PressCeNSE

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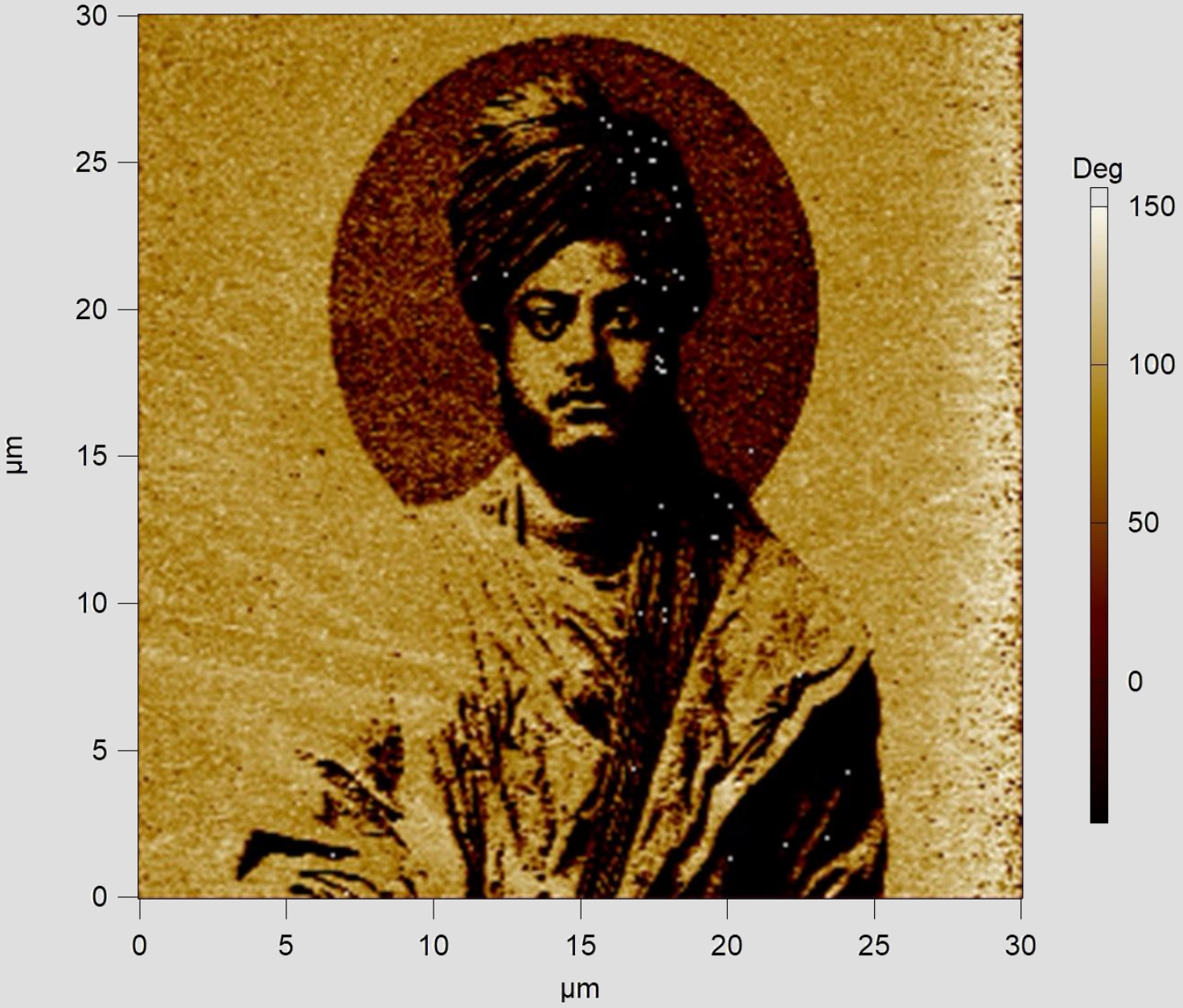


Pic Credits: Mr. Venu V Bhat, MNCF, CeNSE
Nanoscale portrait of Swami Vivekananda, made using PFM Lithography

Message from the Chair

"It has been a time of mixed emotions for our community as we celebrate remarkable achievements while mourning the loss of a beloved colleague."

- Srinivasan Raghavan
Professor, Chair, CeNSE

Dear CeNSE Family,

It has been a time of mixed emotions for our community as we celebrate remarkable achievements while mourning the loss of a beloved colleague.

We are deeply saddened by the passing of Dr. R. Muralidharan, a visionary who pioneered Gallium Nitride (GaN) research at DRDO, marking a significant milestone for the nation. His contributions will continue to inspire generations of researchers.

On a brighter note, CeNSE participated in the first INUP-i2i Users' Meet at IIT Bombay, in collaboration with the Ministry of Electronics and Information Technology and Semicon India 2024. These events showcased the impact of INUP, featuring innovative startups, lively discussions and strategies to advance the ISM, exemplifying how CeNSE bridges research with real-world solutions.

We were privileged to host Dr. Randhir Thakur, CEO and MD of Tata Electronics, during the valedictory session of our Semiconductor Fabrication Training Program. This intensive initiative, which trained over 100 engineers, underscores CeNSE's commitment to strengthening India's semiconductor ecosystem.

Read on to see how our researchers continue to excel, with advancements in 4D printed shape memory composites, piezoelectric MEMS, and Raman fiber lasers opening new avenues in biomedicine, energy, and communication.

Lastly, we celebrate our alumni, like Dr. Awanish Pandey, now Assistant Professor at IIT Delhi, whose successes reflect CeNSE's enduring impact.

Thank you all for your dedication, passion and continued support. Together, we are building a legacy of innovation and excellence.

