PressCeNSE

Issue: Q2 2024

Unity in diversity

Integration of diverse semiconductors
improves functionality

Message from the Chair

"Exciting progress at CeNSE, IISc with initiatives in alignment with the India Semiconductor Mission."

- Srinivasan Raghavan
Professor, Chair, CeNSE

We are thrilled to witness the progress of our country in alignment with the India Semiconductor Mission initiative by MeitY, GoI and CeNSE is proud to contribute to this mission. LAM Research has taken significant steps to deploy Semiverse Solutions™ to develop India's semiconductor manufacturing workforce. In a groundbreaking pilot program, 32 MTech and PhD students were trained using SEMulator 3D™ Application at CeNSE, IISc. Additionally, in collaboration with the Ministry of Tribal Affairs, a NSQF-certified training course on semiconductor technology was developed and offered to students and faculty from the tribal community.

While there is much excitement around semiconductor education, industry, and workforce development, CeNSE continues to make great strides in its research endeavors. Our ongoing collaboration with ISRO exemplifies our strong relationship, and we look forward to achieving even greater milestones together.

In this issue, PhD students Mahek Mehta and Bhumika Sharma from the Heterojunction Lab, along with PI Prof. Sushobhan Avasthi, have written an article titled "Heterojunctions and Hetero Integration – Teamwork of Semiconductors," providing a brief glimpse into their research activities. Additionally, Dr. Sreetosh Goswami discusses exciting progress in developing materials for memristors that are a step closer to mimicking the human brain.

Lastly, don't miss our conversation with Mr. Jayaprakash Reddy, an alumnus from CeNSE, who shares his insights and experiences.

CeNSE NEWS

Understanding electrical characterization and analysis techniques

The Electrical Workshop on Understanding Basics of Electrical Characterization and Analysis Techniques held at Centre for Nano Science and Engineering (CeNSE), Indian Institute of Science (IISc) from 29th to 30th May 2024, benefitted over 100 students and industry professionals.

Organized by the Electrical Bay at Micro and Nano Characterization Facility MNCF, the workshop aimed to provide participants with hands-on experience and theoretical knowledge in various aspects of electrical characterization techniques.

Experts from Keithley Instruments (A Tektronix Company) provided a demonstration of the capabilities and possible measurements that can be performed using the Keithley 4200 SCS.

This would require development of high-performance inductors with novel nano magnetic materials operating in high frequency range (MHz), so that inductor size can be drastically reduced.

New advances in the CeNSE-ISRO collaboration

Exciting developments in our ongoing collaboration with ISRO - Indian Space Research Organization! Researchers from Centre for Nano Science and Engineering (CeNSE), Indian Institute of Science (IISc), recently met with ISRO Chairman Shri. Somanath S and other leading scientists at ISRO headquarters in Bengaluru.

We had fruitful discussions about our long-standing partnership and explored new collaborative ventures. Through this successful collaboration, various innovative sensor technologies have been developed in the fab at CeNSE IISc and delivered for testing. Thanks to the fabrication and characterisation facility at CeNSE IISc and ISRO Scientists for this successful journey. Thanks to ISRO leadership for the support and encouragement.

Looking into the future, the collaboration is looking at leveraging the startup ecosystem for device production, the potential of speciality foundries and packaging technology, next generation of sensor technology for space applications and more innovative collaborations and breakthroughs towards Atmanirbhar Bharat!

CeNSE, IISc – LamResearch Collaboration

- to deploy Semiverse solutions empowering India's semiconductor manufacturing workforce

Centre for Nano Science and Engineering (CeNSE), Indian Institute of Science (IISc) is excited to be a part of this initiative with Lam Research to deploy the Semiverse Solutions to develop India's semiconductor manufacturing workforce in alignment with the India Semiconductor Mission.

A groundbreaking pilot to upskill engineers in semiconductor fabrication technology, run in partnership with LamResearch was recently completed. 32 MTech and PhD students at Centre for Nano Science and Engineering (CeNSE), IISc were trained using Lam's SEMulator 3D™ Application, which is part of its Semiverse Solutions™ portfolio, paving the way for future industry leaders.

Three students from the program have already secured placements at top global semiconductor manufacturing companies, showcasing the immense potential of this initiative.

With an aim to upskill 60,000 engineers over the next decade, ISM, IISc, and Lam Research are set to scale the program nationally across multiple universities, revolutionizing the semiconductor industry in India. Join us in celebrating this milestone towards a brighter future for Indian semiconductor manufacturing!

In collaboration with Ministry of Tribal Affairs, GoI

- Training on semiconductor fabrication and characterization for tribal students and faculty

The Ministry of Tribal Affairs, GoI in collaboration with the Centre for Nano Science and Engineering (CeNSE), Indian Institute of Science (IISc) has taken an initiative to leverage technology and expertise for the holistic development of tribal communities.

A NSQF certified level 6.0 and 6.5 training programs will be offered over three years to aim at delivering 48,000 hours of cutting training in semiconductor technology.

An Advanced Programme in Nano Science and Technology for 600 candidates over three years (200 per year). This programme, oriented towards job readiness, will involve collaboration with companies for student placements in the industry.

- A Foundation Programme in Nano Science and Technology for 1500 students (500 per year).

- Exposure programmes on the semiconductor sector for school and diploma students (100 students per year).

Centre to give tribal students training in semiconductor technology

PNS ■ NEW DELHI

The Centre will provide training to tribal students in semiconductor technology in collaboration with the Bengaluru-based Indian Institute of Science. In partnership with the Indian Space Research Organisation (ISRO), the Tribal Affairs Ministry also plans to use satellite-based technology on a pilot basis to improve mobile and internet connectivity in remote tribal villages.

Officials said there are high prospects of jobs in the semiconductor industry in the coming years against the backdrop of the India Semiconductor Mission (ISM) launched by the government.

The ISM is a specialised and independent business division within the Digital India Corporation that aims to build a vibrant semiconductor and display ecosystem to enable India's emergence as a global hub for electronics manufacturing and design.

The tribal affairs ministry, in partnership with the Indian Institute of Science (IISc), will establish a training fab unit which will offer a course on semiconductor technology to tribal students. An official said, "2100 NSQF-certified level 6.0 and 6.5 trainings in semiconductor technology will be offered over three years."

This will be an advanced job-oriented programme for 200 students with the potential of high-paying placements in the industry. IISc Director G Rangarajan said the country wants to become self-dependent and self-sufficient in the area of semiconductors, and the institute will provide the best possible training to tribal students.

Launching the initiatives at an event here, Tribal Affairs Minister Arjun Munda said the ministry wants to connect them with the PM-JANMAN scheme.

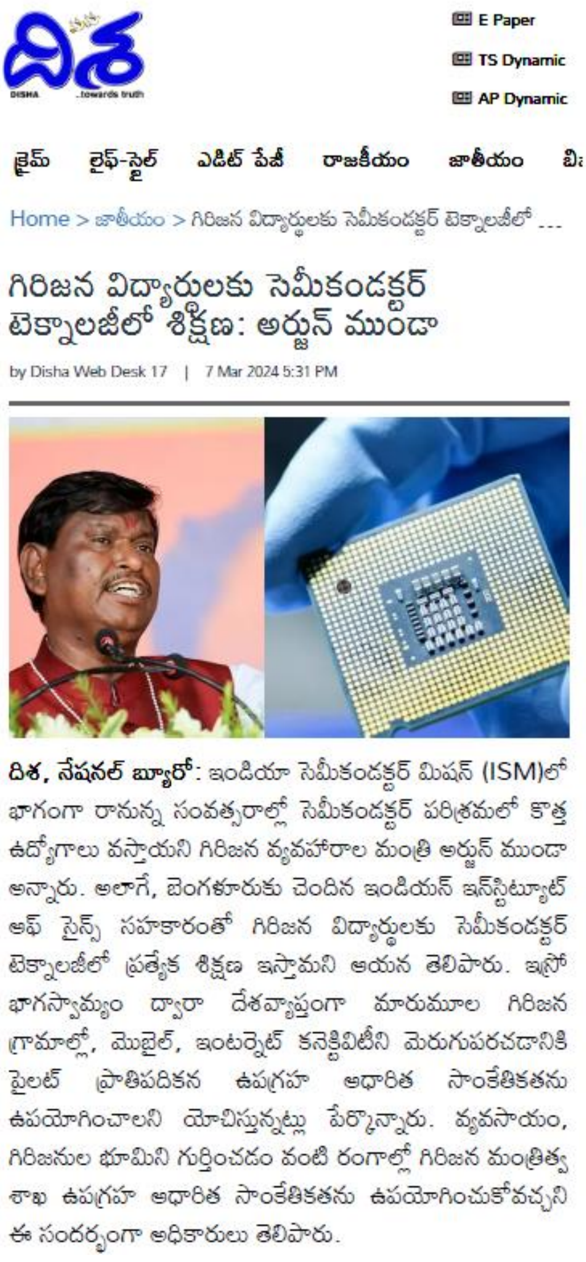
The PM-JANMAN, with a budget of around Rs 24,000 crore, focuses on 11 critical interventions through nine ministries and is aimed at improving the socio-economic conditions of the Particularly Vulnerable Tribal Groups (PVTGs) by saturating PVTG households and habitations with basic facilities.

"When we are moving forward for a Viksit Bharat, it is important that tribals are not left behind," the minister said. Munda also asked officials to give more emphasis on mobile connectivity in remote tribal areas.

The officials said many tribal villages face inadequate connectivity because of geographical remoteness and terrain difficulties, and the ministry, in partnership with ISRO, plans to use satellite-based technology on a pilot basis to improve the connectivity of such tribal villages.

"V-SAT stations will be established to resolve connectivity issues (community internet, e-governance, societal development) in 80 villages in Jharkhand, Madhya Pradesh, Maharashtra and Odisha. The project will be extended to other states in the next phase," an official said.

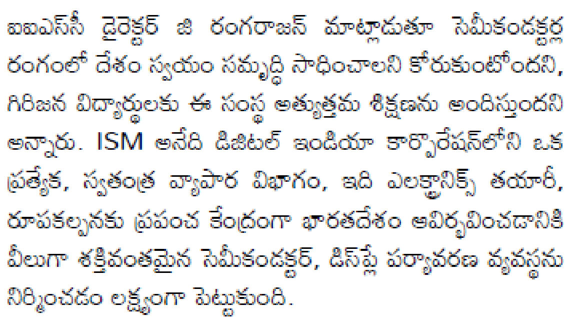
ISRO chairman S Somanath, in a video message, said V-SAT connectivity will help the ministry handle education and healthcare-related activities. He said that the ministry could leverage satellite-based technology in areas such as agriculture and identifying tribal land going ahead.



