on 10-July-2019 on the above topic which was attended by about 15 experts from CeNSE. The main objective of this session was to have a clear understanding on the fab requirement at SSPL, the challenges / problems faced at SSPL and then propose ways to tackle the futuristic problems. Dr. Poornendu covered the topics on architecture of cleanroom, types of cleanroom at SSPL, need of SSPL to sector their cleanroom , handling gases, effluent treatment for smoke, fire, building classifications as per the National Building Code of India. It was seen that Dr. Poornendu had collected a lot of information and the participants appreciated his efforts on this. Finally this turned out to be a mutually beneficial session and it was decided to have networking with the industries such as CMTI, BEL, Rakon and Centum.

Brainstorming session with Dr. Poornendu Chaturvedi, Scientist 'F', SSPL, DRDO

NPOL and RIC Scientists Interaction

DMRL Scientists Interaction Session with CeNSE Faculty

DEBEL Scientists in Cleanroom

Lecture on Overview of CeNSE for GTRE Scientists

Lecture for GTRE Scientists

Demonstration of Pressure Sensor to GTRE Scientists

Lecture session for DLJ Scientists

Visit of Shri. Ravindra Kumar, Director, DLJ, Dr. Anuj Shukla and Dr. Ashok Yadav

Participants for Workshop from VSSC and LEOS

CeNSE Chair addressing the ISRO Scientists during the workshop

CENSE OUTREACH PROGRAM FOR DENTISTS AFFILIATED TO RGUHS

As part of the outreach program, Centre for Nanoscience and Engineering has conducted a workshop for Dentists, who are affiliated to Rajiv Gandhi University of Health Sciences(RGUHS), from 16th -27th September, 2019. The primary objective of the workshop was to create awareness about the recent advancements in the field of nanotechnology. The workshop was inaugurated by Prof Navakanta Bhat, Chairperson, CeNSE along with Dr Suja, Deputy Director, RGUHS and Prof Ambarish Ghosh, Associate Professor, CeNSE. Thirty-three participants from different dental colleges participated in the workshop. The workshop included lectures by faculty members of CeNSE and from other departments at IISc. The technical talks were given by the staff working in National Nanofabrication facility (NNFC) and by Micro and Nano Characterization Facility (MNCF).

The hands-on training included nanoscience based experiments relevant to research in dentistry, utilizing the sophisticated instruments available at the fabrication and characterization facilities. The two-week workshop ended with a feedback session on 27thSeptember and participants expressed their interest to come back again, if there are similar events organized in future.

Some comments below by the participants:

"Extremely useful to change our views towards research on nanotechnology related to dentistry" -Rupali

"Excellent! powerful, passionate, novel and nano-knowledegeable"- Dr Muddugangadhar

VISITORS TO CeNSE

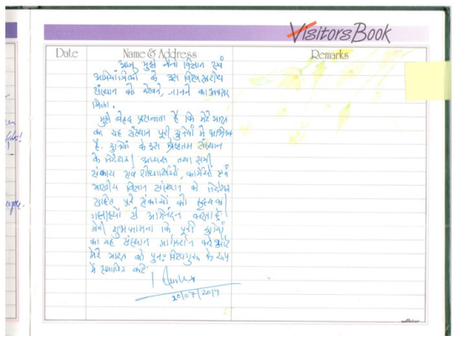
Delegation from British Telecom

On July 02, 2019, we had a visit by a delegation from British Telecom headed by Professor Tim Whatley, MD, Applied Research

Visit of the Honorable MHRD Minister, Government of India

On July 19, 2019, we had the honour to host Dr Ramesh Pokhriyal 'Nishank', the honorable minister for human resource development, government of India. The minister had a tour of the facilities and interacted with the faculty and staff. It was a great visit and he summarized his visit in his own words in hindi, translated to English below -

"Today, I got an opportunity to visit/learn of this world class "Nano Science and Engineering Centre". I am pleased to know that this is unique in the world. I congratulate, from the bottom of my heart, the Director, faculty members, staff and students of one of the best Institutes in the World. I wish that the Institute will help re-establish India as the "Vishwa Guru" again to the World."