CeNSE NEWS

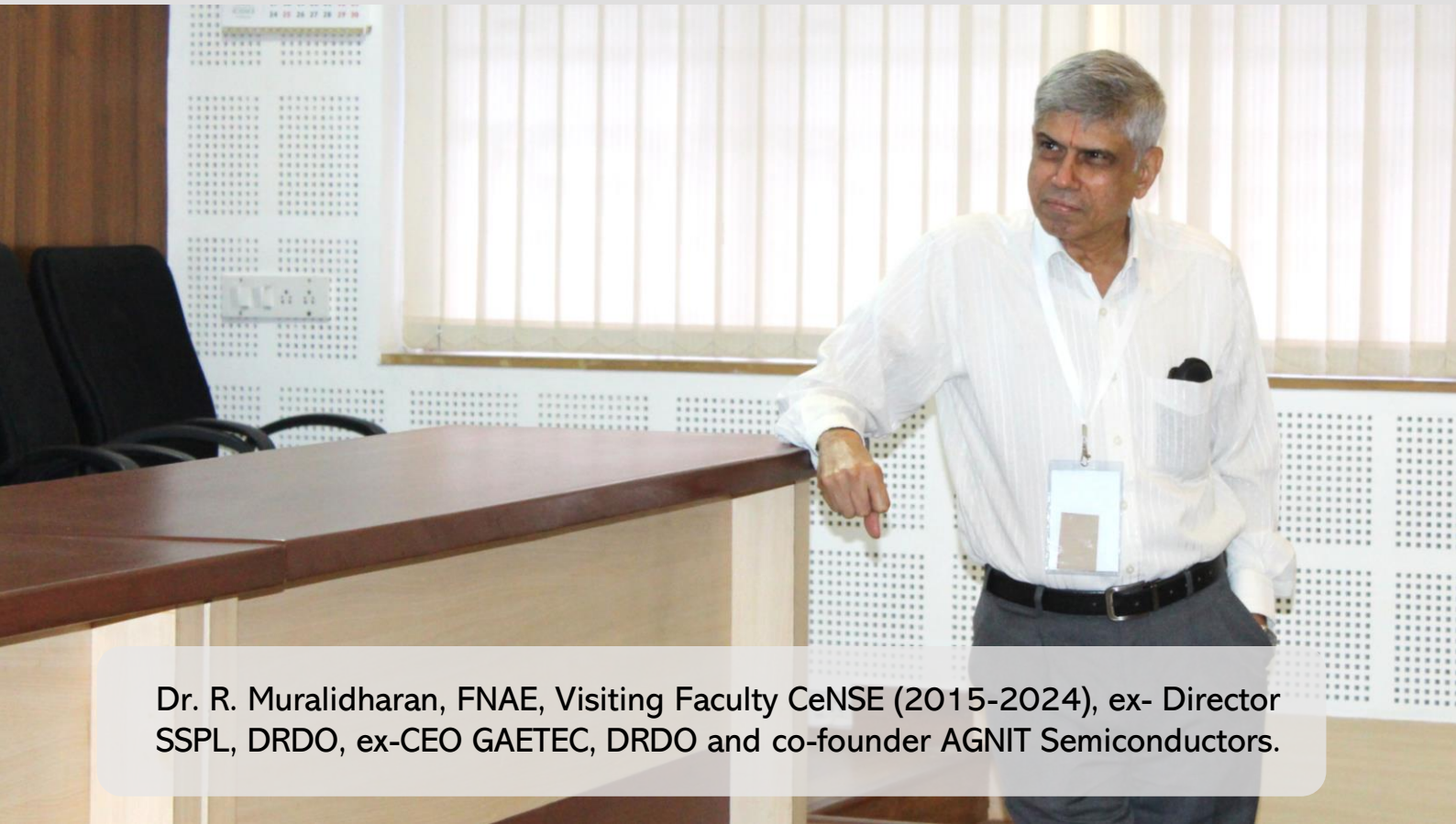
Remembering Prof. Rangarajan Muralidharan

We are deeply saddened to share that Dr. R. Muralidharan, a member of our faculty for years, passed away recently.
Dr. Muralidharan recognized the importance of GaN and was primarily responsible for initiating GaN research in DRDO, probably the first such program in the nation.

- CeNSE Family

“ A man who truly was a genuine 'karma yogi'. Never ever speaking about his accomplishments but contributing immensely to everything that he had worked on. Silently & relentlessly working/mentoring/guiding all the time, and with unmatched passion. He was witty and could invoke technical humor even in the midst of serious discussions.”

- Dr. Digbijoy N Nath



Dr. R. Muralidharan, FNAE, Visiting Faculty CeNSE (2015-2024), ex- Director SSPL, DRDO, ex-CEO GAETEC, DRDO and co-founder AGNIT Semiconductors.

It's rare in today's world to find someone who has true depth of knowledge in a diverse range of topics, with unrivalled experience spanning decades of dedicated work and yet being the epitome of humility, compassion & selfless mentorship. Zero show-off, zero pride. That was Dr. Muralidharan Rangarajan, or Dr. RM as we'd address him.

He wasn't a person who'd sit in his office & instruct students/engineers to do stuff. He would go to the measurement lab and actually measure transistors or photodetectors with students, until his health permitted.

He never sought any limelight. Hard to believe anyone could be so down-to-earth in spite of carrying an ocean of knowledge within him. He would talk to an undergrad student the same way he'd talk to the Director/Chair of some institute - with respect, compassion. He was forever curious to learn, blending in with people of any age group with effortless ease.

We used to refer to him as our 'Bheeshma Pitamah' of the gallium nitride program at IISc and had been helping our (GaN group) PhD/MTech students, and our startup AGNIT and the GaN foundry (GEECI) in ways I can't possibly explain here. Most of my PhD students from the 2015-2020 time period spent more time discussing research problems & data with him than with me. I've learnt more from him than anyone else ever since I joined IISc, more than 10 years back. Speaking of which, I joined IISc without any postdoc experience (or rather a very short postdoc), and so, looking back, I was largely unfocussed/clueless about broad research directions because I was confused, very inexperienced on many fronts and I didn't realize how much I didn't know. Dr. Murali was my 'advisor', sent by God or destiny. He shaped me, guided me, mentored me at every step.

I wish I got more time with him to acquire knowledge & guidance from him. But destiny had other plans.

Oh, I haven't even written how much he cared for and helped me & my family. Buying & bringing medicines for us late at night when my family was in quarantine during covid - just one of many instances.

Still can't believe that I won't hear his voice again on the other side of the phone. A void too big to be filled, personally & professionally.

You left us too soon, guruji.

If there's something called 'soul', may his soul get eternal/divine peace.

- Dr. Digbijoy N Nath

Dr. Rangarajan Muralidharan, Murali to me and us, passed away after a brief illness last month. While it is a great loss and one could mourn, I am sure, if he is looking down, he is saying, “what are you waiting for, move. There are things waiting to be done today. We are already late by 2 weeks.” That was Murali. A down to earth, frank and candid, man of action. Sulochana, his wife, calls him a busy bee. This attitude boiled down to everything he involved himself in from GaN research to helping a young faculty member find a house to stay in Malleswaram, to driving a relative in need to the hospital during the peak of COVID. To the extent I know, he initiated GaN electronics in India. Serving in the Solid State Physics Laboratory (SSPL), DRDO’s flagship devices lab, as a scientist, I am sure he had a ringside view of emerging global trends in technology. Knowing him, he must have recognized the evolution from GaAs to GaN, when it came to high power and high frequency and then decided to push management to start a GaN effort in India. It probably crystallized around the late 90s when he spent a year in Germany working on GaN MBE. I came back to India in 2005 after 10 years in the US. Murali was my host in SSPL. What touched me the most immediately was the fact that even though his daughter was not well and if I remember correctly hospitalized, he still managed time to coordinate my talk at SSPL. When I eventually decided to join IISc, he was most supportive, even though I had to decline the offer from SSPL. One tends to have a chip on one’s young shoulders on returning from a stay abroad. Such interactions quickly grounded me. Fast forward to 2009 to 2014 when the IISc GaN project was launched as part of a larger SSPL initiative, I was witness to his shepherding a large group of SSPL scientists, of all age groups, from epitaxial growth to MMIC design and testing, from berating them to cracking a joke the very next moment to deliver India’s first GaN technology. I don’t use the term technology in a light sense here but as one that has met end user qualification criteria. It also opened my eyes to the fact that there is no dearth of talent, only resources and systemic adequacies.

In 2016 he joined CeNSE, IISc. Our team here could not have accomplished what we have on the academic front in mentoring students, across departments, in setting up GEECI and in getting AGNIT going without his critical inputs. We may know the road, have the energy to travel on it, but he already had and knew what was out there. We don’t have anybody now with is kind of foresight. Rest in peace Murali. We will miss you.

