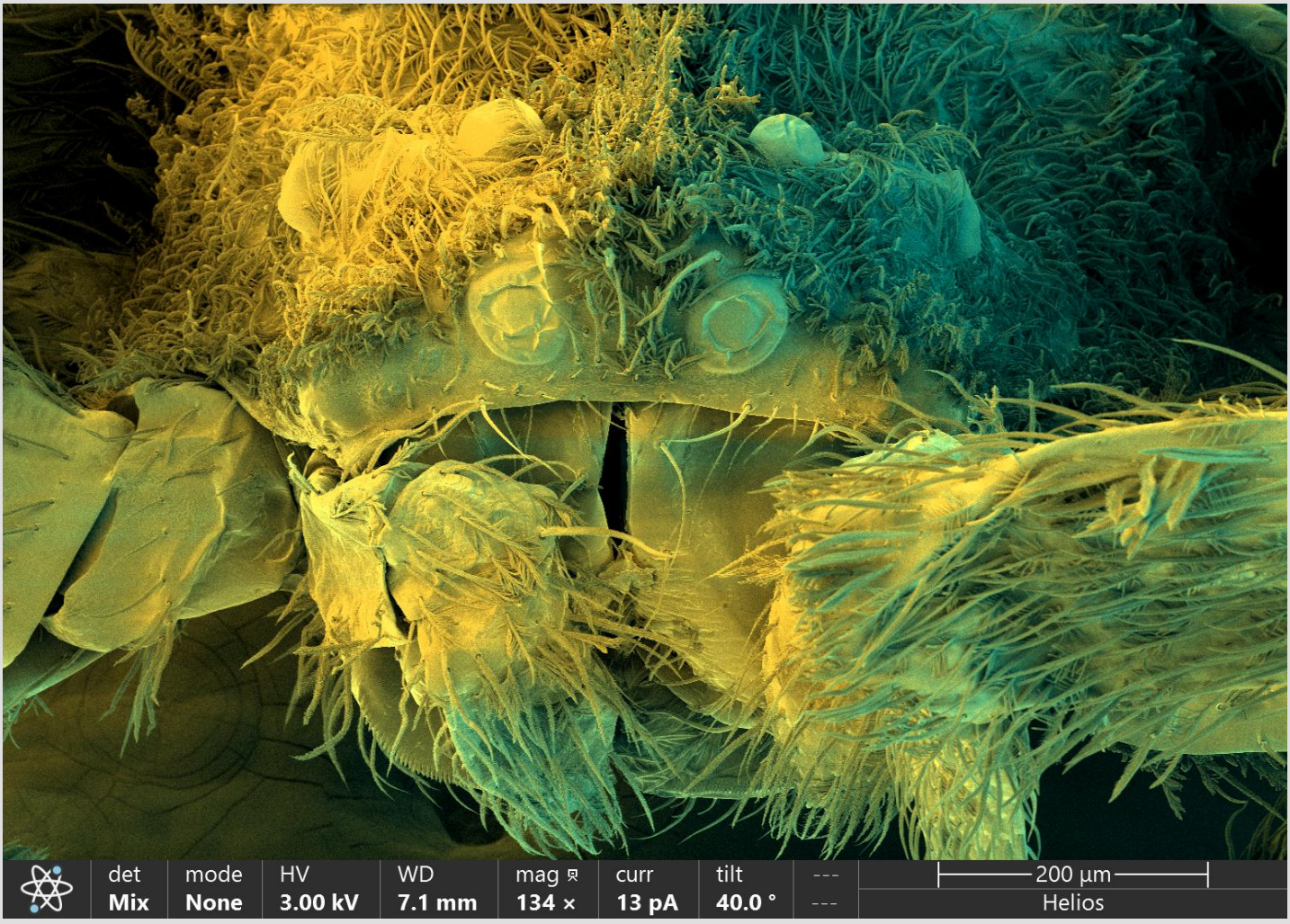
PressCeNSE

Issue: Q3 2025



Pic Credits: Micro and Nano Characterization Facility, CeNSE, IISc

Spiders are already fascinating — and maybe a little scary — but ever wondered what they look like at the microscale? This Scanning Electron Microscope (SEM) image captures nature's complexity in stunning detail

Message from the Chair

It is a privilege to take on the role of Chair, along with Prof. Shankar K Selvaraja as the Associate Chair at CeNSE — a place that continues to inspire with its spirit of innovation and excellence. We are deeply excited about the opportunities ahead as we strengthen CeNSE's contributions to India's rapidly evolving semiconductor, quantum, and neuromorphic landscapes. With our world-class facilities, exceptional researchers, and growing collaborations with academia and industry, I believe CeNSE is poised to make an even greater impact nationally and internationally. Together, we will continue to push boundaries, nurture talent, and position CeNSE as a global leader in deep science and technology.

- Ambarish Ghosh, Professor, Chair, CeNSE

The past few months at CeNSE have been nothing short of remarkable. From cutting-edge research in neuromorphic and quantum technologies to strengthening our semiconductor fabrication and training ecosystem, CeNSE continues to be at the forefront of innovation that will shape India's technological future.