గిరిజన విద్యార్థులకు సెమీకండక్టర్ టెక్నాలజీలో శిక్షణ: అర్జున్ ముండా

by Disha Web Desk 17 | 7 Mar 2024 5:31 PM

దిశ, నేషనల్ బ్యూరో: ఇండియా సెమీకండక్టర్ మిషన్ (ISM)లో భాగంగా రానున్న సంవత్సరాల్లో సెమీకండక్టర్ పరిశ్రమలో కొత్త ఉద్యోగాలు వస్తాయని గిరిజన వ్యవహారాల మంత్రి అర్జున్ ముండా అన్నారు. అలాగే, బెంగళూరుకు చెందిన ఇండియన్ ఇన్‌స్టిట్యూట్ ఆఫ్ సైన్స్ సహకారంతో గిరిజన విద్యార్థులకు సెమీకండక్టర్ టెక్నాలజీలో ప్రత్యేక శిక్షణ ఇస్తామని ఆయన తెలిపారు. ఇస్రో భాగస్వామ్యం ద్వారా దేశవ్యాప్తంగా మారుమూల గిరిజన గ్రామాల్లో, మొబైల్, ఇంటర్నెట్ కనెక్టివిటీని మెరుగుపరచడానికి పైలట్ ప్రాతిపదికన ఉపగ్రహ ఆధారిత సాంకేతికతను ఉపయోగించాలని యోచిస్తున్నట్లు పేర్కొన్నారు. వ్యవసాయం, గిరిజనుల భూమిని గుర్తించడం వంటి రంగాల్లో గిరిజన మంత్రిత్వ శాఖ ఉపగ్రహ ఆధారిత సాంకేతికతను ఉపయోగించుకోవచ్చని ఈ సందర్భంగా అధికారులు తెలిపారు.



ఐఐఎస్‌సీ డైరెక్టర్ జి రంగరాజన్ మాట్లాడుతూ సెమీకండక్టర్ల రంగంలో దేశం స్వయం సమృద్ధి సాధించాలని కోరుకుంటోందని, గిరిజన విద్యార్థులకు ఈ సంస్థ అత్యుత్తమ శిక్షణను అందిస్తుందని అన్నారు. ISM అనేది డిజిటల్ ఇండియా కార్పొరేషన్‌లోని ఒక ప్రత్యేక, స్వతంత్ర వ్యాపార విభాగం, ఇది ఎలక్ట్రానిక్స్ తయారీ, రూపకల్పనకు ప్రపంచ కేంద్రంగా భారతదేశం ఆవిర్భవించడానికి వీలుగా శక్తివంతమైన సెమీకండక్టర్, డిస్‌ప్లే పర్యావరణ వ్యవస్థను నిర్మించడం లక్ష్యంగా పెట్టుకుంది.

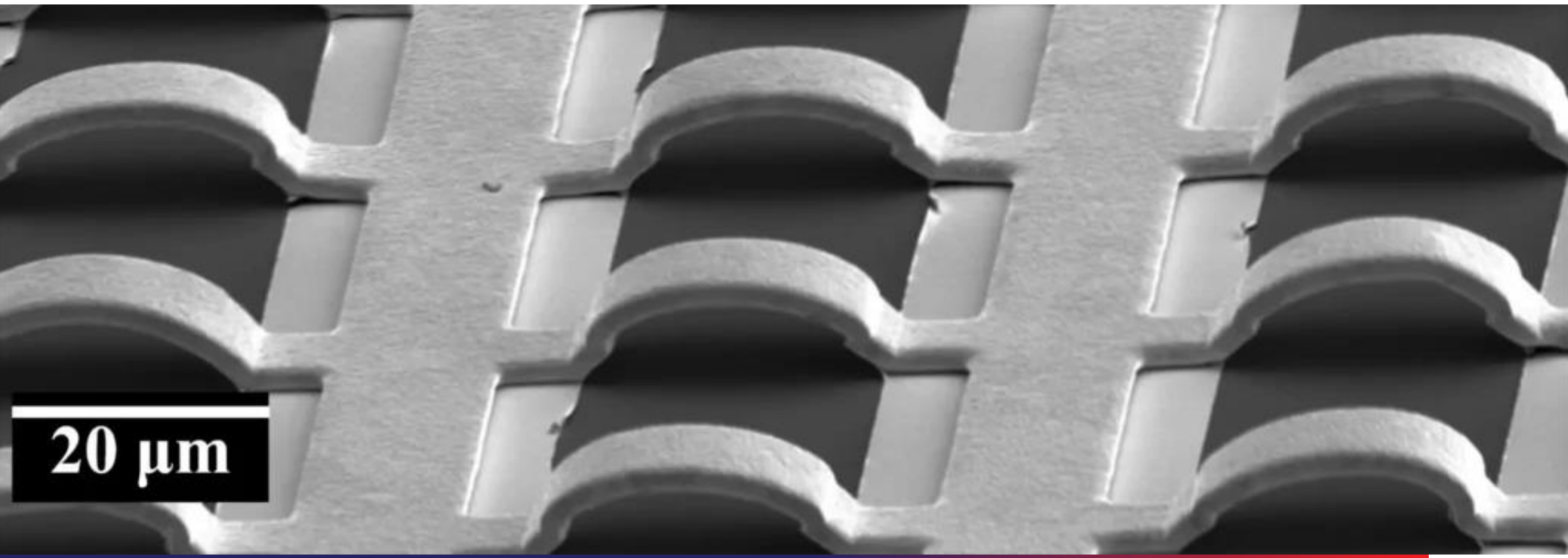
A NSQF credited level 1 training program on "Training on semiconductor fabrication and characterization" for 2 credits has been developed for a target audience from the tribal community including of 4th year UG students, 1st year PG students and faculty employed in PG institutions for science and engineering.

With thousands of applications and an online selection test, a batch of 111 participants were selected for the course. The training was successfully executed through online mode from 18-20 June, 2024 from 9AM to 6PM

Application image competition on advanced micro- and nano-fabrication 2023/2024

By Heidelberg Instruments

GaN devices: Fabricated Array of Gold Air Bridges



4th place – Shonkho Shurvo, PhD scholar & team at CeNSE, IISc

Shonkho

Roopa

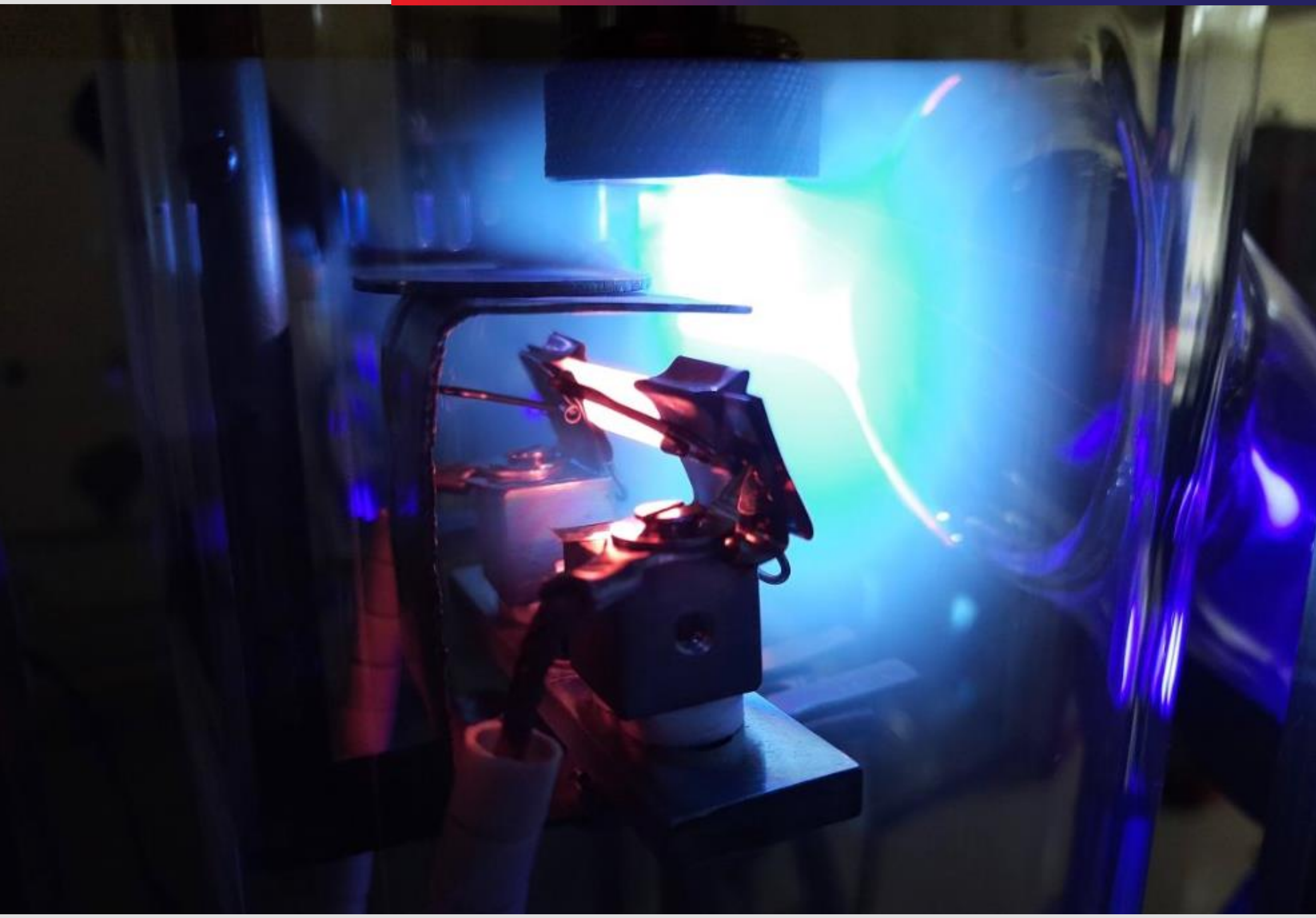
Prosenjit Sen

Digbijoy Nath

Muralidharan

Unity in diversity - Integration of diverse semiconductors improves functionality