- Prof. Srinivasan Raghavan

CeNSE NEWS

CeNSE participates in the INUP-i2i Users Meet at Indian Institute of Technology, Bombay

The first Indian Nanoelectronics Users' Programme - Idea to Innovation (INUP - i2i) Users' Meet was organized in association with Ministry of Electronics and Information Technology, GoI on August 10, 2024, at IIT Bombay and CeNSE, IISc was honored to be a part of this meet.

This event was organized to celebrate INUP's success, share the experiences, and shape the future of India Semiconductor Mission. This special event was a platform for the users from academics and industry to showcase the achievements as well as to participate in special sessions, lively discussions, and fantastic networking opportunities!

The event highlighted some of the most promising startups in India's semiconductor industry, showcasing their innovative R&D projects and the resulting patents and publications.

A key feature was the panel discussions focused on shaping the future of India's Semiconductor Mission, NSQF Certificates with insights into upcoming projects and strategic plans to further enhance the country's capabilities in nanoelectronics research and development.

Tata – CeNSE, IISc Training Program on Semiconductor Fabrication

1st to 30th July 2024

We were honoured to host Dr. Randhir Thakur, CEO and MD of Tata Electronics, at the Valedictory Session of the Tata Electronics-Centre for Nano Science and Engineering (CeNSE), Indian Institute of Science (IISc) Semiconductor Fabrication Training.

Dr Thakur's presence highlighted the culmination of our intensive month-long program, where over 100 engineers from Tata Electronics refined their semiconductor fabrication skills.

During the session, Prof. Sushobhan Avasthi provided a comprehensive summary of the training, and we celebrated the achievements of our top performers with a certificate distribution.

The young, energetic participants also had the invaluable chance to engage directly with Dr Thakur, posing insightful questions about the future of Tata Electronics in India's burgeoning semiconductor industry. Dr Thakur, alongside Phi Nguyen, offered promising insights and timelines, fuelling our excitement for what's to come.

Semicon India 2024

We had an exciting and productive experience at SemiconIndia 2024, held at IEML, Greater Noida from September 11-13, 2024!CeNSE had the opportunity to showcase the groundbreaking research carried out by our professors, highlighting our cutting-edge technologies, prototypes, products, and collaborative projects. Our Industry Affiliate Program and INCeNSE, the deep-tech business incubator, were also featured, along with our outreach activities. The event provided a fantastic platform for our startups to showcase their innovations and engage with a diverse and enthusiastic audience.It was wonderful to connect with passionate students, budding and established entrepreneurs, as well as reconnect with old friends, collaborators, and industry partners.The event was an invaluable experience, brimming with insights and new connections. We are especially excited about the future as we continue to witness rapid progress in the India Semiconductor Mission.

Congratulations to AGNIT Semiconductors Pvt Ltd on raising $3.5M from 3one4 Capital and Zephyr Peacock India.

AGNIT is India's first startup dedicated to Gallium Nitride semiconductor technology. Founded by faculty and alumni from CeNSE, DESE at IISc it is currently incubated at INCeNSE, a deep tech technology business incubator housed at CeNSE, IISc.

AGNIT is leading the charge in GaN technology to bridge critical gaps in India's energy and telecom infrastructure, positioning itself at the forefront of global trends in AI, 5G, and power electronics.

With 15 years of R&D at IISc, AGNIT is set to scale production and expand into consumer electronics and EV markets, aiming for 100,000 chip sales this year!

Congratulations to Theranautilus Pvt Ltd on raising $1.2M from pi Ventures in participation from Golden Sparrow Ventures, and angel investors, Abhishek Goyal and Lalit Keshre

Theranautilus is a pioneering deep-tech and hardware company focused on nanotechnology for oral health. Founded by faculty and alumni from CeNSE, IISc, it is currently incubated at INCeNSE, a deep tech technology business incubator housed at CeNSE, IISc.

Theranautilus focusses on fabricating nanorobots, ensuring their safe deployment in living systems, and developing innovative mechanisms to remotely guide them to their target within the body.

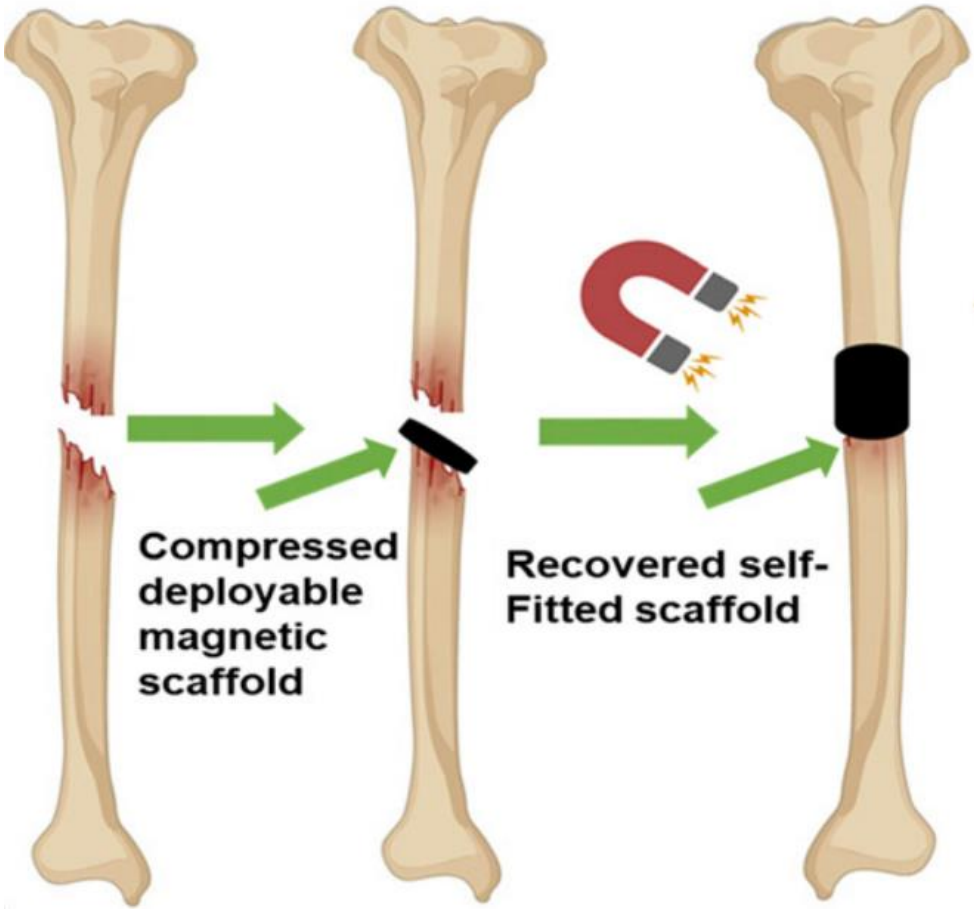
They are developing magnetically-controlled nanorobots that can treat dental hypersensitivity in a 10-minute procedure. They will use the fresh capital to set up an ISO-certified manufacturing facility, advance its clinical development, and prepare for human trials in 2025!

CeNSE RESEARCH NEWS

Revolutionizing Biomedical Engineering: 4D Printed Shape Memory Composites for In Vivo Applications

- Research by the QuAN2M Lab – Prof. Ambarish Ghosh

4D printing is revolutionizing the field of material science by integrating 3D printing with smart materials to create structures that can change shape over time in response to external stimuli. One breakthrough in this arena is the development of shape memory polymers (SMPs) that can be programmed to hold a temporary shape and recover to their original form when triggered. Despite their potential, applications for in vivo use have been limited due to the need for SMPs that respond at physiological temperatures and the challenges of practical activation methods.