What makes our work truly exciting is the convergence of disciplines — where physics, chemistry, materials, and engineering come together to address some of the most complex challenges in computing, sensing, and manufacturing. Whether it's pioneering molecular hardware for AI, advancing quantum materials, or building India's semiconductor talent pipeline, every initiative at CeNSE reflects our shared commitment to excellence and impact. We are proud of our students, faculty, and staff whose creativity and perseverance drive this momentum. As India steps into a new era of technological self-reliance, CeNSE stands as a key enabler — transforming ideas from the lab into innovations for the nation. Together, we are not just building devices or processes; we are building the foundations of the future semiconductor, quantum, and neuromorphic landscapes of India.

Let us continue to push boundaries, collaborate across disciplines, and pursue our mission of making CeNSE a global hub for nanoscale science and engineering.

CeNSE NEWS

Congratulations to our Graduates!

11th July 2025

Every year, a new batch of students steps out from CeNSE, and every year, our hearts are filled with warmth and pride. Watching you grow, persevere, and achieve your goals has been truly rewarding. As you move forward, we are confident that each of you will carry the spirit of CeNSE wherever you go—driving innovation, creating impact, and shaping the future. A special congratulations to all our medalists for their exceptional achievements! You have made us proud and continue to inspire those who follow in your footsteps. As you embark on new paths - whether in academia, industry, or entrepreneurship - we wish you every success in your future endeavors. May your curiosity and passion continue to light your path.

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CeNSE NEWS

Congratulations to Medalists at IISc Convocation 2025!

11th July 2025

- Meenakshi S and Vaishakh U - Prof. R Vasudevan Medal for M.Tech in Semiconductor Technology
- Manu Rockey - Institute Medal for M.Engg in Semiconductor Technology
- Rutvik Lathia - Revati and Satya Nadam Aluri Medal for PhD thesis work

CeNSE NEWS

2025 CeNSE Industry-Sponsored MTech Fellows!

Congratulations to our 2025 MTech Fellowship awardees: Ashutosh Jareda, Sampad Barik, Rutwik Reddy Rikkala, Nilotpal M., Kartik Kataria, Rushikesh Patil, Aasheik Saran, and Nikhil Venkata Sai Pernapatti

The CeNSE Industry-Sponsored MTech Fellowship encourages exceptional students from engineering and science backgrounds to explore careers in the electronics and semiconductor sectors.

A heartfelt thank you to our sponsoring partners — Lam Research, MacDermid Alpha, Element Solutions, Applied Materials, and Tokyo Electron (TEL) — for their continued support in nurturing the next generation of semiconductor professionals.

We congratulate the fellows and wish them success as they shape the future of the semiconductor industry!

Sponsored by:

Lam RESEARCH

element solutions

MacDermid Alpha

APPLIED MATERIALS

TEL TOKYO ELECTRON

Ashutosh Jareda

Aasheik Saran

Rikkala Rutwik

Kartik Kataria

Sampad Barik

Nikhil Venkata Sai

Nilotpal Mukherjee

Rushikesh Patil

CeNSE NEWS

Welcome to the New Batch of CeNSE Students! (M.Engg. | M.Tech. | Ph.D.)

Batch starts in August 2025

M.Tech.

Ph.D.

M.Engg.

A warm welcome to all the new students joining CeNSE this year! Each new batch brings fresh energy, curiosity, and ideas — and we are thrilled to have you become part of our vibrant community of researchers and innovators. At CeNSE, you'll find an ecosystem that encourages exploration, collaboration, and excellence. We hope your time here will be filled with learning, discovery, and lasting friendships. Welcome aboard — your journey into the world of nanoscale science and engineering begins now!

Micron Day
9th May 2025

Micron Day 2025 was held on 9th May at CeNSE, IISc, bringing together technology, innovation, and collaboration through insightful sessions and an exciting SSD Hackathon. The event, hosted in partnership with Micron Technology, saw enthusiastic participation from over 45 students across IISc.