Visit of his excellency Walter J Linder, Ambassador of Germany to India

On July 23, 2019, we had the honour to host his excellency Walter J Linder, the German ambassador to India. He was accompanied by Ms Margit Hellwig-Botte, the consul general of Germany in Bengaluru. The Ambassador and the consul general had an extensive interaction with the faculty and had a tour of the facilities. The chairman, Prof Navakanta Bhat provided an overview of CeNSE and ongoing international collaborations and the meeting ended with a deliberation of possible approaches to enhance collaboration between CeNSE and German universities and industry.

ALUMNI PROFILE

Full Name: Krishna Bharadwaj Balasubramanian

Year of graduation at CeNSE: 2016

PhD/MTech: PhD

Advisor/Co-advisor: Prof. Rudra Pratap & Prof. Srinivasan Raghavan

Current designation & affiliation: Technion Post-doctoral fellow, Technion – Israel Institute of technology, Haifa

Q: Tell us about what you are currently working on: *Superconductor semiconductor interfaces. Superconductor based entangled light emitters*

Q: Describe your work as a PhD/MTech student at CeNSE? *Growth, device fabrication and characterization of 2-D materials.*

Q: How does your work now relate to what you did at CeNSE (If it doesn't explain how did you move to a different area) (OR) How did the work you did at CeNSE prepare you for your current role?

I work on interfaces of superconductors with different kinds of materials. That includes low dimensional materials such as hetero-structures and 2-D materials. I learnt at CeNSE to work with low dimensional materials and understood the underlying principles. I used NNFC to fabricate nanometer sized devices with graphene, MoS2 and GaN/AlGaN based heterojunctions. MNCF allowed me to gain expertise in the most modern equipments in electrical and optical characterization. Multiple characterization techniques allow orthogonal inspection of the device under test and build confidence in the obtained results.

Q: How would you describe your experience as a student at CeNSE? (Please share any moments that stand out/ interesting stories related to working with your advisor)?

I had the chance to join CeNSE at an early stage and grow along with the department and the lab as well. It aided to develop a sense of team and culture of working and learning together. I felt CeNSE to be an inclusive community of professors, students, research associates and staff members which was fair, transparent and progressive. I personally have many moments that I cherish starting from Open day activities, CeNSE annual seminars, badminton hours, group discussions and more. I am indebted to my advisors who were patient when I learnt the background from scratch and supportive to explore and venture uncharted research domains. I thoroughly enjoyed all the professional and personal interactions with the CeNSE fraternity and the Indian Institute of science.

Q: Based on your experiences do you have any career advice for our students?

I am too early in my career to solicit an advice. However, from the experience that I have had outside, I would like to say to the CeNSE students that the facilities and opportunities in the department (and institute) is on-par with best places in the world. Students who have entered the institute are among the brightest in the country and possibly world-wide. I urge them to believe in their ability and choose carefully problems of fundamental importance and relevance to work on. I think this can encourage a co-operative and globally competitive research environment.

Q: May our students contact you if they'd like to discuss more about career options? If yes, please share an email ID.

Sure. I can be reached at krishnab@campus.technion.ac.il

EVENTS

A brief on CeNSE Graduation Dinner:

Reported by Dr RN Narahari, Admin. Manager

IISc convocation 2019 was held on 12th September with Mr. Azim Premji from WIPRO delivering the convocation address. On the same evening CeNSE chair hosted dinner for the graduating students and their families. CeNSE is very proud to have started this unique tradition since 2016, to place on record the contributions of graduating students.

This academic year we have had a total of 30 Ph.D., 8 M.Tech., and 1 M.Sc., awardees. Due to various reasons, only some of these students could attend. A few students could also bring their family. A special plaque was presented to all the graduating students. Each plaque carried the thesis title, abstract of thesis and a customised-N-etched silicon wafer.