In a recent study, researchers have successfully combined polylactide-co-trimethylene carbonate (PLMC) with magnetic iron oxide (Fe_3O_4) nanoparticles, unlocking the ability to remotely activate these materials using an alternating magnetic field at a biocompatible 40°C. The innovative PLMC–5% Fe_3O_4 composite was 3D printed into various structures, including scaffolds, which could be compacted for minimally invasive deployment and restored to their original shape within seconds (recovery times under 30 seconds). This magnetic actuation also enables guiding the material to specific sites using external magnets, offering precise control during medical procedures.

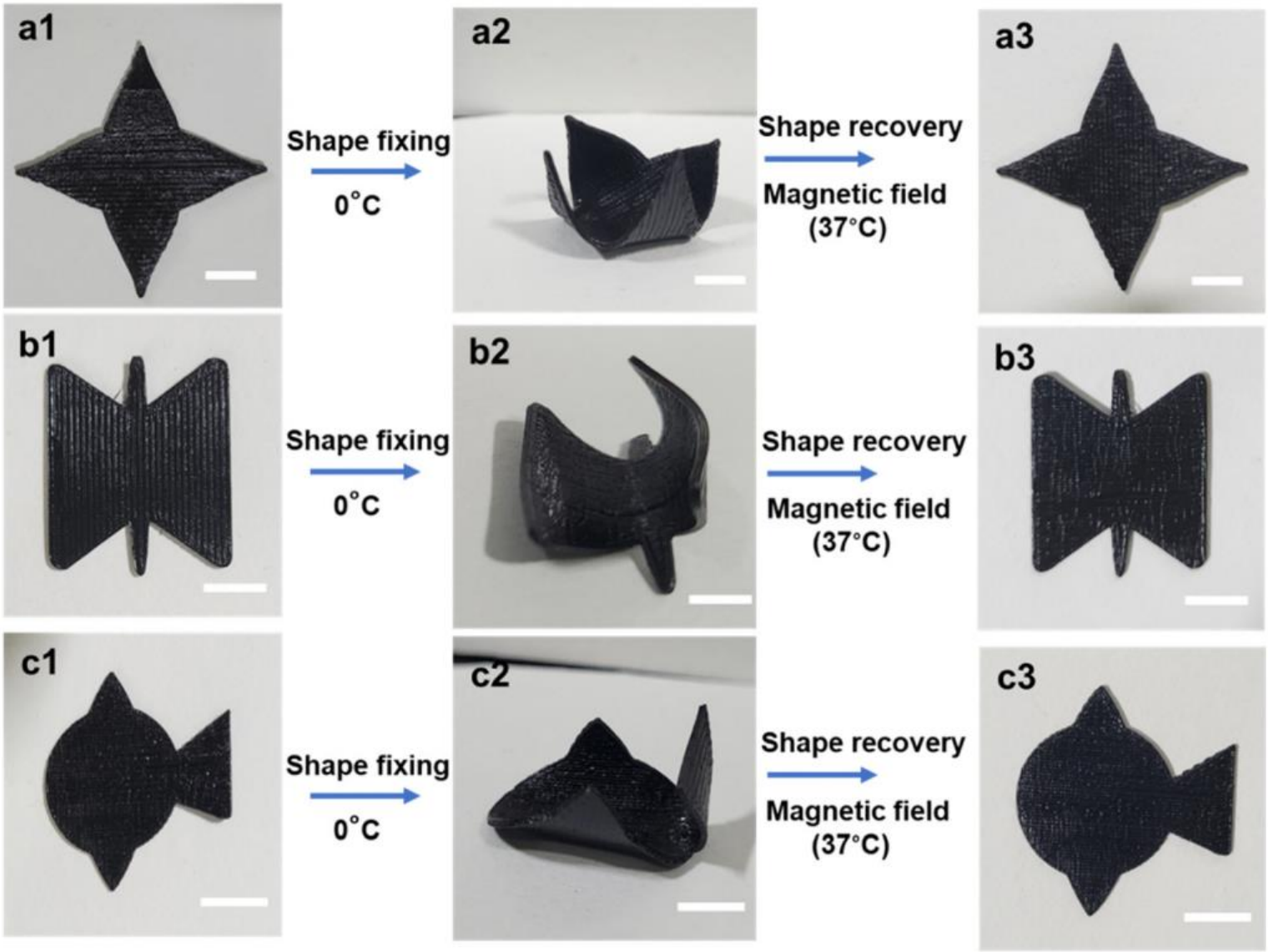


Fig. Shape fixing and recovery under an alternate magnetic field

A significant achievement of this study was the demonstration of excellent shape fixity (over 95%) and recovery (over 99%) in both 2D and 3D printed structures. Dual-material printing further allowed for selective actuation using different stimuli—magnetic fields or direct heat—within the same structure. Importantly, the biocompatibility of PLMC and its nanocomposite was confirmed in vitro and in vivo, with the material effectively supporting osteogenic differentiation and mineralization, making it an exceptional candidate for bone tissue engineering.

This advancement positions 4D printed SMPs as powerful tools not only in biomedicine, but also in fields like soft robotics, environmental technology, and space applications, where dynamic and responsive structures are key. The combination of fast, remote activation and biocompatibility opens new horizons for medical devices, deployable implants, and other applications requiring smart, adaptable materials.