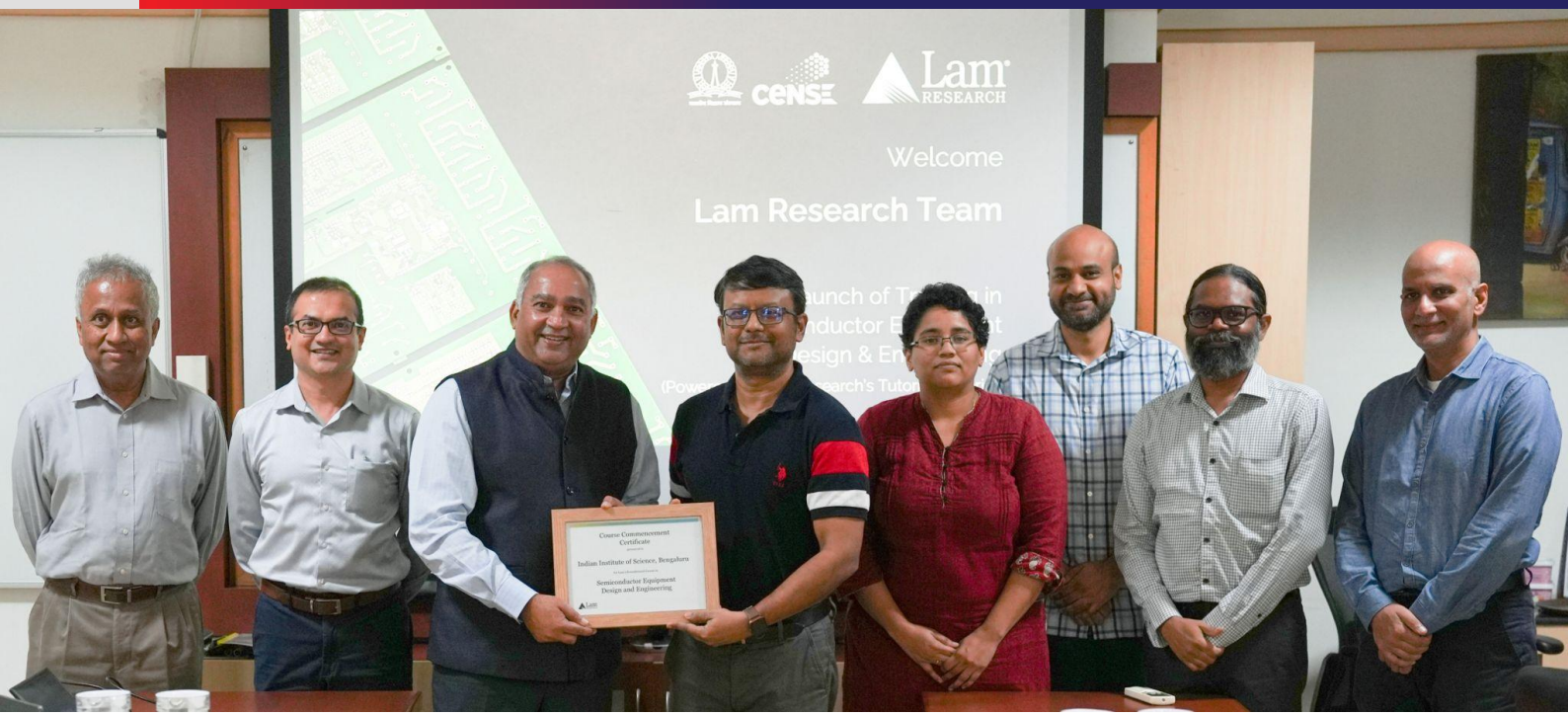
Congratulations to the hackathon winners and runners-up — Priyabrata Mallick, Keshavan A., Raghuttama B. N., Aadithya R., Kartik Jain, and Shatrughan Kumar Singh!

Our sincere thanks to Micron Technology, Deepika Dadi, and all participants for making the event a success.

We look forward to more such industry–academia collaborations at CeNSE.

Building India's Semiconductor Workforce

Lam Research transfers tutorial materials for CeNSE to launch Hands-on Training Modules focused on Semiconductor Equipment Design and Manufacturing



We are proud to partner with Lam Research Corporation in a collaborative effort to strengthen India's semiconductor talent pipeline. As part of this partnership, Lam Research has transferred a set of its tutorial materials to CeNSE, enabling the development of hands-on training modules focused on semiconductor equipment design and process technology.

This initiative aligns with the Government of India's vision to create a robust and skilled semiconductor workforce. Together, academia and industry are empowering the next generation of engineers and researchers who will drive innovation and shape the future of microelectronics in India.

Course Commencement Certificate

presented to

Indian Institute of Science, Bengaluru

for Lam's Foundational Course in

Semiconductor Equipment Design and Engineering

Lam RESEARCH CeNSE

India's Neuromorphic Technology Initiative at CeNSE, IISc

India's flagship Neuromorphic Technology Initiative at the Centre for Nano Science and Engineering (CeNSE), IISc Bengaluru, nurtured by the Ministry of Electronics and Information Technology (MeitY) over the past year, is entering an exciting new phase. The initiative now joins forces with the DRDO's DIA-CoE and CAIR to pioneer indigenous, ultra-efficient AI software for practical applications on molecular neuromorphic hardware.

This collaboration marks a major step toward developing energy-efficient, brain-inspired computing systems and advancing India's leadership in next-generation AI hardware research.