- Written by Bhumika Sharma, Mahek Mehta and Prof. Sushobhan Avasthi

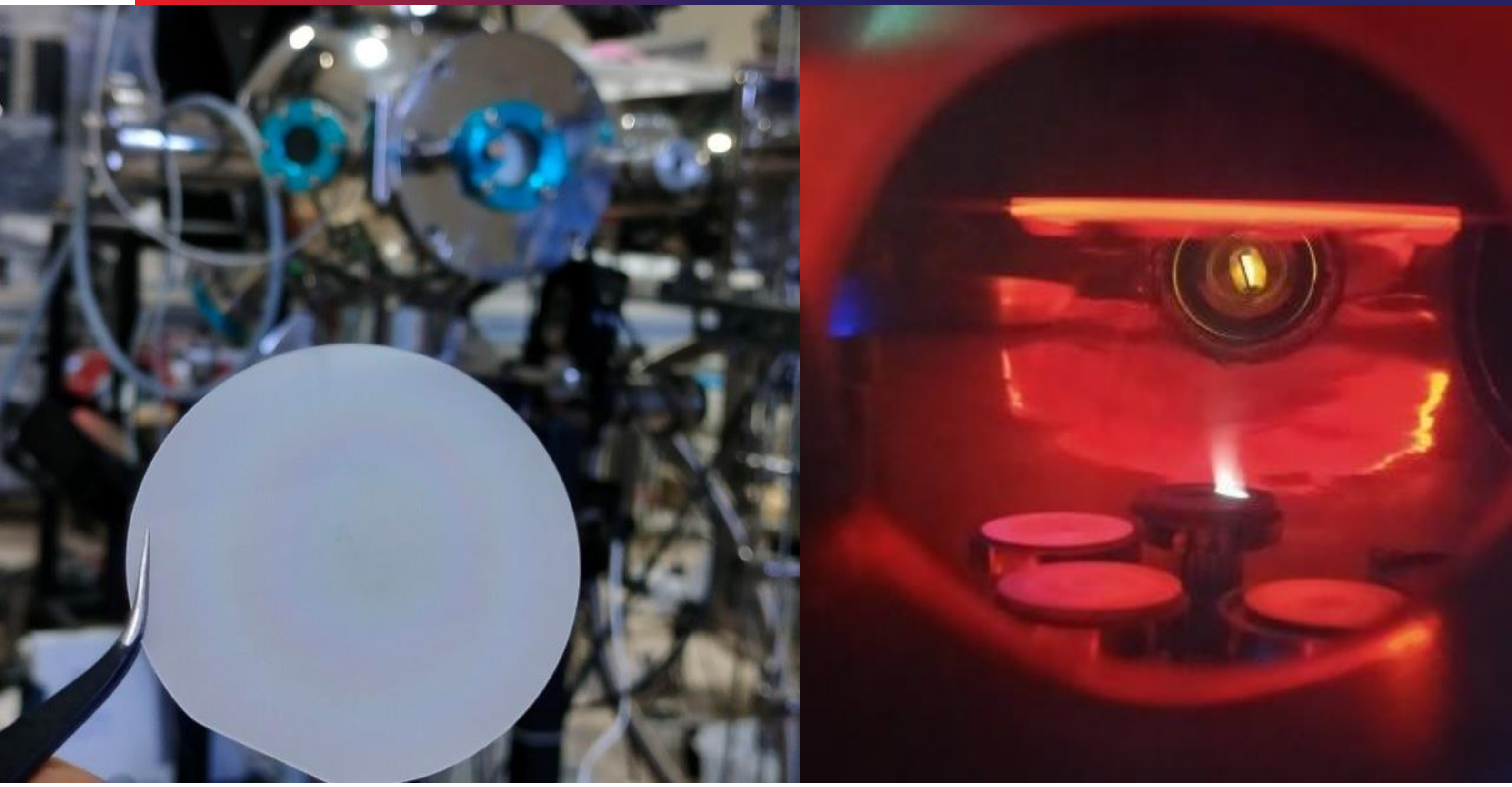


Semiconductors are building blocks of modern electronics, from phones and computers to lights to even solar panels. Why are they so special? Semiconductors are like dimmers for electricity. We can easily control how much electricity flows through them, unlike metals (which conduct too freely) or plastic (which blocks electricity completely). Like the silk and cotton threads blended in a sari, we can combine different types of semiconductors in heterojunctions to create even more powerful fabrics. It's like adding spices to a dish - each semiconductor brings unique properties, enhancing the overall performance.

We're exploring two exciting areas:

Perovskite solar cells: These next-generation solar panels turn sunlight into electricity almost as well as silicon, but they're thinner and potentially cheaper. We improve their efficiency, stability & make them eco-friendly by replacing toxic ingredients like Lead.

Functional oxide devices and integration: We make electronic devices from functional oxides that can handle high power, sense infrared light, or store data densely. We also integrate these functions on a cheap and mature platform like silicon.



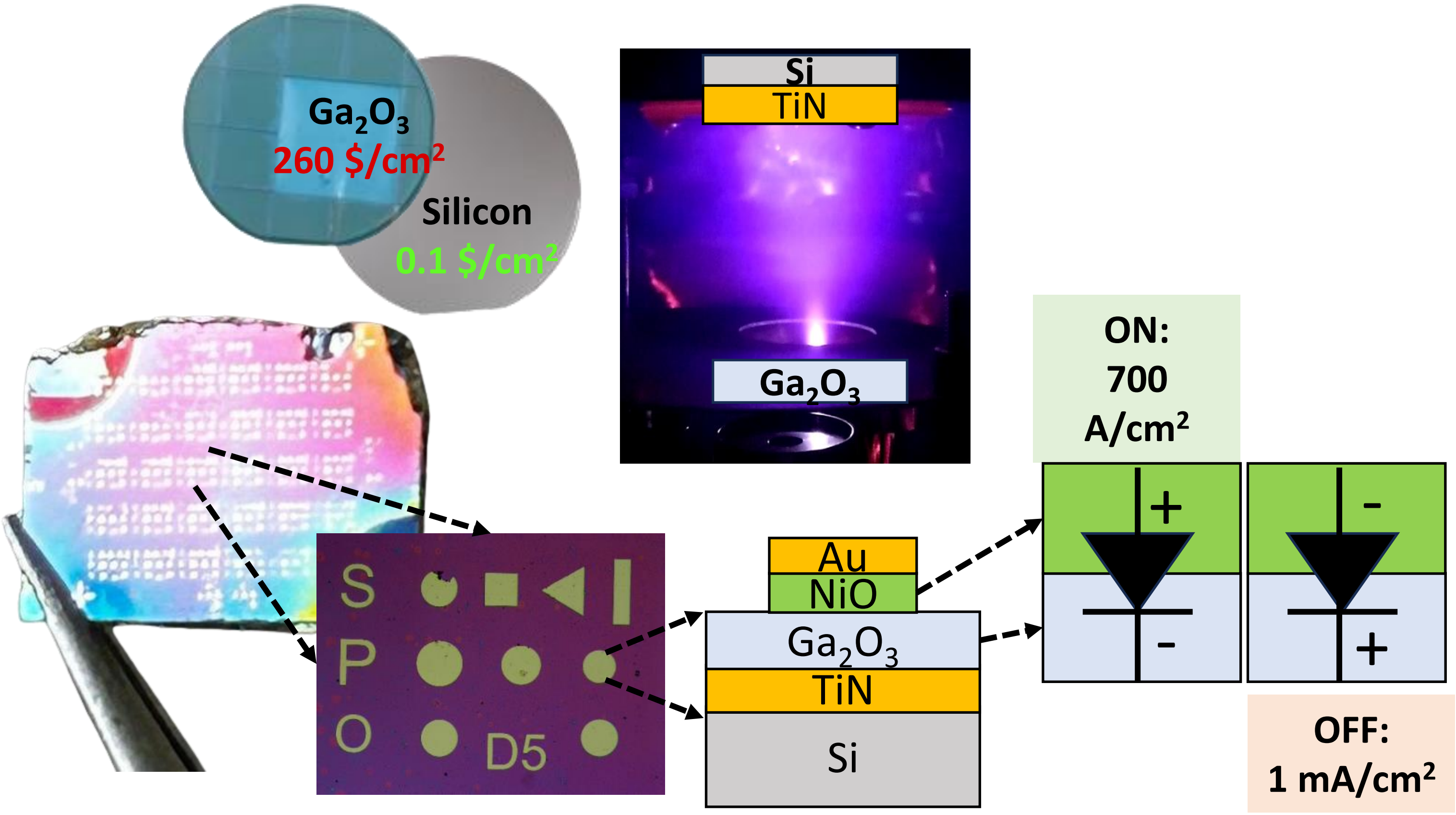
(from left)

- *conductive* Ga_2O_3*:Si film on Sapphire.*
- *High substrate temperature (1000 °C) oxide-PLD chamber*

Functional oxide devices and integration

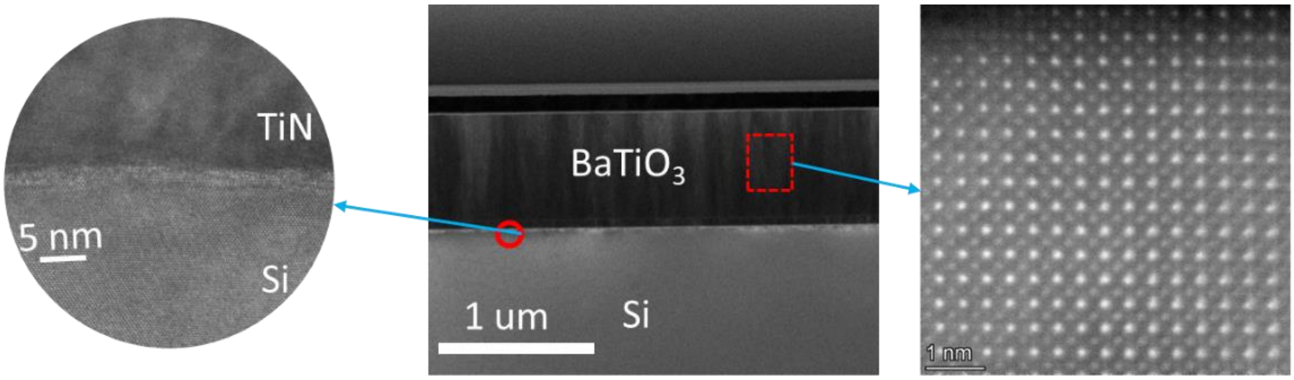
Imagine a combination of the power of silicon - the workhorse of electronics - with the unique abilities of materials like Gallium Oxide and Barium Titanate. We're doing exactly this by growing these "functional oxides" directly onto silicon. Why silicon? It's cheap, plentiful, and has decades of established technology. Think of it as a sturdy platform; we're adding powerful new tools to its arsenal. How do we do it? We use a technique called pulsed laser deposition, where a laser zaps a ceramic pellet, turning it into vapor. This vapor then condenses onto the silicon, forming a perfectly aligned (epitaxial) layer of the desired oxide.

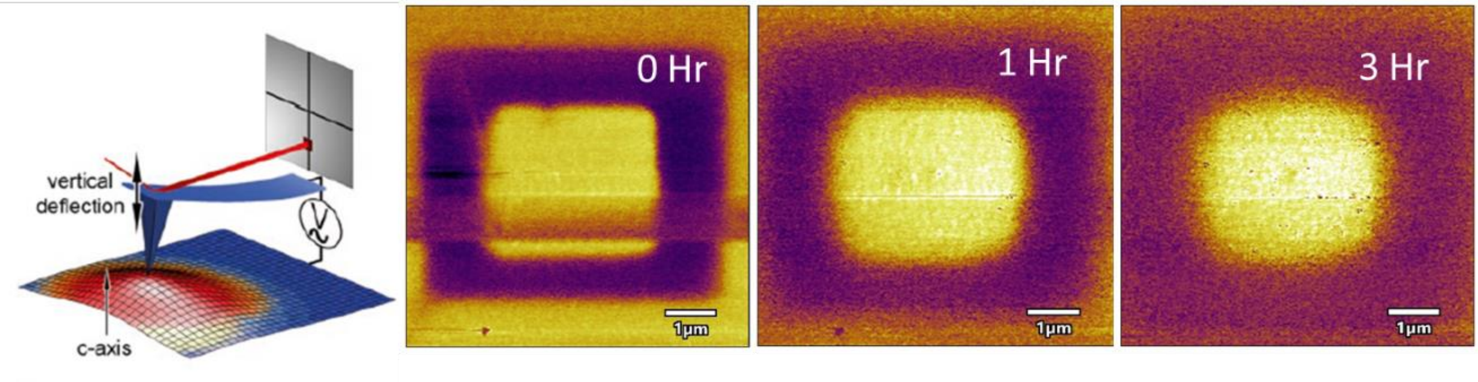
Ga2O3 is an emerging star in the world of power semiconductors that has the potential to revolutionize everything from smartphone and laptop chargers to electric vehicles and even power grids. It is 4 times more efficient at handling power than GaN, 10 times better than SiC, and a whopping 3000 times better than regular silicon! That means less energy wasted as heat and smaller devices. However, Ga2O3's native crystal is expensive and doesn't conduct heat well. Here's how we make Ga2O3 work its magic:



(top) Gallium oxide and silicon substrate prices, Ga_2O_3 deposition on TiN coated Si substrate (bottom) Ga_2O_3 on Si diode zoomed in and power electronic performance.

We coat a regular silicon chip with a thin layer of a metal called titanium nitride (TiN). TiN acts like a bridge connecting the powerful Ga2O3 to an affordable (~ 1000 times cheaper) silicon platform that is 5-10 times more efficient at dissipating the wasted power. Imagine a small, 1 cm x 1 cm diode made with this technology. When turned on, it could handle a whopping 700 A of electricity but leaks only a measly 0.001 amps when off.