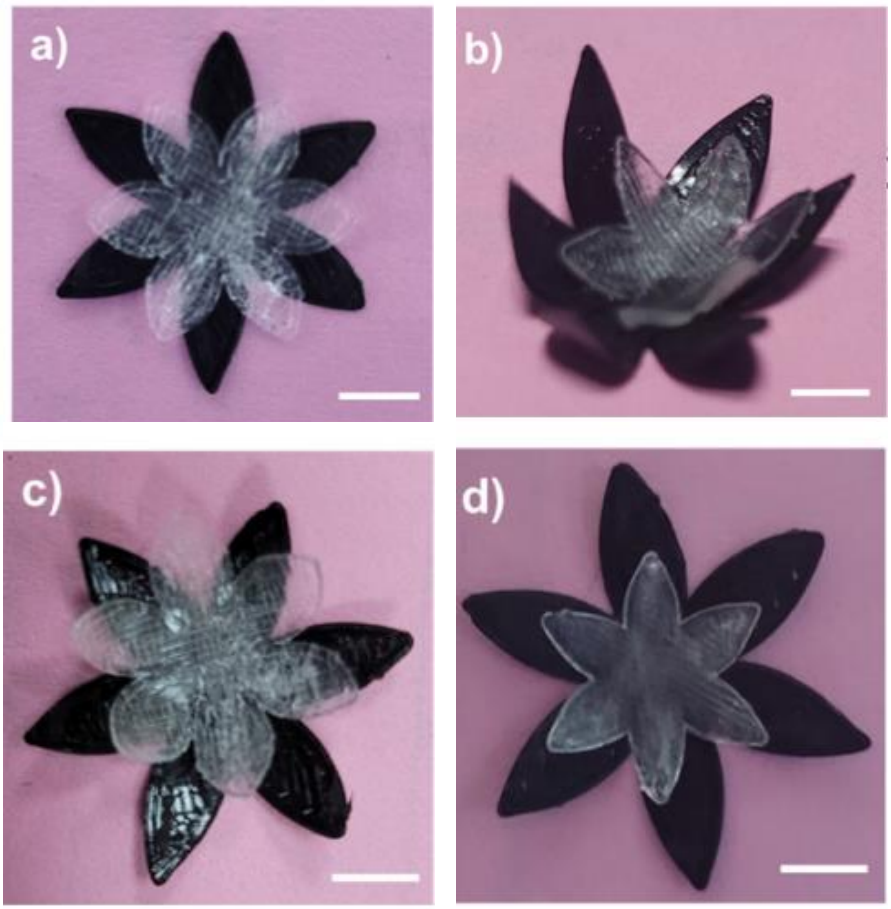


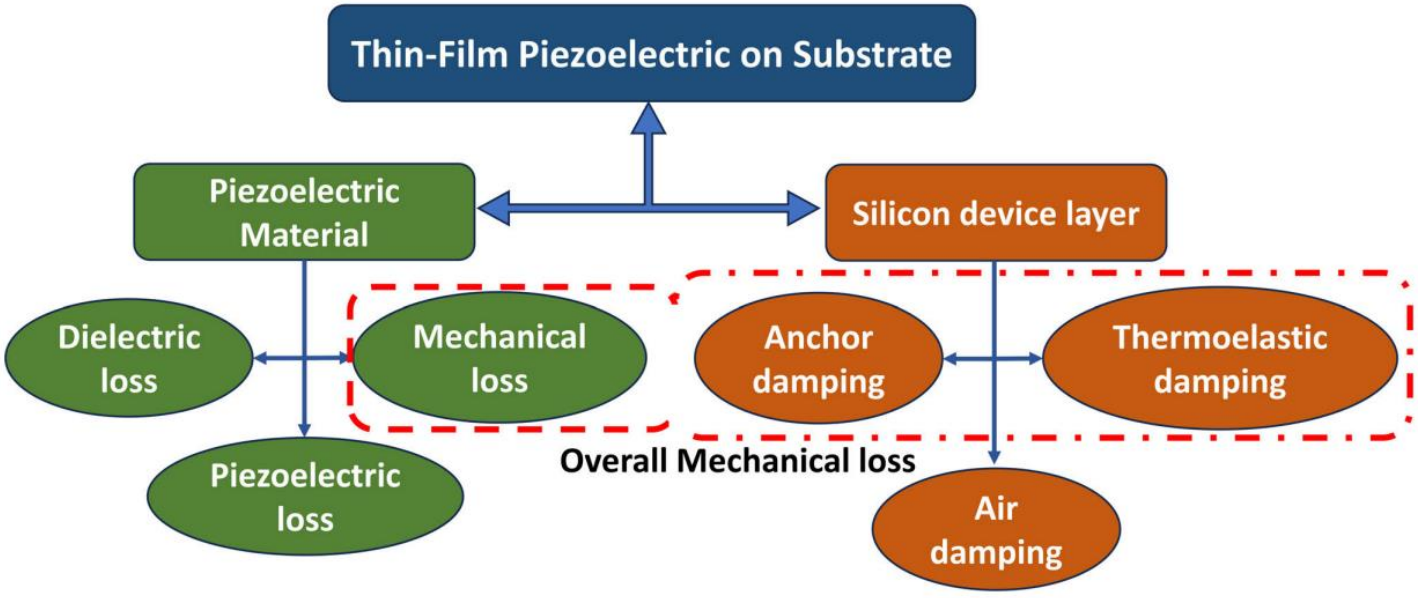
Fig. Sequential and selective shape recovery under an alternating field and then by heat

CeNSE RESEARCH NEWS

Advancing Piezoelectric MEMS for Higher Performance and Precision

- Collaborative research amongst the groups led by Dr. Saurabh Chandorkar, Dr. Gayathri Pillai and Prof. Rudra Pratap

Piezoelectric microelectromechanical systems (MEMS) are vital in modern technology, playing critical roles in sensors, actuators, and energy harvesting devices. Their ability to convert mechanical energy into electrical energy (and vice versa) makes them superior to traditional devices in many applications. However, a common challenge lies in the lossiness of piezoelectric films, which can reduce the Quality Factor (Q) and affect performance. Understanding and accurately measuring energy loss in these devices is crucial to enhance their efficiency and reliability.