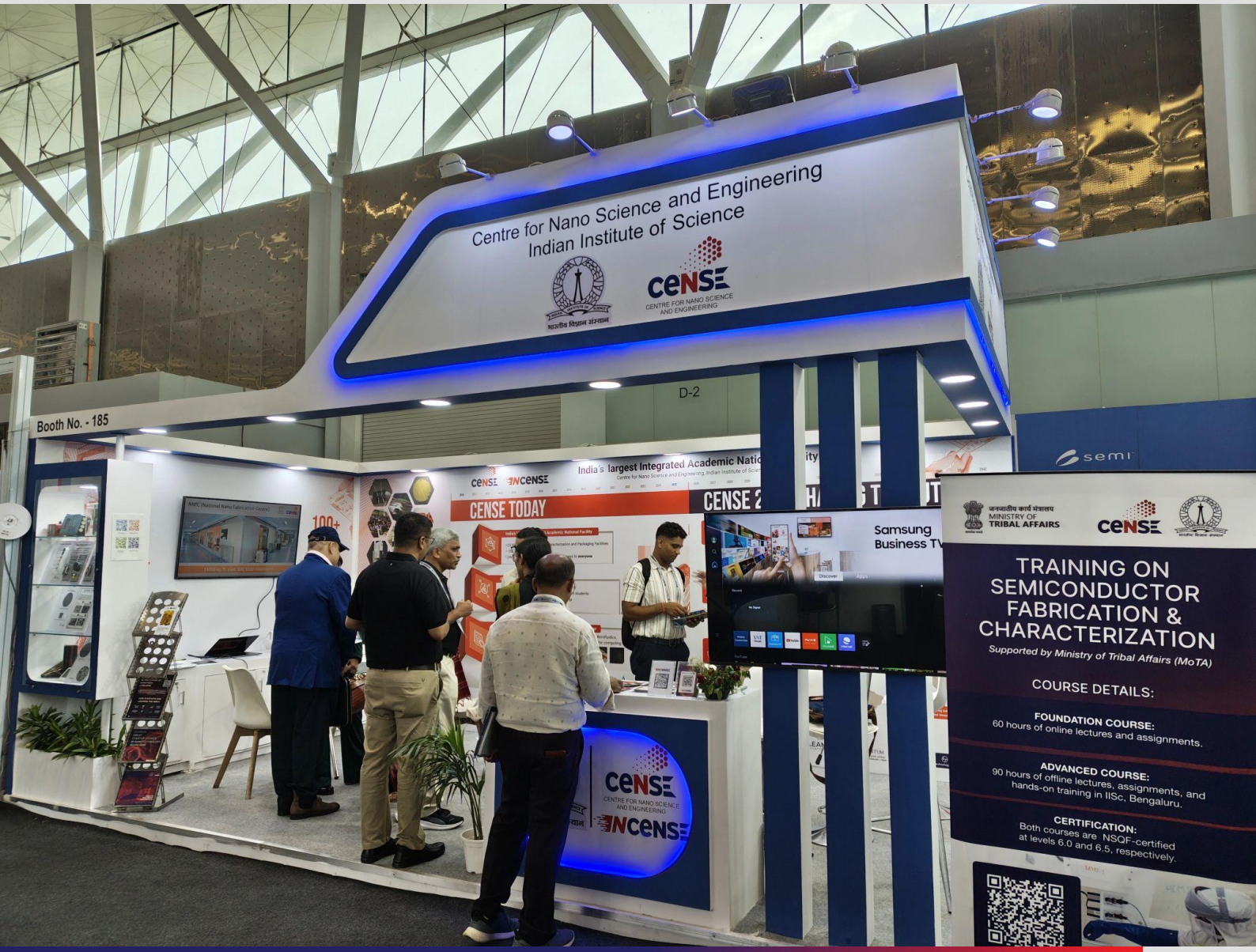
CeNSE at Quantum India Bengaluru Summit 2025

CeNSE, IISc — a major hub for quantum research at IISc, with 12 of its 19 faculty members working directly in or closely with quantum technologies — was proud to participate in Quantum India Bengaluru 2025, celebrating the International Year of Quantum.

We showcased our quantum research projects, national facilities, and incubation programs. Student team of Purna Pal and Roopa J won the Best Poster Award for their presentation on miniaturized atomic clocks

CeNSE looks forward to advancing quantum science and technology through collaboration, innovation, and cutting-edge research that will shape the future of India's quantum ecosystem.

CeNSE at Semicon India 2025



CeNSE, IISc was proud to be part of Semicon India 2025, a dynamic platform that brought together students, researchers, industry professionals, and global leaders shaping the semiconductor future.

At our booth, visitors explored CeNSE's cutting-edge research, ISO-certified national facilities, and training and education programs designed to strengthen India's semiconductor talent pipeline.

A big thank you to everyone who visited and engaged with us during the event. We look forward to building on these connections and continuing to contribute to India's growing semiconductor ecosystem.

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India's Semiconductor Dream: Training the Fab-Ready Workforce

Global Reset Episode CNBC-TV18, with Prof. Sushobhan Avasthi, CeNSE, IISc

They explore India's growing efforts to build a strong semiconductor manufacturing ecosystem by developing a skilled workforce. While India has established its strength in semiconductor design, the country still faces a significant gap in manufacturing expertise — particularly in areas like cleanroom operations, wafer fabrication, and process engineering. This interview highlights how training programs are being set up across institutes and industry partnerships to create "fab-ready" engineers who can meet the technical and operational demands of upcoming semiconductor fabs. These programs combine classroom learning with extensive hands-on training on real fabrication and characterization tools, giving participants the ability to work directly in cleanroom environments. They emphasize that as India invests in semiconductor infrastructure, the success of this initiative will depend equally on developing the right human capital.