- *Barium titanate on silicon TEM image: interface (left) atomic scale magnification (right)*
- *BaTiO$_3$ on Si: polarization/memory retention study through AFM*

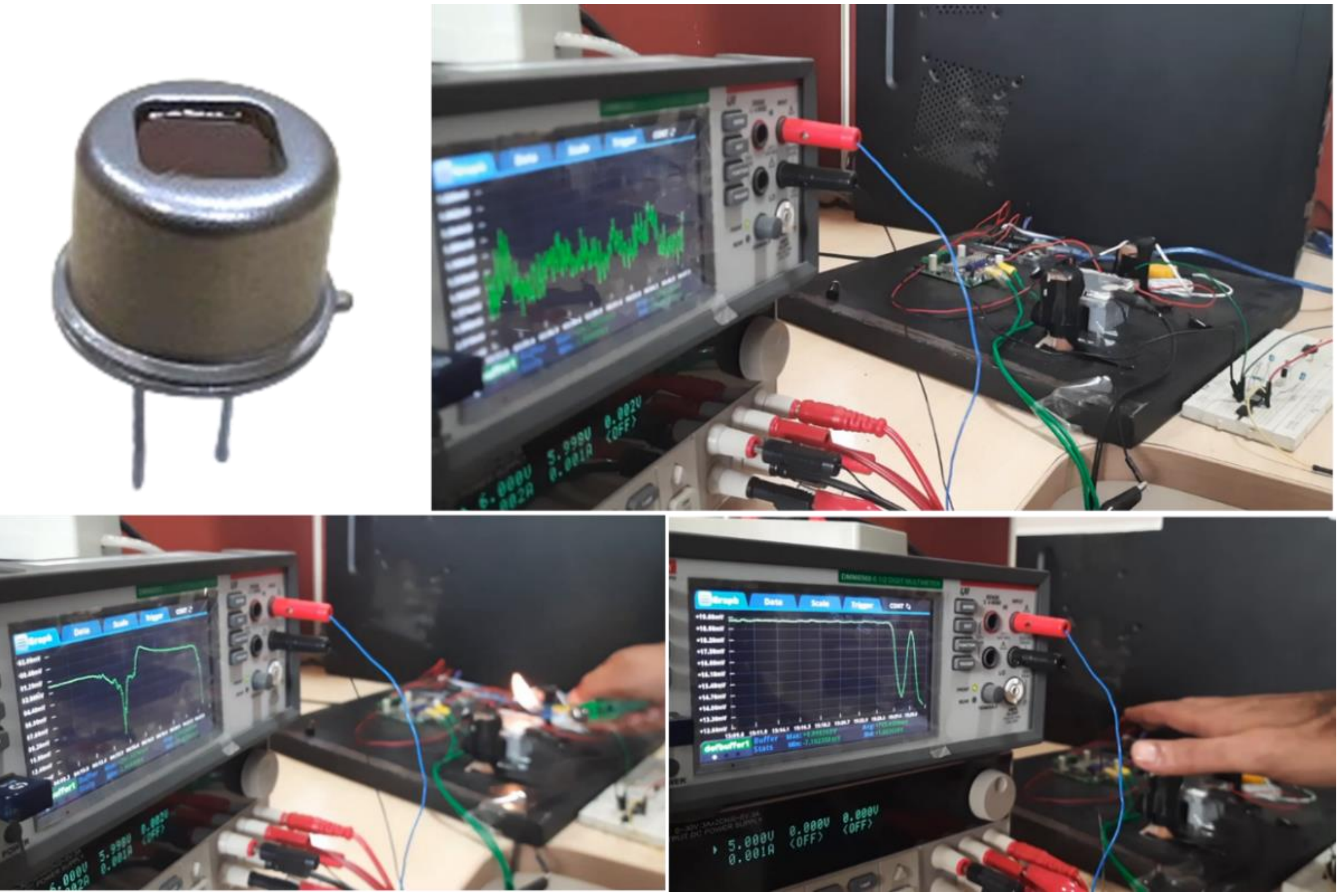
BaTiO3's ferroelectricity allows its memory to remember "on" and "off" positions, even when powered off, similar to magnetic HDDs. BaTiO3 non-volatile memory is faster, consumes less energy, and can store more data than flash drives or SSDs. While such devices work well on expensive strontium titanate substrates, integrating with affordable and industry-ready silicon is challenging. The ultra-thin BaTiO3 layers are necessary for these switches, but they don't retain the data for long when grown on silicon. We address this challenge by carefully controlling the growth environment, fine-tuning oxygen pressure, laser power, and the temperature of the silicon base.

Imagine a world where you can see not just colors but heat itself! That's the magic of infrared (IR) vision, and we're building cameras that let you do just that! Think of it like having X-ray vision for heat. Animals, trees, and even the Earth constantly radiate warmth like tiny furnaces. We can't see this with our eyes, but mid-IR (2 µm - 20 µm wavelength) detectors can, revealing a hidden world. We combine carbon, which soaks up mid-IR "light" like a sponge, with Lithium Tantalate (LiTaO3), a material that gets super-sensitive to even the tiniest temperature changes. When mid-IR light hits the carbon, it heats up the LiTaO3, producing a big electrical signal. That's how the camera "sees" the heat! Our sensitive (> 1000 V/W) mid-IR detectors are also:

Fast: They react to heat in < 20 milliseconds, as fast as hummingbird wing flutter!

Rugged: They can handle temperatures from freezing cold (-50°C) to scorching hot (120°C) for over 200 hours!

Imagine soldiers using these heat cameras to see enemies hiding in the dark, firefighters spotting hidden fires before they spread, or engineers finding cracks in bridges and faulty machine parts before they cause accidents. That's the power of mid-IR vision!



(top) Pyroelectric IR detector: development (right) and complete package (right)
(bottom) IR response of the detector to the flame and human hand

Perovskite solar cells

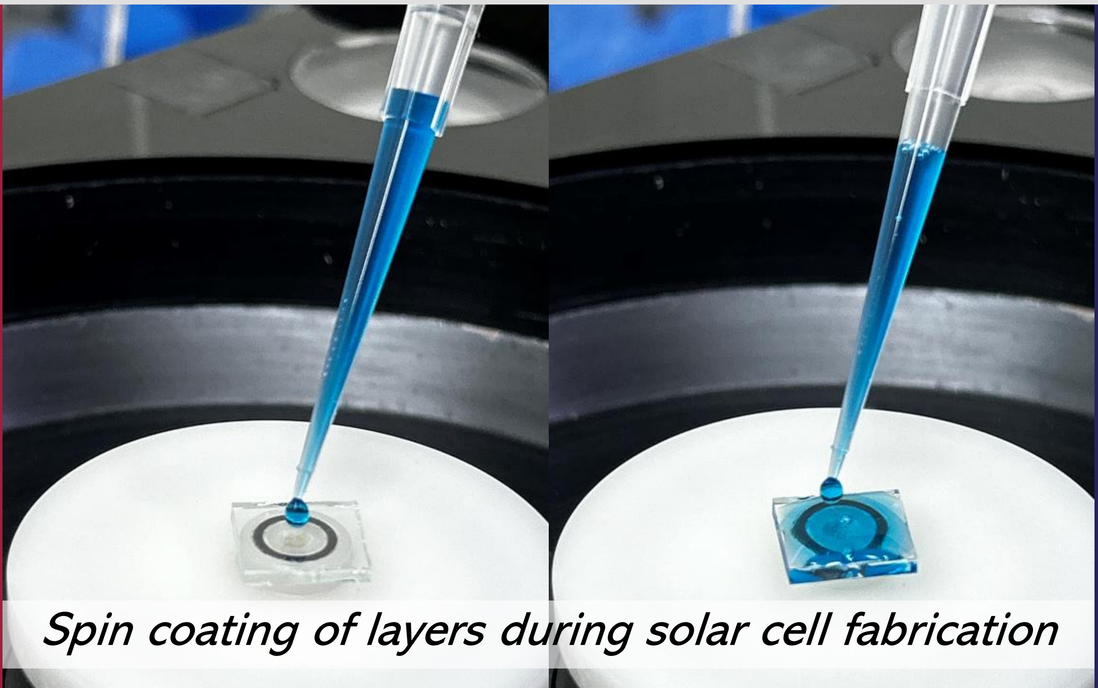
Solar energy reaching the Earth's surface is more than 1000 times global electricity consumption. To harness this available solar energy, we need solar cells. Perovskite on the other hand is a rapidly emerging technology. These perovskite cells are almost as good as the silicon ones, boasting an efficiency of 26%. Perovskite solar cells are p-i-n junction-based devices that generate carriers via photogeneration. The most researched perovskite-based absorbers in solar cells are 3D perovskites, represented chemically as the ABX_3 class. They are said to achieve better efficiencies but are unstable in ambient. This gave birth to more stable low-dimensional perovskites as absorbers. The ease of bandgap tunability by changing chemistry makes perovskites a flexible material for various applications. Apart from conventional use, some hybrid applications are agrivoltaics, building-integrated photovoltaics, and tandem cells, all of which use the semi-transparent nature of perovskites to serve dual purposes. Flexible photovoltaics are of interest in scientific and commercial domains; thus, perovskites can serve interesting applications in future generations.

Semi-transparent perovskite solar cells

In the era of transformative change and sustainable development, the integration of solar cells stands as a beacon of innovation and progress. In the pursuit of pioneering solutions for our nation's (world) energy needs, the emergence of solar cells represents a groundbreaking frontier that demands our attention. These cutting-edge technologies hold the potential to reshape our energy landscape and usher in a new era of sustainability and innovation. Solar energy reaching the Earth's surface is more than 1000 times global electricity consumption. To harness this available solar energy, we need solar cells. They're like tiny, super-efficient power magicians that do something insanely cool—they turn sunlight, yes, the mighty rays of the sun, into electricity. Silicon solar cells are like the superheroes of the energy market, capturing sunlight and turning it into electricity with efficiencies ranging from 18-22%. Perovskite solar cells, on the other hand, are the cool new kids on the block. They use a smart design with a thinner layer to convert sunlight into power efficiently, potentially costing less than the traditional silicon ones. Plus, they're like the flexible gymnasts of the solar world, easy to work with and bendy.

These perovskite cells are almost as good as the silicon ones, boasting an efficiency of 26%. But here's the catch – they have a challenge. Think of these solar cells like champions in a triple challenge: they must be really good at turning sunlight into electricity (high power conversion efficiency), they need to stick around for a long time without giving up (long-term stability), and they must be kind to the environment (environmental friendliness). It's like asking them to be both high-performance athletes and eco-warriors at the same time.

Now, imagine we're on a quest to solve a mystery –to unravel the mystery of making these solar champs extraordinary at turning sunlight into electricity and how to make these solar champs last even longer. It's like finding the secret sauce to keep them going strong. And here's the twist: there's this tricky character called Lead that we want to replace with something safer. It's like trying to find a superhero sidekick that's just as strong but way friendlier to the planet.