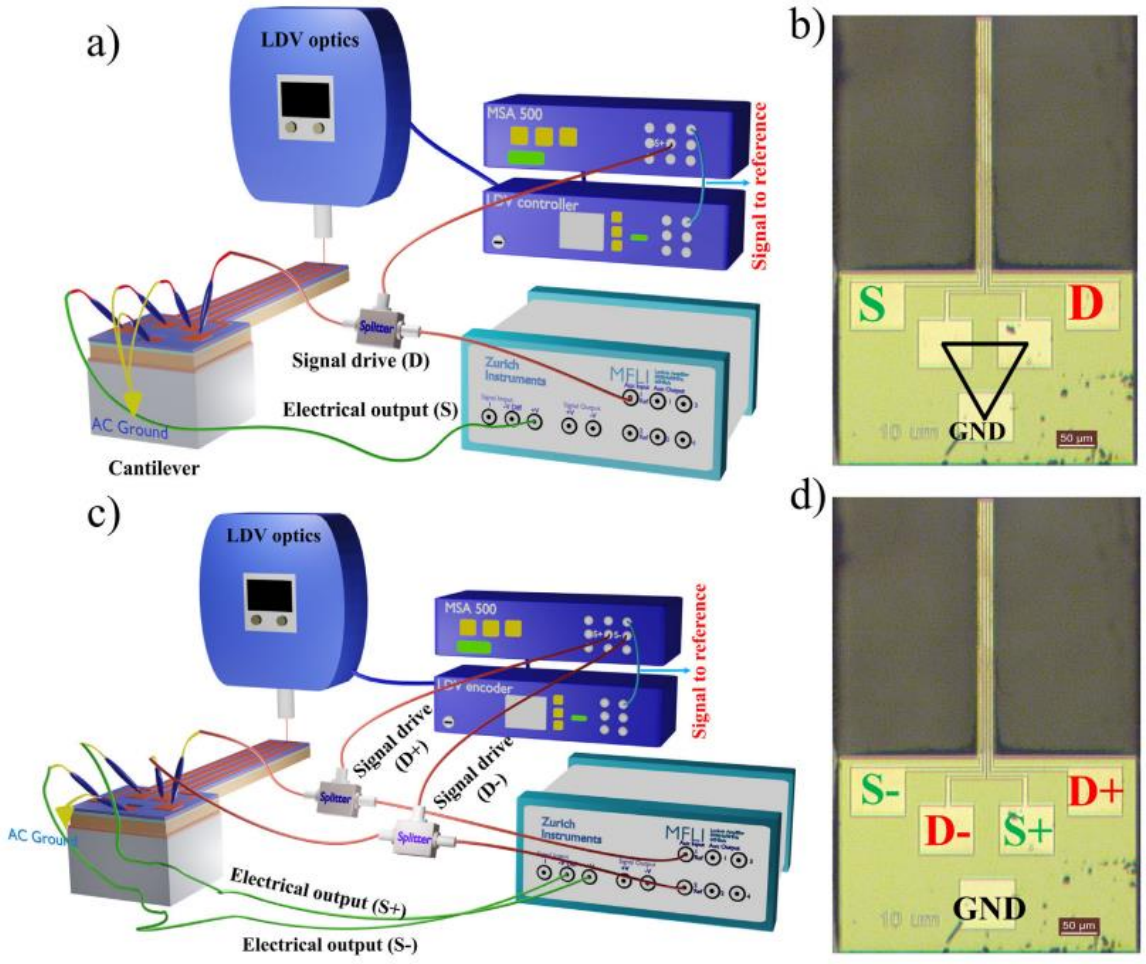


Energy dissipation mechanisms in TPoS MEMS/NEMS devices

Currently, the methods used to analyze energy loss often rely on measurements that are not well-suited for advanced thin-film piezoelectric-on-substrate (TPoS) MEMS devices. These devices have unique characteristics, such as energy stored in the substrate, low signal strength due to film losses, and increased capacitance from their structural design. This makes traditional approaches ineffective for evaluating TPoS devices.

To overcome these limitations, researchers have developed a new method that combines synchronized optical and electrical measurements. This approach leverages a physics-based model to extract essential parameters, including piezoelectric coupling, capacitance, and various types of energy losses (dielectric, mechanical, and piezoelectric). Demonstrated with a TPoS MEMS cantilever and ultrasonic transducers, this technique accurately measures device performance.

This advanced method provides a more thorough way to assess and optimize the behavior of piezoelectric MEMS devices, enhancing their design and expanding their potential applications in technology.



Single input single output (SISO) synchronized opto-electro-mechanical measurement schematic, and Double input double output (DIDO) measurement schematic

CeNSE RESEARCH NEWS

Advancing Laser Technology with Tunable and Efficient Raman Fiber Lasers

- Research by Non-linear Photonics and High-power Lasers Laboratory led by Dr. V.R. Supradeepa

Want to reduce the linewidth of Raman fiber lasers?

Use dual feedback!

Then frequency double it to get >100 mW single mode power.

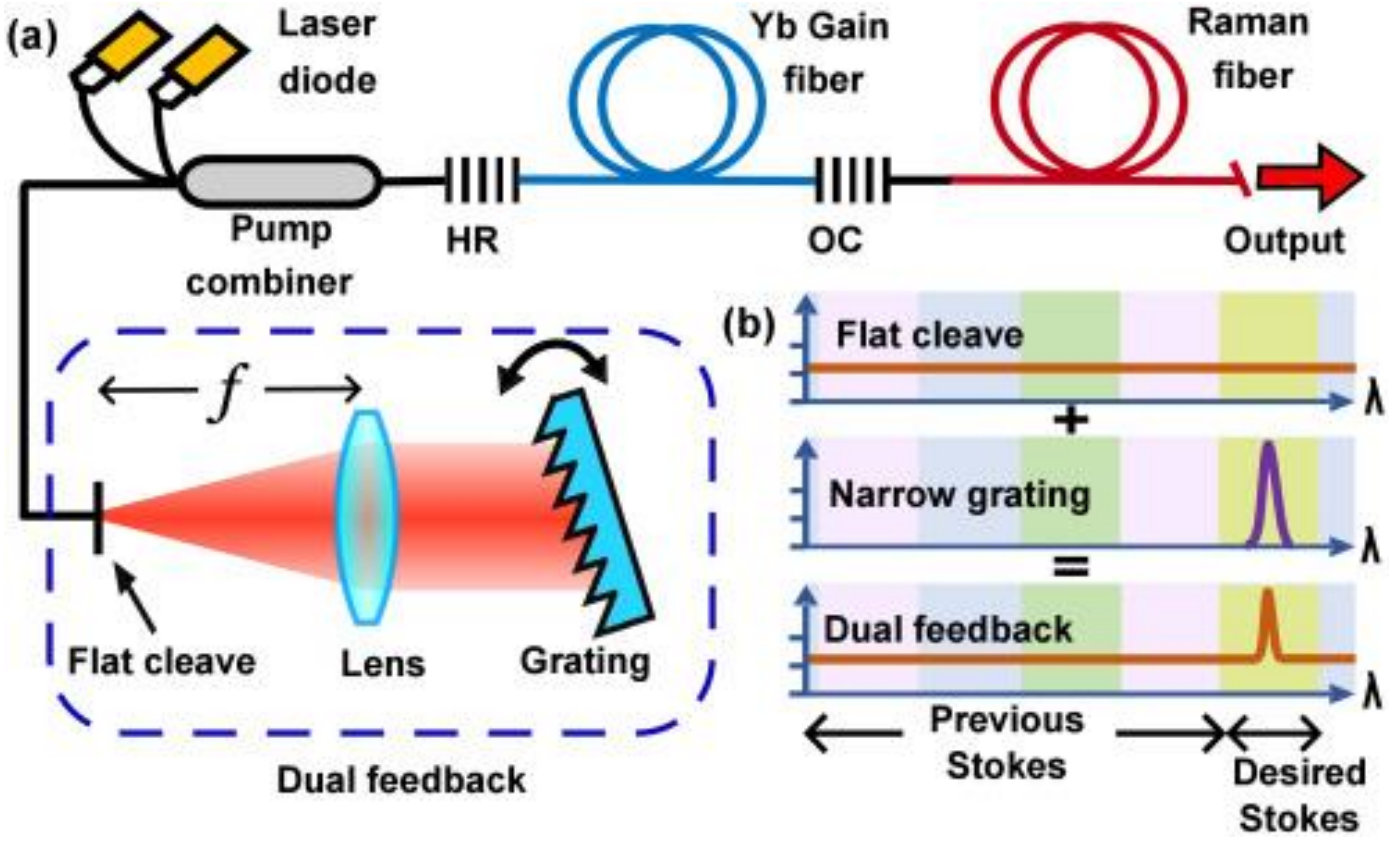


Fig. Schematic of the setup showing dual feedback

Cascaded Raman Fiber Lasers (CRFLs) are highly versatile light sources capable of producing wavelengths across the near-infrared (NIR) region. Unlike traditional lasers that are limited to specific wavelength bands, CRFLs can seamlessly fill the gaps, making them invaluable for applications requiring a wide range of wavelengths. This is achieved through a process called stimulated Raman scattering (SRS), where light interacts with the fiber medium to shift to longer wavelengths. By cascading this process, CRFLs can generate light far beyond the capabilities of conventional rare-earth-doped lasers like Ytterbium or Erbium. One significant limitation of CRFLs has been their broad linewidths, which can span several nanometers. Such broad outputs are unsuitable for applications like frequency doubling, where NIR light is converted to visible wavelengths (e.g., green and yellow). Narrow linewidths are essential for efficient conversion in these applications. To overcome this, researchers developed a dual-feedback system. This method combines broadband feedback, which supports the entire wavelength range, with narrowband feedback using a grating filter, which sharpens the output at a specific wavelength. This innovation reduces the linewidth from 4–5 nanometers to just 1 nanometer, while still allowing the laser to be tuned across a broad range. With this improved design, CRFLs can produce high-power, tunable output from 1100 to 1500 nm and beyond. Such precise, tunable, and high-power outputs are crucial for applications in fields like medical diagnostics, environmental sensing, and optical communications. Future advancements, such as enhanced polarization control and refined filtering methods, could further increase the efficiency and power of these lasers. This progress paves the way for compact, reliable, and tunable light sources that span from infrared to visible wavelengths, unlocking new possibilities in science and industry.