"Bridging this skill gap is crucial to ensure that India's semiconductor fabs can operate efficiently and contribute meaningfully to the country's vision of technological self-reliance and global competitiveness." – Sushobhan Avasthi

Faculty Achievements

Congratulations to Dr. Saurabh Chandorkar and Dr. Pavan Nukala on being promoted as Associate Professors at CeNSE, IISc

Congratulations to Dr. Pavan Nukala on receiving the Excellence in Microscopy Award 2025 awarded by Electron Microscopy Society of India.

Faculty Achievements

Congratulations to Prof. Rudra Pratap, Prof. Late K N Bhat, Prof. M. M. Nayak and the PASF team (Veera Pandi, Linet Thomas C, Pavithra B, Nithin, Sankaran N, Jeyabal V) on winning the ASI - Sarvshreshtha Team Achievement Award – 2023.

This was issued for their work on “Design, development, fabrication, integration, packaging, acceptance and qualification of Aerospace grade MEMS pressure transducers leading to commercialization”

Student Achievements

Sanket Jugade, PhD - Best Poster Presentation Award

3rd Conference on Force Spectroscopy and Microscopy
Poster: Dynamic Scanning Force Microscopy for Nanoscale Imaging of Ultrathin Graphene on Liquid Interface

Sri Harsha Paladugu, PhD - National Bio Entrepreneurship Competition (NBEC) 2025

A cash prize of ₹3 Lakhs sponsored by Syngene
An investment opportunity from Ideaspring Capital

Purna Pal, PhD Student and Dr. Roopa J – Best Poster Award

At Quantum India Bengaluru Summit 2025 for their work on Microfabricated Cs Vapor Cell for CPT based Miniaturized Atomic Clock

Student Awards at the IEEE South Asian Ferroelectric Symposium 2025

Oral Presentation: Yeswanth Pattipati, Shubham Parate
Poster Presentation: Kartick Biswas, Vivek Dey

CeNSE RESEARCH UPDATES

Journal Publications

41

Jan-June'25

46

Current Quarter

Patents Granted (Jan-Sept'25)

	Patent Title	Country	Inventor	Co-inventor	Patent Number
1	Device For Tuning Laser Output	India	Supradeepa V.R.		570019
2	A microfluidic system and method for dynamically determining a rheology of a picoliter-scale sample	India	Prosenjit Sen		568831
3	Heterostructure semiconductor, chemiresistive gas sensor made thereof, and method of fabrication thereof	USA	Navakanta Bhat		12265046
4	A method for locomotion of a nanorobot and implementations thereof	USA	Ambarish Ghosh		12336779
5	Tuneable, Broadband Ultraviolet Light Detector	India	Digbijoy Nath	Srinivasan Raghavan	563968
6	A semiconductor device for audio playback and sound generation	India	Rudra Pratap		557610

CeNSE RESEARCH NEWS

Revolution in Dental Care: Nanotech Takes on Tooth Sensitivity

- Research by Prof. Ambarish Ghosh's Group


Shanmukh P


Prajwal Hedge


Prannay R


Anaxee Barman


Arnab Barik


Debayan D


Ambarish Ghosh

If you've ever felt a sharp jolt of pain when sipping an ice-cold drink or biting into something sweet, you've experienced dental hypersensitivity — a condition that affects over a billion people worldwide. Traditional desensitizing toothpastes only mask the pain temporarily, coating the tooth surface without addressing the problem deep within. But what if science could send tiny "bots" into your teeth to fix the issue from the inside out?

A new study from researchers at the Quan2m Lab at CeNSE, IISc, introduces CalBots — magnetically guided, calcium-based nanomaterials designed to permanently seal the microscopic channels, or dentinal tubules, that cause sensitivity. These tubules connect the outer surface of the tooth to the inner nerve-rich pulp. When exposed due to enamel loss or gum recession, they allow temperature changes and mechanical forces to trigger pain.