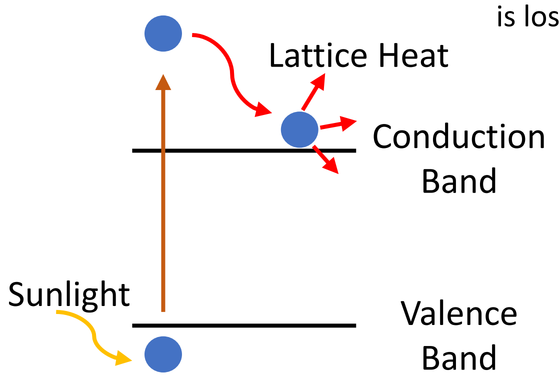
Spin coating of layers during solar cell fabrication

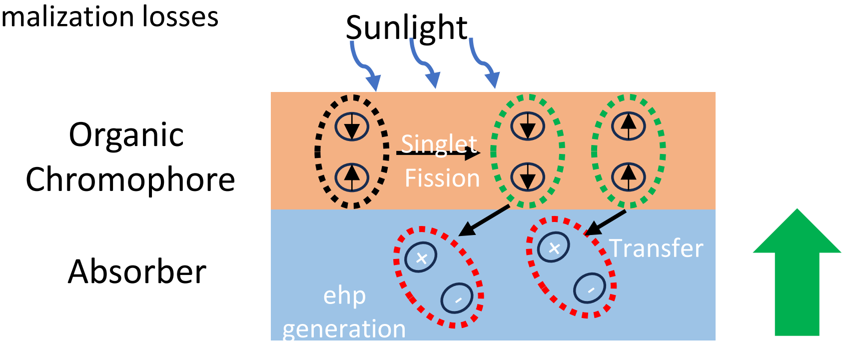
That's the puzzle we're tackling – making solar cells that are not just powerful and long-lasting but also Earth's best friends. Once we crack that, we're looking at a solar revolution that's not only efficient but also friendly to the environment. Cool, right?

Boosting Efficiency

Strategy I

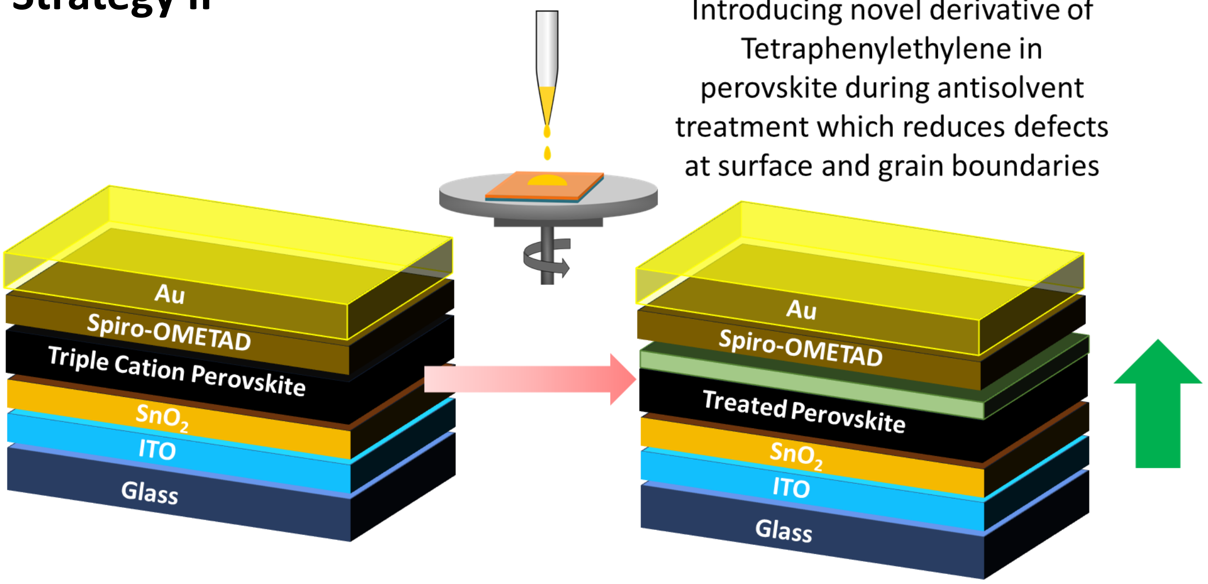
33% of available solar energy (excess to bandgap of the absorber material) is lost as heat energy also called thermalization losses





2X improvement in EQE!
Thereby, exceeding SQ-Limit

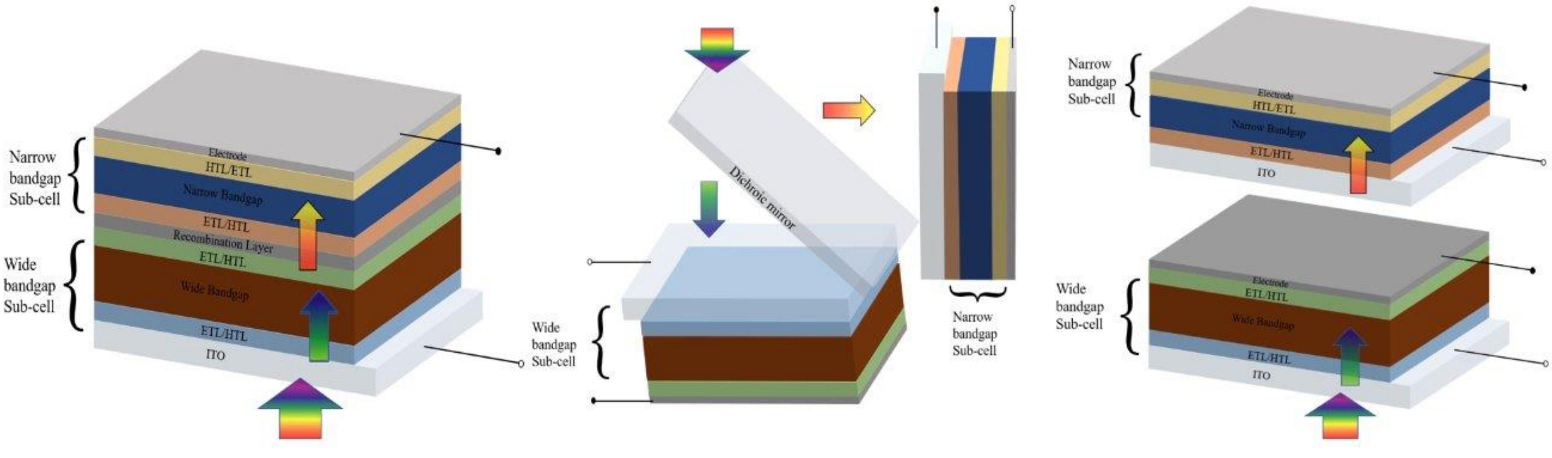
Strategy II



Introducing novel derivative of Tetraphenylethylene in perovskite during antisolvent treatment which reduces defects at surface and grain boundaries

21.4 % increase in power conversion efficiency

Strategy III



(A) 2- Terminal Tandem (B) 4- Terminal Tandem (C) 4- Terminal Tandem

In our quest to unravel the solar mystery, we've crafted a strategic approach to enhance efficiency on this exciting journey:

Boosting Efficiency-

Sensitizing Silicon with Singlet Fission- Tackling thermalization loss in single-junction solar cells by sensitizing silicon using singlet fission in organic chromophores. This innovative approach aims to double the external quantum efficiency and thereby break SQ Limit

Reduced defect Perovskite Solar Cells- Collaborating with chemists and materialists to fabricate high-efficiency single-junction perovskite solar cells. The focus is on addressing defects at the interface using cutting-edge materials, ensuring optimal performance.

Tandem Solar Cell Innovations- Pushing boundaries with multi-junction tandem solar cells. Exploring combinations like perovskite-silicon, perovskite-organic, and perovskite-perovskite to create powerful solar tandems that amplify energy conversion.

Ensuring Stability

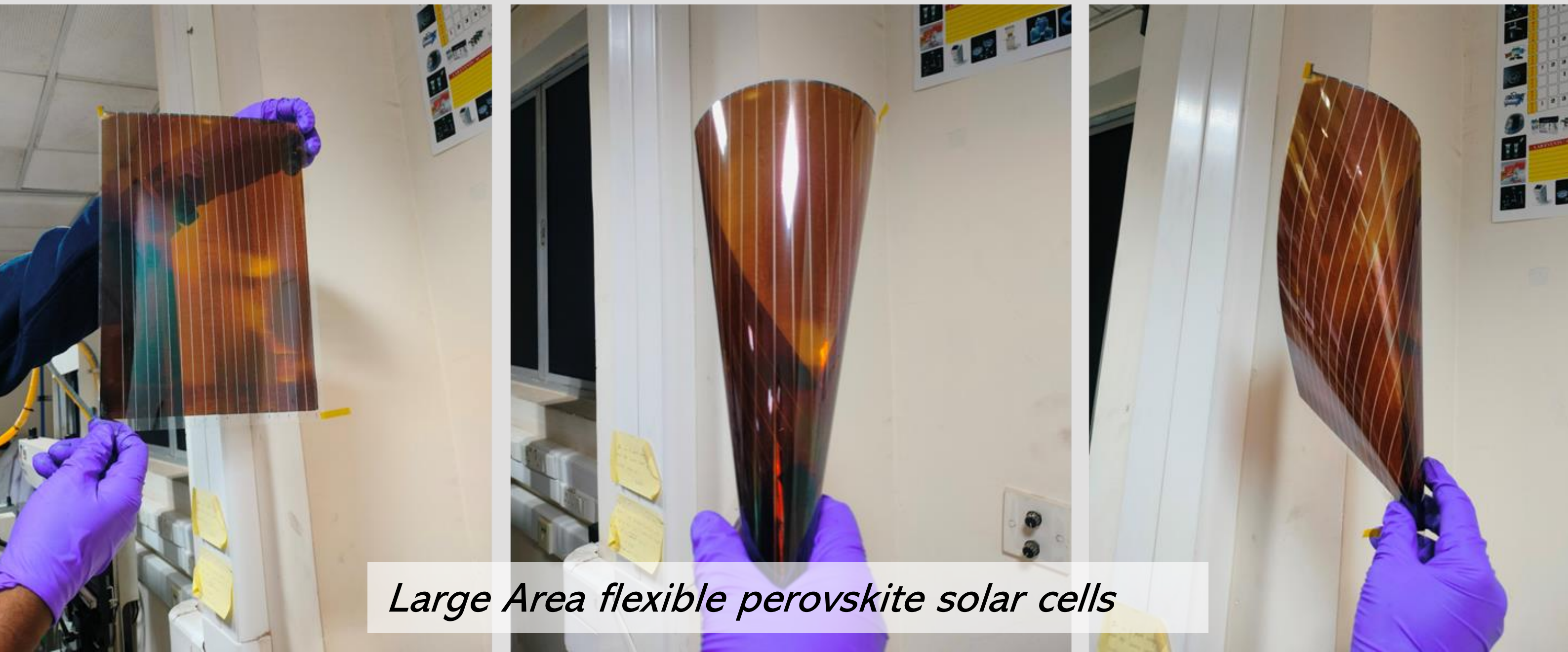
Low Dimensional Perovskite Exploration- Confronting the challenge of stability by delving into low-dimensional perovskites with novel materials. This approach aims to enhance the robustness of solar cells against environmental factors.

Optimizing Absorber Layer- Playing with the stoichiometry and materials of the absorber layer. This intricate dance with materials seeks to improve the overall stability of solar cells, ensuring they stand the test of time. Current solar cells provide power conversion efficiency of ~22%. We were the first to reproduce solar cells having efficiency greater than 20% in India in 2022 followed by IIT Bombay.