The formal program began with a hearty welcome by the Manager (admin) and handing over the stage to the Chair. The Chair welcomed one and all and highlighted the important research contributions from CeNSE. This was followed by distribution of plaques to the awardees/parents who were present.

The plaques were handed over to the awardees/parents after a brief account of the awardees' stay at CeNSE and some special and memorable moments shared by their research supervisors. After receiving the plaque, the students shared their special moments at CeNSE. This year we had a special guest, the recipient of Institute Medal 2018-19, Dr KJP Reddy. The other medal winner from CeNSE Mr Kruthikesh Sahu for M.Tech., couldn't attend the event.

TECHNOLOGY BUSINESS INCUBATOR

Medical Technology (MedTech) workshop on
DESIGN FOR MANUFACTURING AND CERTIFICATION

InCeNSE, the Technology Business Incubator (TBI) at the Centre of Nano Science and Engineering (CeNSE), IISc Bengaluru, organized 2 days' workshop on 5th and 6th of September, 2019 in collaboration MedTech & Geriatric Healthcare Technology Business Incubator (CPDMed TBI) at the Centre for Product Design and Manufacturing (CPDM), IISc, Bengaluru and Tata Trust PATH Impact Lab, New Delhi. Dr. Satya Dash and his colleagues from PATH lab coordinated these efforts along with the TBI teams at CeNSE and CPDM.

The theme of the workshop was "Medical Device: Development, Testing, Regulation & Market Access." The resource persons for this workshop included domain experts from regulatory bodies, legal experts, leaders from established medtech industries, start-up founders with experience in translating research to market ready products. This made the workshop deliberations very engaging due to the commonality of challenges that most of participating stat-up founders were facing in their early stage of market validation and product development.

There were about 76 registered participants from over 50 start-ups, mainly from medtech field and another 28 participants from various research institutions, engineering colleges, incubation centres and IISc Bengaluru.

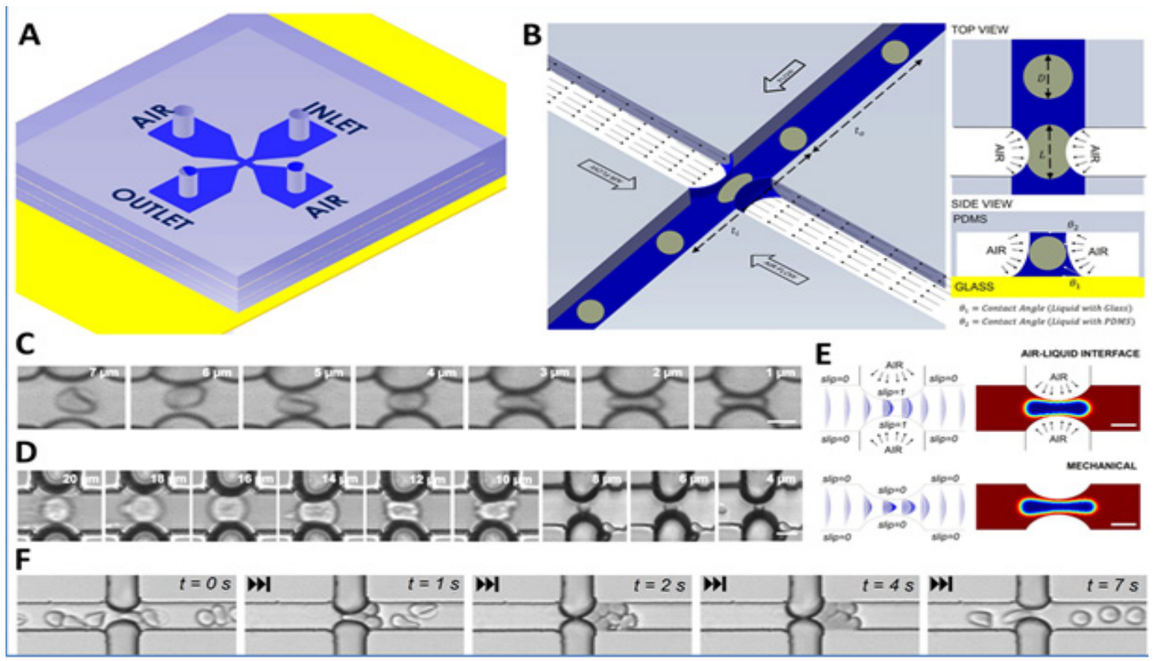
The workshop sessions were conducted under the following seven focus areas: (1) Safety and Performance testing, Quality management, (2) Sensor technologies in MedTech, (3) Regulatory requirements – CDSCO