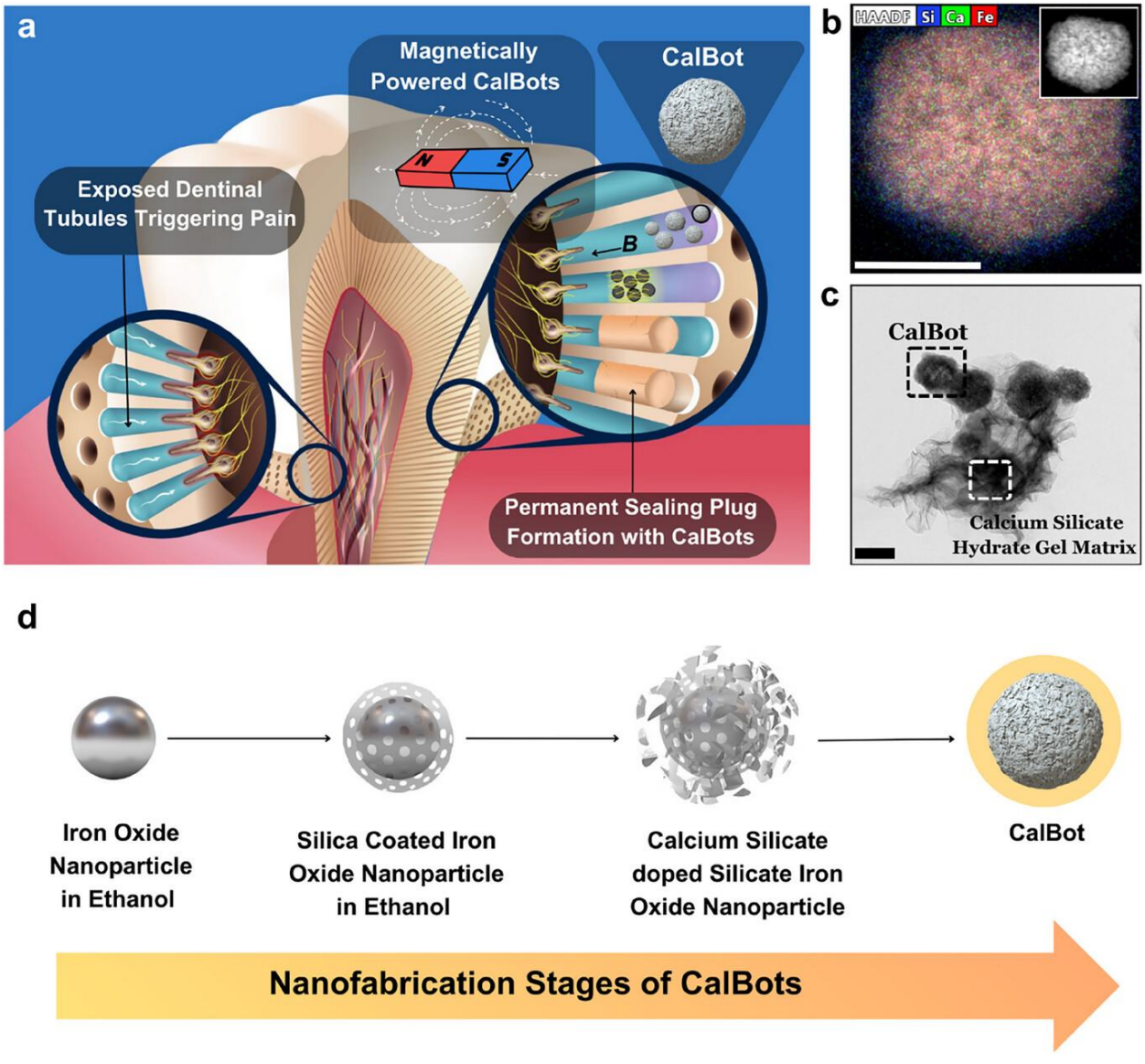


Fig. Schematic representation of dental hypersensitivity and the physiology of plug formation inside dentinal tubules using CalBots suspended in CaO gel

The innovation lies in how CalBots behave. When exposed to controlled magnetic fields, these nanoparticles self-assemble into flexible chain-like structures that can travel more than 300 micrometres deep into the tooth's porous network — far beyond what conventional treatments can reach. Once in place, they undergo a chemical transformation, forming a biocompatible, cement-like seal that blocks pain pathways and even prevents bacterial intrusion.

In animal trials, teeth treated with CalBots showed complete reversal of hypersensitivity symptoms, without any signs of toxicity. The material's natural compatibility with biological tissues makes it a strong candidate for future clinical applications — not just in dentistry, but potentially in regenerating other calcified tissues like bone.

This breakthrough marks a shift from short-term surface care to targeted regenerative treatment, embodying the dream of "tiny machines" working within our bodies to restore function — an idea once imagined by physicist Richard Feynman. If successful in human trials, CalBots could transform dental care forever — replacing daily toothpaste rituals with a single, lasting solution to tooth sensitivity.