Eliminating Toxic Lead

Lead-Free Perovskite Solar Cells- Unveiling a revolutionary approach by fabricating lead-free perovskite solar cells with innovative materials. This is our commitment to addressing environmental concerns while maintaining the exceptional qualities of perovskite technology.

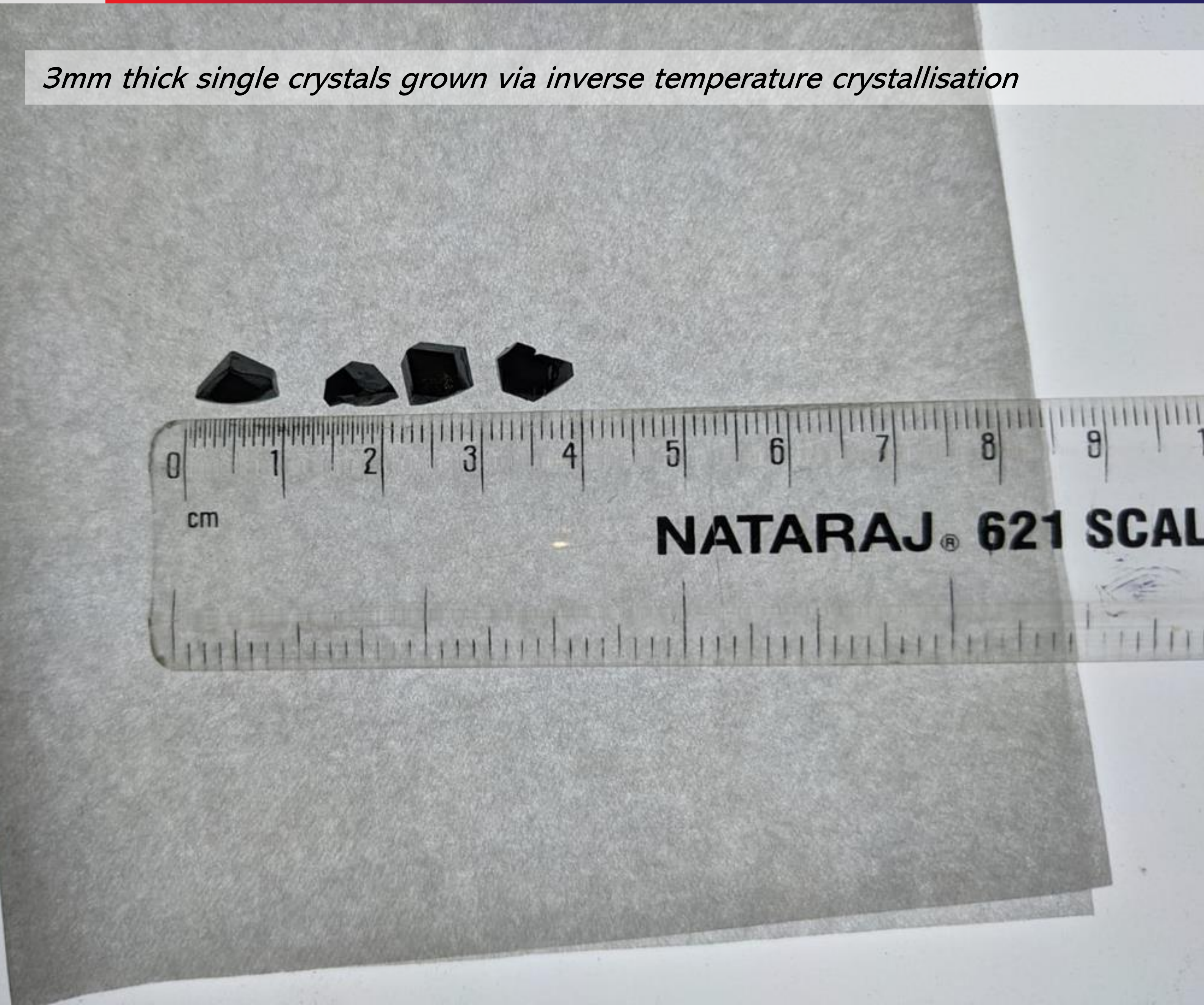
In this scientific expedition, we're not just solving the mystery; we're attempt to change the narrative of solar technology with groundbreaking advancements. Together with our interdisciplinary smart team, we are trying to pave the way for solar solutions that are not only highly efficient but also stable, sustainable, and eco-friendly!



Large Area flexible perovskite solar cells

Photoelectromagnetic effect

The photoelectromagnetic effect (PEM) is helpful in the analysis of recombination of photo-generated electron-hole pairs in perovskite single crystals and thin films. The photo generation that happens dominantly near the surface causes diffusion of the excess carriers into the bulk of the semiconductor. An external magnetic field perpendicular to this diffusion current deflects electrons and holes into opposite directions, giving rise to an emf in the direction perpendicular to the light and applied magnetic field. Combined with photoconductivity measurements, PEM can study the photo-absorber's photovoltaic capabilities (diffusion and recombination properties). If mobility is known, the PEM technique provides an unambiguous estimate of the photo-generated carrier lifetime in bulk and at the surface separately, something most other measurements struggle with.



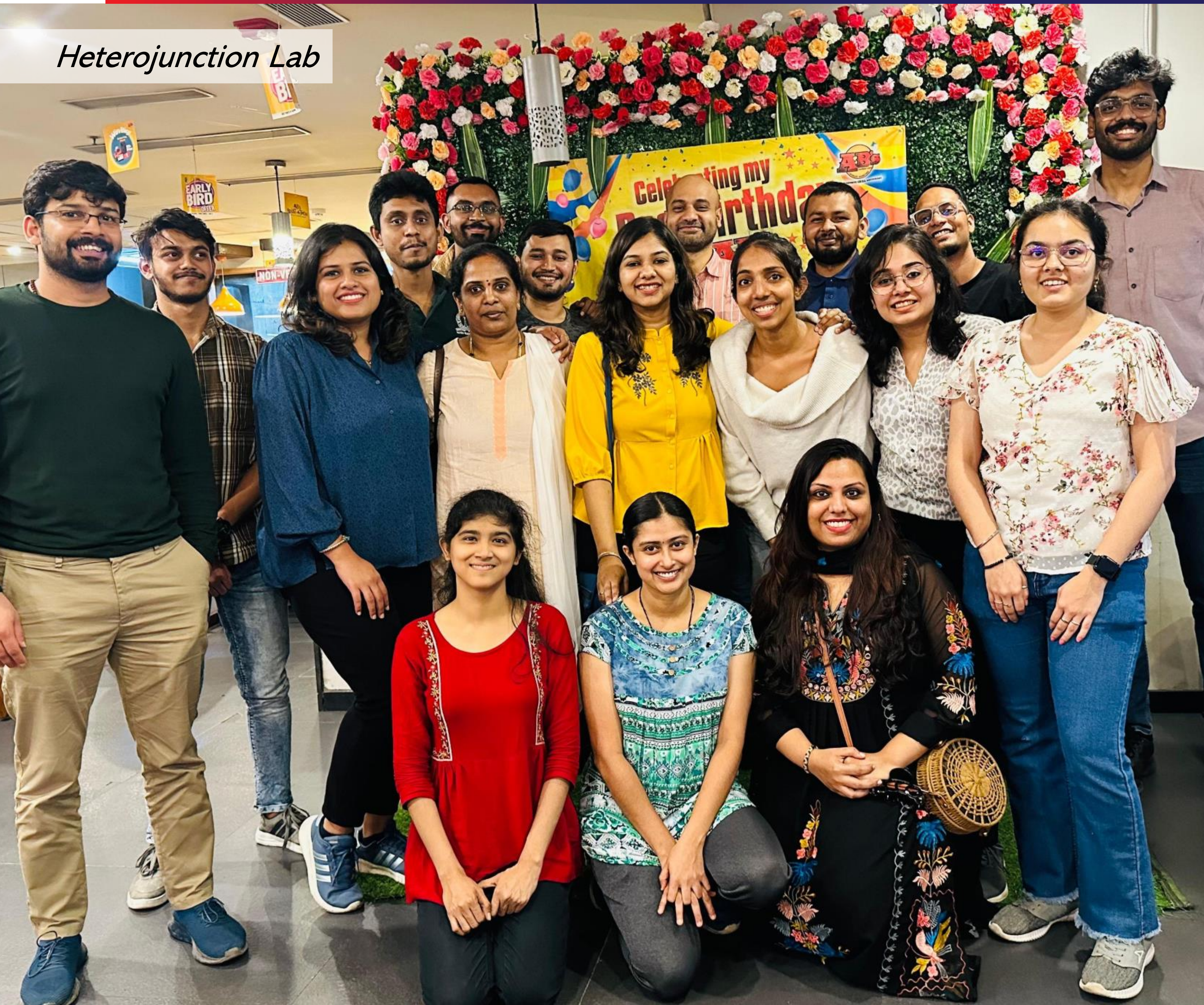
3mm thick single crystals grown via inverse temperature crystallisation

Meet the authors

Bhumika Sharma
(PhD Student)

Mahek Mehta
(PhD Student)

Sushobhan Avasthi
Principal Investigator



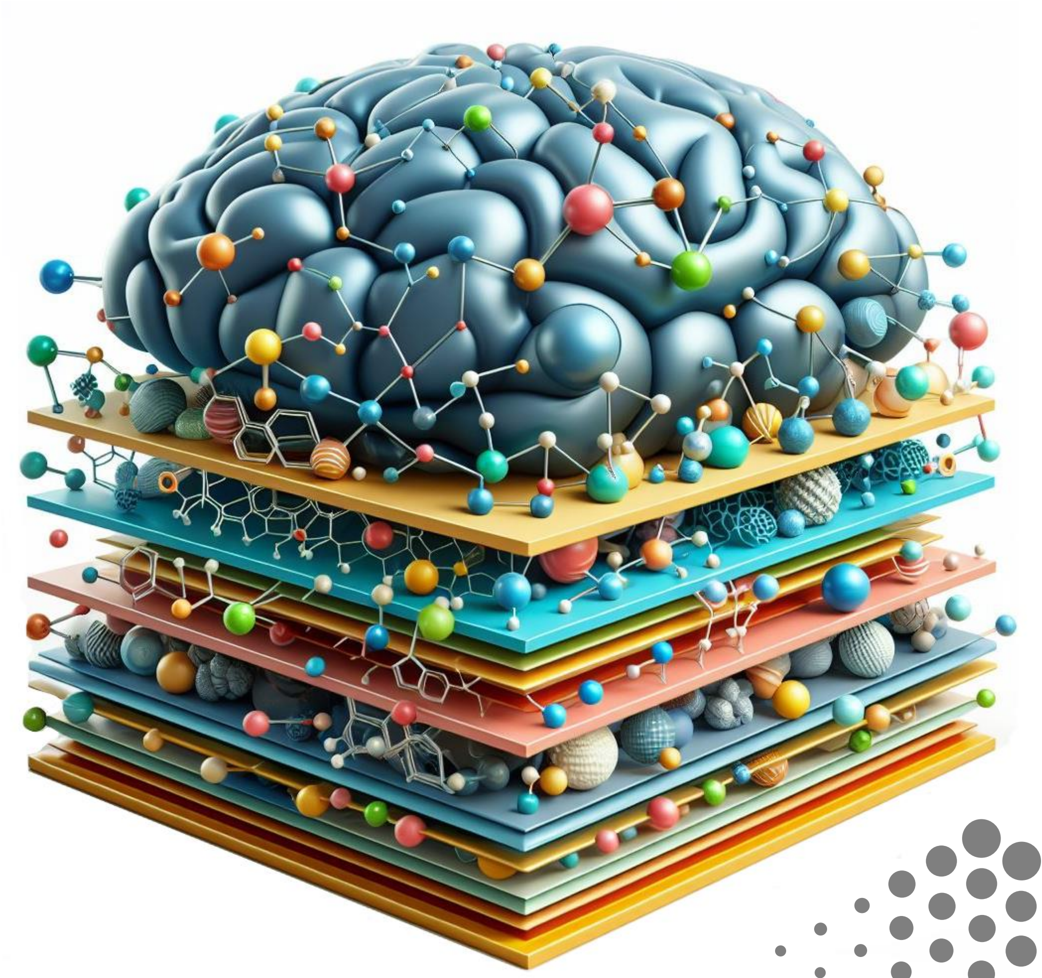
Heterojunction Lab

Mimicking a human brain
- Many-body molecular interactions In a memristor
- Research by the group at the Molecular Neuromorphic computing and Cognitive Systems Lab (MoNCS)