Memorium: Remembering Rahul

Rahul Singh Kotesa (1989-2019)

Rahul was born on 17th November, 1989. He hails from Rajasthan and studied in DAV school from class X to XII. He graduated with the BE in Mechanical Engineering from BITS-Pilani, Goa campus in 2011 and ME-Design degree in 2013 from BITS-Pilani. He joined the PhD programme in CeNSE, IISc, in 2014. His first passion of life was research. In his own words "he was driven by thirst for knowledge and perseverant aim for perfection". He was a cheerful person who was eager to help everyone. He was an avid traveler and had a passion for photography. He has also played state level U-13 table tennis. He developed "air-squeeze cytometry" in his doctoral thesis research.

Air-squeeze cytometry, as Rahul had christened the technique he developed to characterize stiffness of cells as they flowed in microchannels, occupied much of Rahul's time in the last four years. Unlike many PhD students, Rahul Singh Kotesa owned his thesis topic. Most people are familiar with microchannels today. One can chemically etch them using photolithography in any tortuous or straight patterns. It is common now to put a constriction in a channel by reducing the width. When biological cells flow through such a channel, they have to squeeze and move on, if at all they can. If they are flexible, they easily deform and quickly pass through the constriction. If they are less flexible, they take longer. One can use the extent of deformability, and the time of transit of cells through the constriction, for stiffness-based phenotyping. If cells are too stiff, they clog at the entrance of the constriction. This is a nagging problem.



Air-squeeze cytometry

Rahul's work brought about a twist to this familiar story. He devised two air-channels that are transverse to the flow-channel. As the air pressure is adjusted, with two syringe pumps deftly handled by Rahul, an air-liquid interface would form on either side of the junction of the flow-channel and the air-channel as the flow presses on forward. The constriction is thus created with half-bubbles on either side of the flow. By adjusting the air pressure, Rahul showed that he can change the size of the constriction at his will. If cells clog, he can reduce the pressure and make the channel just wide enough for any cell to pass, stiff or flexible. Unlike solid walls of hard-wired constrictions, the shear stress on the cells is minimal in this method. This innovative idea of gently squeezing cells with an air-liquid interface took many forms in Rahul's fertile imagination. He could slow down or stop a cell at the constriction to let it take up particles, which is called mechano-poration, and brought in Prof. Siddharth Jhunjhunwala to collaborate. He also experimented with red blood cells extensively and enthused Prof. Utpal Tatu to look at hemoglobinopathies from mechanics perspective. He observed that a cell at the constriction would slowly rotate because of differential flow of minute leaks around it. It led to another invention disclosure of being able to acquire 3D images of cells at low cost. Rahul was prompt in writing up his results for numerous international conferences. He attended about a dozen conferences abroad in his five years at IISc. Attendees in those conferences began to associate Rahul with air-squeeze cytometry, which he deserved.

Ironically, air-squeeze is what probably happened to Rahul on the morning of August 17th, 2019, in New Delhi at his uncle's home, where he had gone for a medical check-up having recovered from acute bronchitis. He collapsed suddenly, feeling breathless. He did not live to see his air-squeeze cytometry work published in a journal of repute. Years of hard work did not yet make it into a PhD thesis.

—Prosenjit Sen and G.K. Ananthasuresh, PhD Thesis Advisers

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