Published in Advanced Science, 2025, e07664

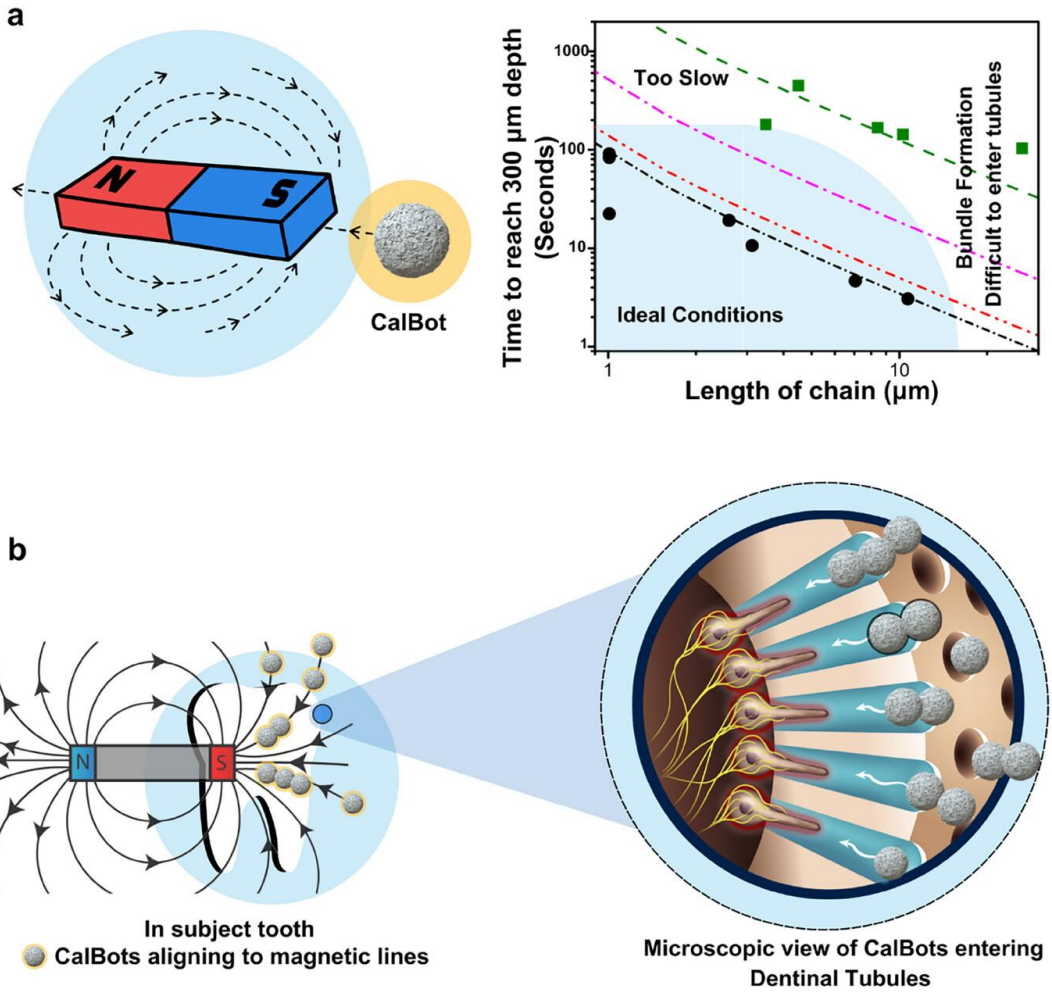


Fig. Schematic of CalBot chains moving towards a permanent magnet.