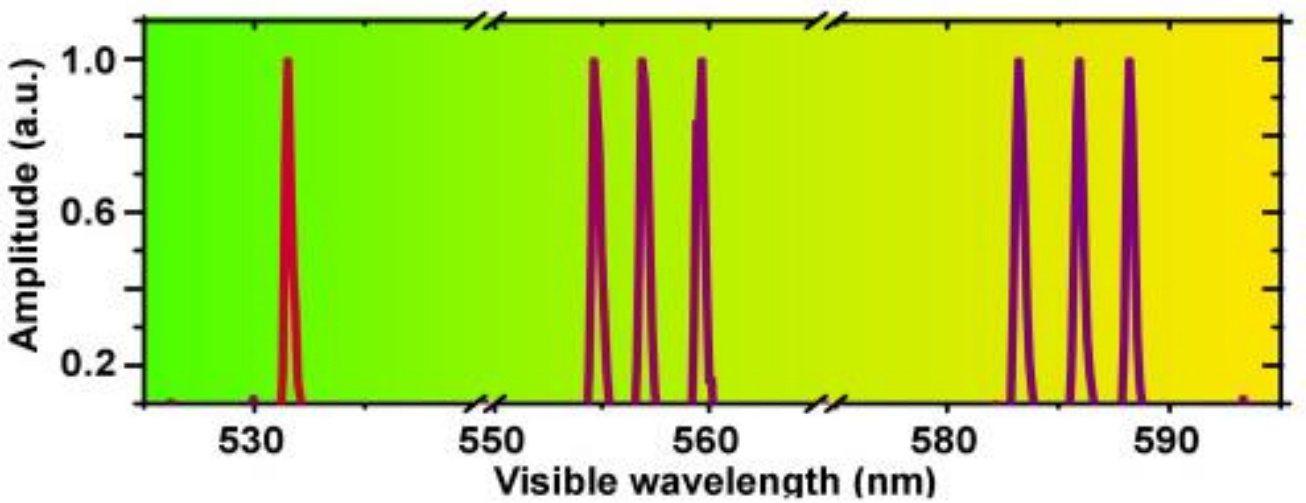


Fig. Achieving wavelength tunability

ALUMNI SPEAKS

Meet Our CeNSE Alumnus !!
Awanish Pandey pursued his PhD from 2014 to 2018 at CeNSE under the guidance of Prof. Shankar Kumar Selvaraja. He is currently working as an Assistant Professor at IIT Delhi. Read on to know more !!

Can you briefly describe your academic background?

I did my B. Tech from IIIT Jabalpur and joined CeNSE, IISc.after that to do my Ph.D. with Prof. Shankar K. Selvaraja. My Ph.D. thesis was primarily based on designing, fabricating, and characterizing nanophotonic devices on Silicon. After my doctorate, I joined photonics research group (PRG) in Belgium for my post-doc and subsequently moved to Switzerland to work at CERN as a senior fellow.
I had one of the best four and half years of my life during my Ph.D. CeNSE had every facility required under a single roof to carry out all my experiments and IISc. had the best friends I could hope for in a campus. I was mentored by one of the finest and I am happy that I am still continuing with my supervisor not just as a collaborator but also as a dear friend.

What is unique about OPC, IIT Delhi as compared to traditional departments at IIT?

I believe the Optics and Photonics Centre (OPC) is one of the few centres in the world dedicated to teaching and research excellence in the field of photonics. It builds on the strong background and history of optics in IIT Delhi exemplified by the fact the first M. Tech program dedicated towards optics started in mid 1960s. The centre's diverse expertise—ranging from quantum photonics to metamaterials to sensors—enables us to explore the intersection of various concepts in optics, fostering a unique approach to problem-solving. The close collaboration within this field has already resulted in incubation of three start-ups which is just a glimpse of things to come in future. Furthermore, the dedicated centre allows students to explore a broader range of topics within photonics, sparking their curiosity and enhancing their drive for learning and conducting research.

How easy or difficult is it to enter the Indian academic scene as a faculty?

Entering the Indian academic scene as a faculty member is indeed quite challenging. One of the primary reasons is the limited number of high-quality research institutions in India. This means that a vast pool of highly skilled and remarkably qualified individuals are all competing for a very limited number of positions, making the process intensely challenging.
Moreover, candidates are expected to excel not only in their research and academic qualifications but also in teaching, mentorship, and contributing to the institution's broader goals. While the process is demanding, it ensures that those who succeed are well-equipped to make significant contributions to the academic community and drive innovation in their respective fields.

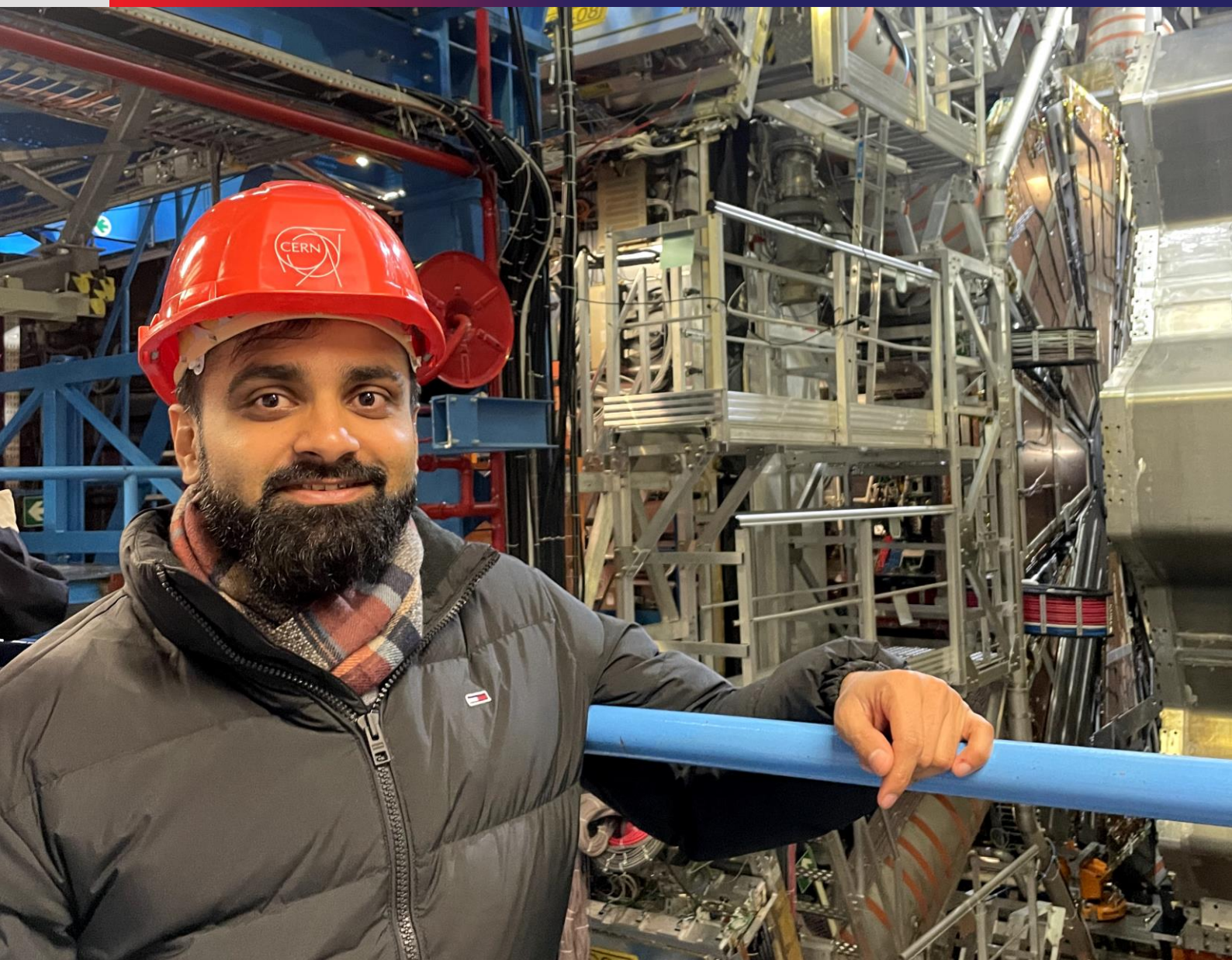
How does it feel for you to transition from academia to academia, from student to a faculty?