Dr. Santi P. Rath


Prof. Sreebrata G

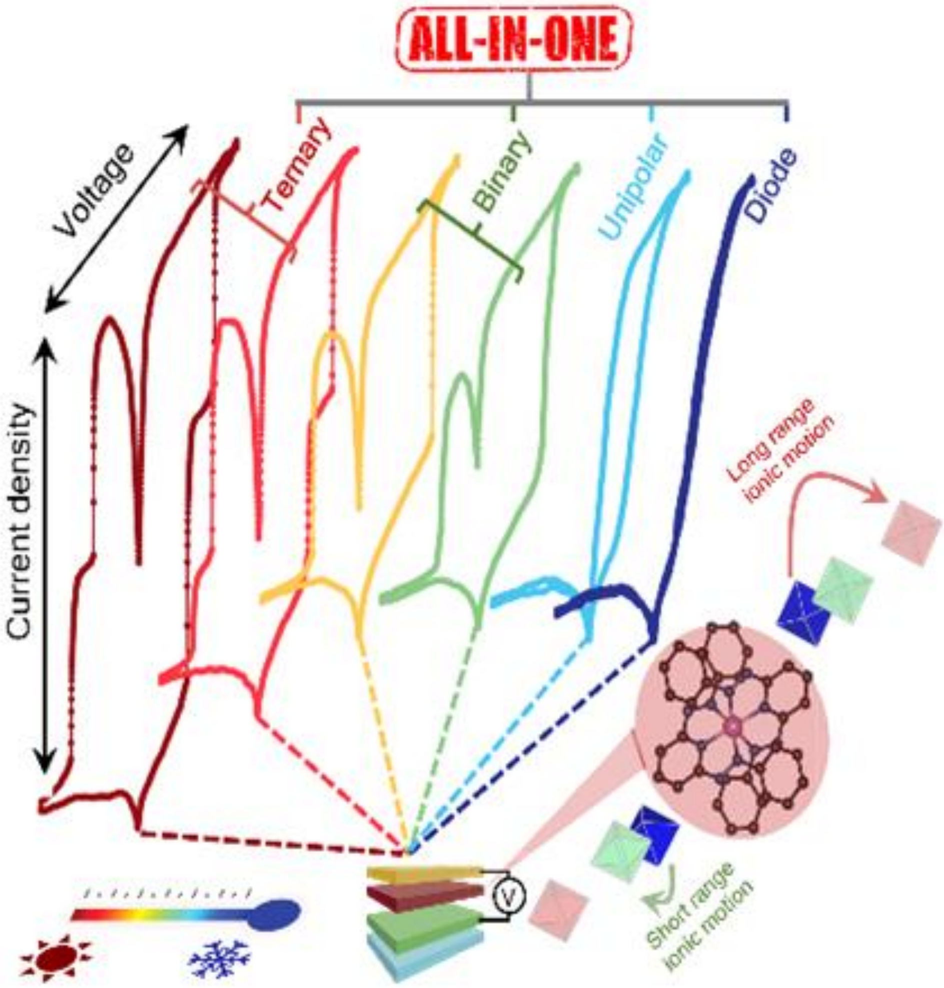

Dr. Sreetosh Goswami



MIMICKING A HUMAN BRAIN

https://onlinelibrary.wiley.com/doi/abs/10.1002/adma.202204551

Artificial intelligence (AI) has been heralded as the flagbearer of the fourth Industrial revolution. It is projected that AI and the services it will enable, represent the largest market opportunity in the history of mankind. Despite several hype cycles, a full-scale rollout of AI is yet too far. This is simply because we do not have computing hardware to support AI. The main difficulty is that the building blocks we are using today are made for precision but not perception. Our circuit elements such as transistors were designed for conventional computations but not to capture intelligence and cognition that are the pillars of AI or ML. Today, we are at an interesting juncture where we are at a dire need to reinvent computing technologies.

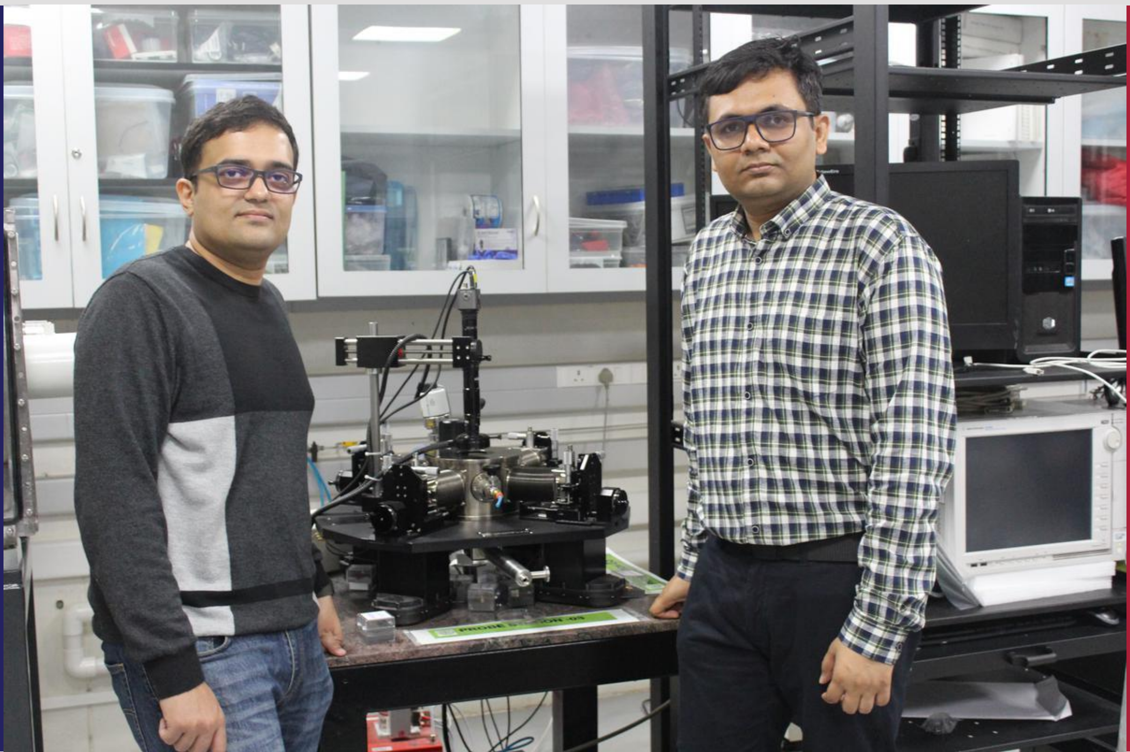


<u>Aim:</u> For designing the new generation computing hardware, Brain is the inspiration because the neuronal network in our brain vastly outperforms any artificial electronic analogues in terms of its learning, cognition and decision-making ability. We are designing devices that mimic the functionalities of neurons and neuronal network.

For a computer scientist, brain is amazing not only due of its abilities like cognition and decision making, but also because it does those remarkable capabilities are executed at the cost of just 20W power within a space of 1260cc. To put this number in context, let's consider an example. BrainScaleS machine was built from 20 complete conventional wafers incorporating 4 million neurons and 1 billion synapses and fills a large room but can simulate less than 0.4% of the human brain consuming orders of magnitude higher power.

According to Neuroscientists, Brain's computing supremacy primarily comes from the neuronal network contained in which is massively interconnected and reconfigurable. On top, the neurons in a brain operate on verge of chaos with a highly non-linear feedback mechanism. We are in search of materials that can capture such properties which is an elusive goal in any of todays circuits.

The idea behind this work is that in molecular materials hinge on complex interactions between molecules and ions, offering a multi-dimensional parameter space to embed, access, and optimize material functionalities. Can we manipulate this many body interactions to achieve plasticity, reconfigurability in device responses? We did that by performing the measurements as a function of temperature capturing functionalities spanning bipolar, unipolar, non-volatile, and volatile memristors with sharp as well as gradual analog transitions were captured within a single device. This insane amount of variability could not be captured in any standard theoretical platform, and we ended up designing a mathematical space that could enable almost all possible characteristic variations, desirable in neuromorphic devices. The same device could be operated both in analog and digital regime just by tuning the activation energy which was simply mind boggling. This could potentially offer a blueprint for designing the next generation of molecular neuromorphic devices that can be plastic, fault tolerant and can be operated on the Edge of Chaos, like a bunch of neurons.



ALUMNI SPEAKS

Meet Our CeNSE Alumnus !!
Jayaprakash Reddy pursued his PhD from 2012 to 2017 at CeNSE under the guidance of Prof. Rudra Pratap. He is currently working as a scientist at the ISRO Inertial Systems Unit, Thiruvananthapuram. Read on to know more !!

Can you briefly describe your academic background?

My journey began with a bachelor's in Mechanical Engineering at Jawaharlal Nehru Technological University, Anantapur. Achieving GATE AIR-16 led me to pursue a Master's in Mechanical Engineering at IISc and later a Ph.D. at CeNSE, focusing on “Towards design and development of MEMS (microelectromechanical systems) gyroscopes” under Prof. Rudra Pratap. Proudly, our research resulted in the first indigenous MEMS gyroscope at CeNSE. Notably, a technology I developed contributed to India's first set of MEMS gyroscopes on ISRO's PSLV-C55 POEM2 Mission in 2023.

What is your current role at your job and how does your everyday work look like?

I currently serve as a Senior Scientist/Engineer at ISRO-Inertial Systems Unit (IISU), Indian Space Research Organization. My responsibilities predominantly involve hardware realization of inertial sensors and establishing experimental setups for characterization. I am actively engaged in review meetings for various sensors and inertial systems, occasionally managing and coordinating teams to meet space mission deliverables. Additionally, I allocate time for various technology development programs and advanced R&D activities.

Can you give a brief of the sector you work in, and its significance?

I am employed at ISRO-Inertial Systems Unit (IISU). The IISU specializes in developing and realizing inertial systems for all ISRO and Indian space missions. These sensors/systems fall under the strategic category, emphasizing the need for self-reliance and the development of cutting-edge technologies. Inertial systems play a critical role as subsystems in rockets and spacecraft. They are vital for determining the designated path, position, and orbital parameters of rockets and spacecraft in real-time. This information is instrumental in guiding control systems to command actuators and small boosters, ensuring the rocket or spacecraft follows its intended trajectory.

What motivated you to transition from academia to India's space agency, and how did this transition feel like?

Several motivating factors drove my transition from academia to ISRO, a government agency, as outlined below:

Applied Research: The chance to apply theoretical knowledge gained in academia to real-world space exploration and technology development.