Life is difficult for everyone. But if you want to test how much you can really endure, transition from academia to academia is the perfect way forward for you. It's a path that demands both intellectual endurance and personal fortitude, as you're now accountable not only for your own growth but also for fostering growth in others. It requires balancing administrative duties, conducting research, and the mentorship of young minds, all while continuing to learn and pushing the boundaries of your own field.

The transition from "student" to "faculty" is quite interesting. As a student, I often thought that professors tend to forget what we discussed in our last meeting. Now, as a professor, I find that students often forget about all the discussions we had in our previous meetings. I always wonder how both of these things can be true at the same time!

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

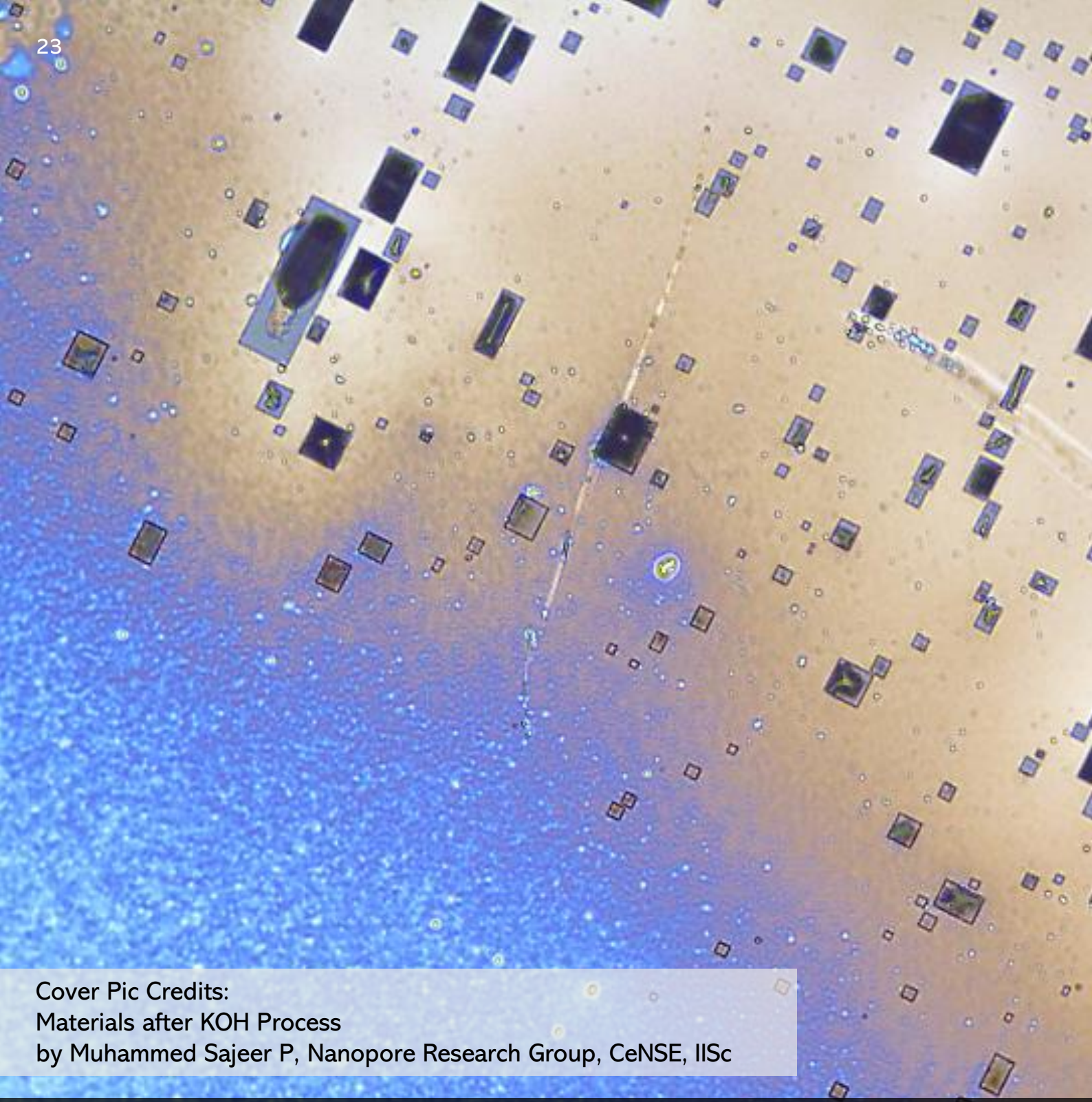
Maintaining a healthy work-life balance is ultimately a personal decision, with the nature of the job playing only a secondary role. Once you've set clear boundaries around the kind of working hours and family life you want, sticking to that routine becomes much more manageable. In academia, there are always new responsibilities, from teaching and research to mentoring and administrative work, but sticking to a routine keep things balanced. I make it a point to reach office by 9:15 am and leave by 5:15 pm. The strict adherence to timing keeps the schedule well managed allowing me to explore other aspects of life.
Of course, all of this advice goes out the window when funding agencies call on short notice to defend a project. In that case, my compromise with the work-life balance becomes directly proportional to the funding involved.



Any advice you have for the current students who might want to choose this career path?

The term "growth mindset" is often associated with cliché YouTube motivational speeches, but in my peer group, I've seen people surpass expectations precisely because of this mindset. They didn't pursue certifications for the sake of adding another credential to their resume, nor did they network just to gain an advantage later. Instead, they were genuinely interested in the programs they engaged with, and they networked because they truly valued connecting with others.

My advice is simple: be genuinely interested about what you do, whether you chose academia or any other profession. If you've enrolled in a Ph.D. program, sooner or later, you will earn the degree. But the real question is whether you're pursuing it just to check a box or whether you're making it an epic journey—one worth reminiscing about over a drink at Gilly's bar just outside the BEL gate. Your genuine interest will make all the difference.



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Materials after KOH Process
by Muhammed Sajeer P, Nanopore Research Group, CeNSE, IISc

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