Cutting-Edge Projects: Involvement in cutting-edge projects and missions that have a direct impact on space exploration and scientific discovery.

Access to Resources: Government space agencies often have substantial resources, including funding, advanced facilities, and access to state-of-the-art equipment.

Mission-driven Work: Contributing to missions with specific goals, such as advancing space exploration, sensor technology or scientific research, are motivating factors.

Global Impact: Working on space programs that have a global impact, raising international collaboration in space exploration and research.

Inspiration and Passion: The passion for space technology exploration and a desire to be part of endeavours that push the boundaries of human understanding.


22 July 2015

Describe any challenges you faced while transitioning and how did you overcome them?

The transition from academia to industry/government organization presented several challenges:

Lack of Industry Experience: Navigating the practical requirements of the job with an academic background posed a challenge.

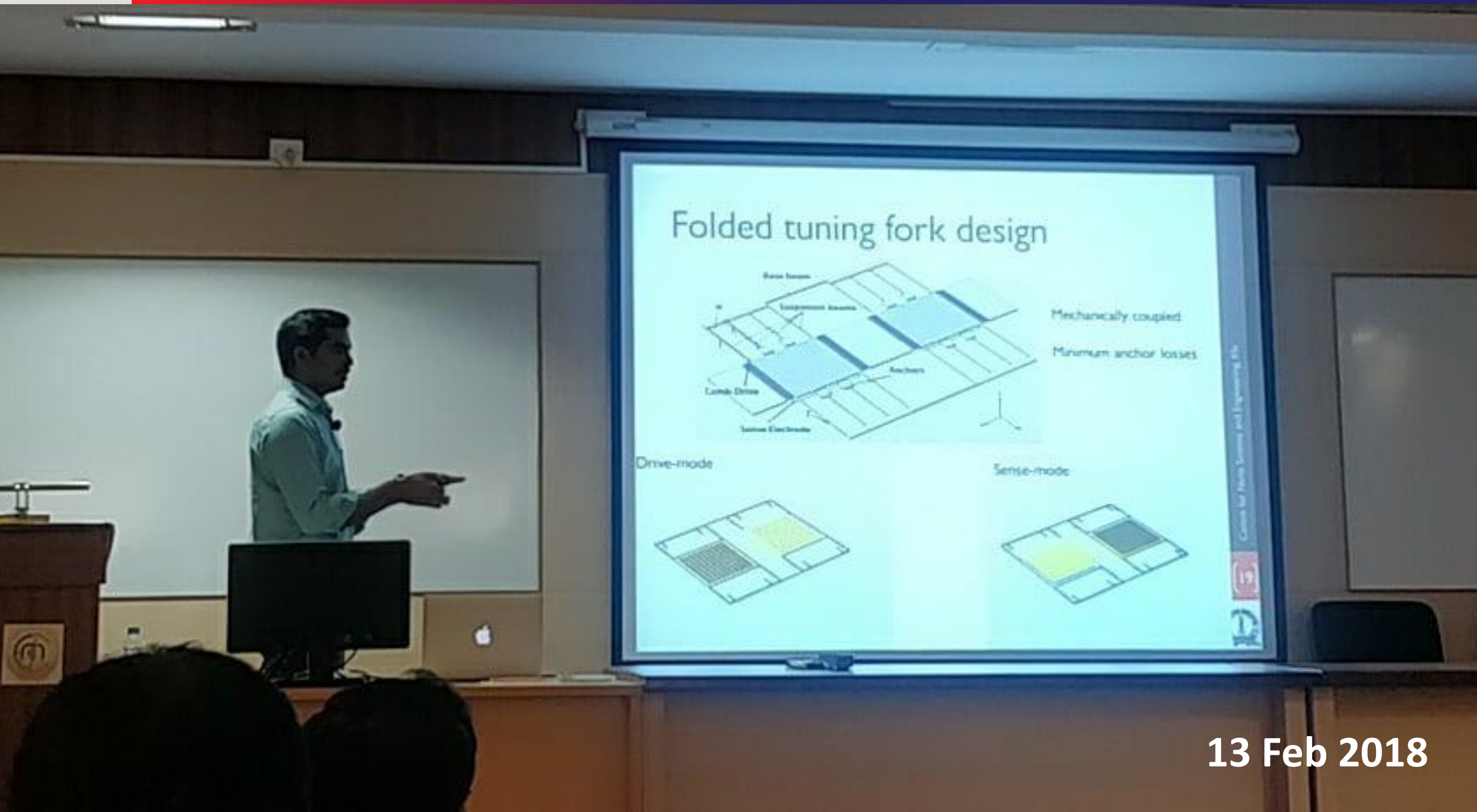
Overcoming: Actively seeking guidance from experienced colleagues helped me understand the nuances specific to the government organization, distinct from academia.

Team-Oriented Background: Shifting from independent research in academia to a team-oriented setting proved challenging.

Overcoming: I focused on improving teamwork skills, fostering relationships, actively participating, maintaining flexibility, celebrating team successes, and practicing patience and persistence.

Going the Extra Mile: Moving from an idea to a working product, especially in the context of space technology, required going above and beyond.

Overcoming: I delved into the internal knowledge base, engaged in discussions with senior colleagues, and consistently followed event calendars of inter-centre activities. Attending technical review forums helped me gain in-depth insights into the processes involved.



13 Feb 2018

How easy is it to maintain a healthy work-life balance in your job, and what do you do, to achieve it?

With day-to-day work experience, I anticipate the demands of the job in terms of deliverables, often facing urgent requirements. Through the accumulation of knowledge and experience, I've learned that planning, coordinating, and managing tasks are essential for maintaining a healthy work-life balance. Introducing sports into my routine has proven to be a valuable way to recharge and establish a healthy equilibrium between my work responsibilities and personal life.

Any advice you have for the current students who might want to choose this career path (courses, certifications, networking, myths/ misconceptions of the industry, and any advice in general)?

Educational Foundation: Establish a solid foundation with fundamental educational base in pertinent fields such as physics, basic electronics-circuits, mechanical engineering, depending on your interests. Taking courses in MEMS design and microfabrication process will prove to be highly beneficial.

Optimize Time: Optimizing time involves diversifying activities beyond research, as engaging in hobbies and socializing contributes to overall well-being. Balancing work with leisure fosters creativity and resilience, positively impacting the quality of research efforts.

Networking: Create connections in your field by attending events and joining online communities. Engaging with professional bodies like IEEE, IEI, ASME and others can lead to job possibilities and collaborative opportunities.

Myths and Misconceptions: Government organizations possess financial resources dedicated to conducting applied research in advanced technologies to meet the needs of the country and humanity.

What are your future/ long-term career goals?

My long-term career goal is to take a proactive role in advancing MEMS and miniature sensor technology. Ultimately, I aim to motivate and empower upcoming innovators, encouraging them to make substantial contributions to the field of MEMS and miniature sensor technology, with a significant impact on both space and ground applications

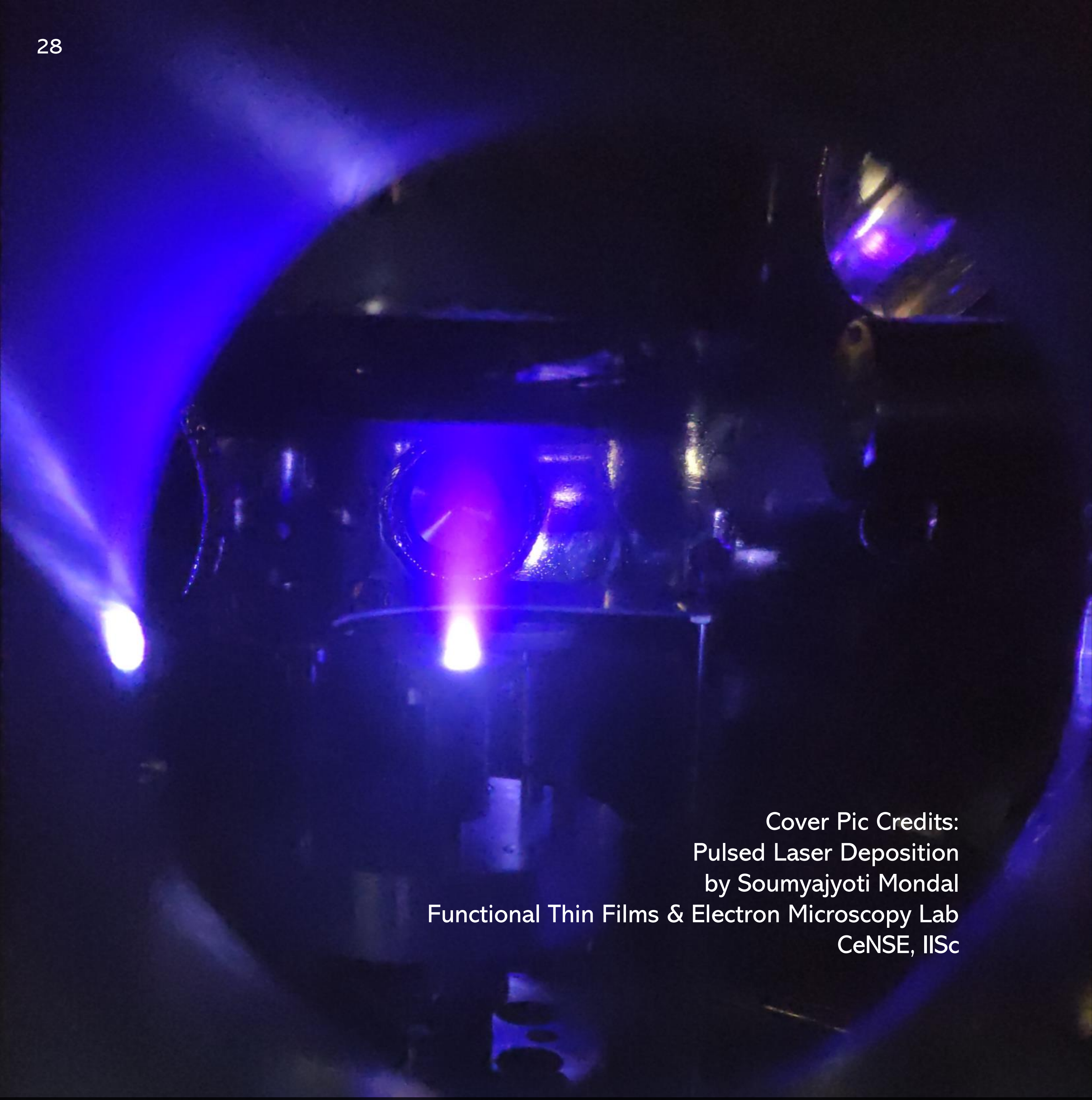
Any other advice/ words of wisdom you have for the current student community in India, specifically IISc and CeNSE, maybe?

Being Accountable: Students should feel a sense of accountability for scholarships funded by taxpayers, recognizing the public investment in their education.

Being privileged: Researchers should embrace a profound sense of privilege in having access to state-of-the-art research facilities and distinguished faculties.

Open Mindset: Maintaining an open mindset, with both attentive ears and keen eyes, is paramount for researchers seeking to uncover novel insights across diverse research domains.

Collaboration and Acknowledgment: For researchers, successful collaboration and proper acknowledgment are vital. Establish clear communication channels, define roles and contributions upfront, and stand-in an inclusive environment where diverse perspectives are valued.



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CeNSE, IISc

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