CeNSE RESEARCH NEWS

Shaping Vibrations for the future: Tunable Phononic Frequency Combs

- Research Led by the group of Dr. Gayathri Pillai's Group

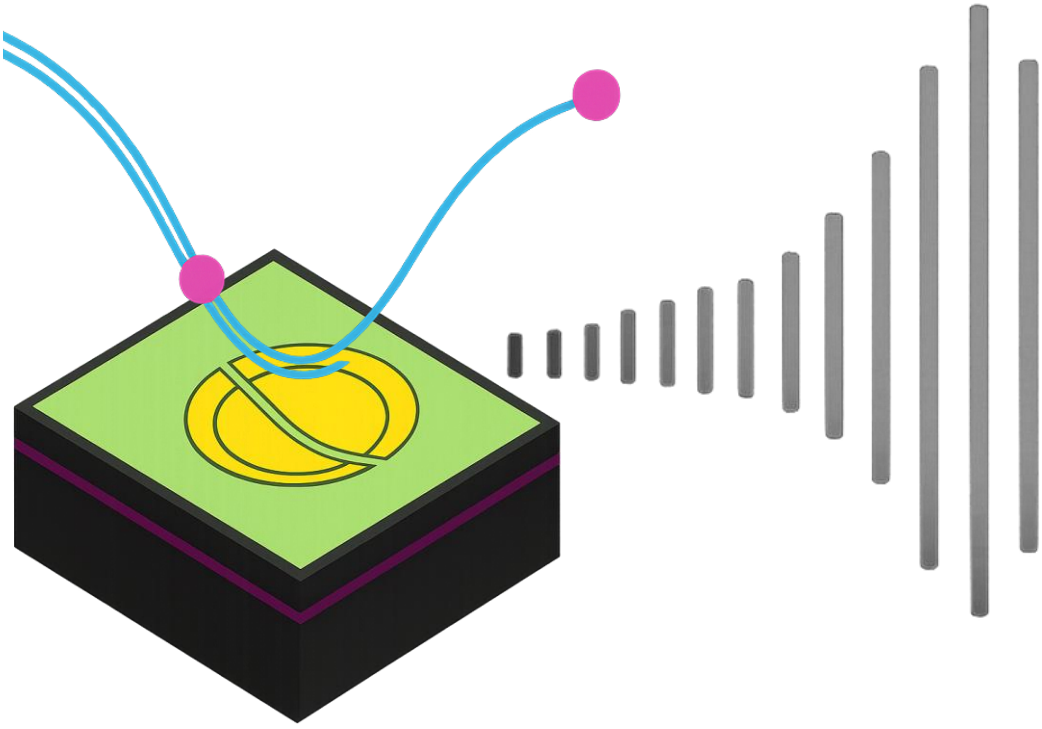

Praveen Kumar


L N Chandrashekar

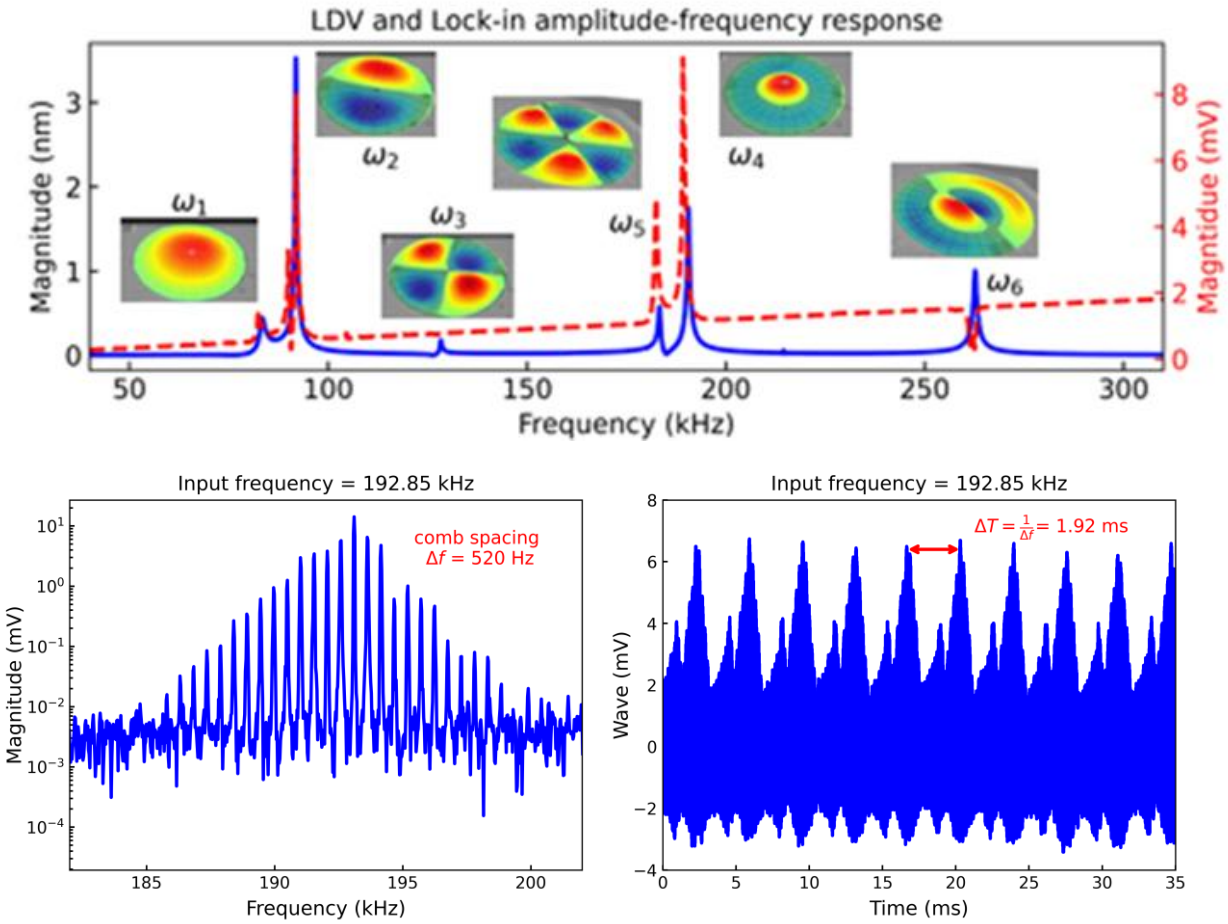

Antony Jeyaseelan


Gayathri Pillai

In a world increasingly defined by control over waves—from light in optical fibers to sound in ultrasound imaging—researchers at the Multidisciplinary Micro and Nano Systems Group at CeNSE, IISc have achieved a breakthrough in shaping sound waves with unprecedented precision. Their recent studies reveal how tiny, curved micromechanical devices can generate and fine-tune phononic frequency combs—intricate patterns of vibrations that could revolutionize sensing, signal processing, and acoustic technologies.



Much like the optical frequency combs that have transformed precision metrology and spectroscopy, phononic frequency combs (PFCs) are their mechanical counterparts—vibrations that appear as equally spaced spectral lines. These combs arise from the nonlinear coupling of vibrational modes within a device, allowing energy to flow between them in complex but predictable ways. However, controlling and tuning such combs at the microscale has long been a challenge. The CeNSE team tackled this by designing curved piezoelectric micromachined ultrasound transducers (PMUTs)—tiny drum-like structures that can generate and sense vibrations. In the first of two complementary studies, the researchers demonstrated that these curved PMUTs can produce tunable phononic frequency combs through a phenomenon called 2:1 internal resonance. This occurs when two vibrational modes oscillate at frequencies in an exact two-to-one ratio, allowing them to exchange energy efficiently and generate a rich comb-like vibration spectrum. The team achieved fine control over the comb spacing using an integrated ferroelectric thin film of lead zirconate titanate (PZT), enabling voltage-based tunability without additional hardware.



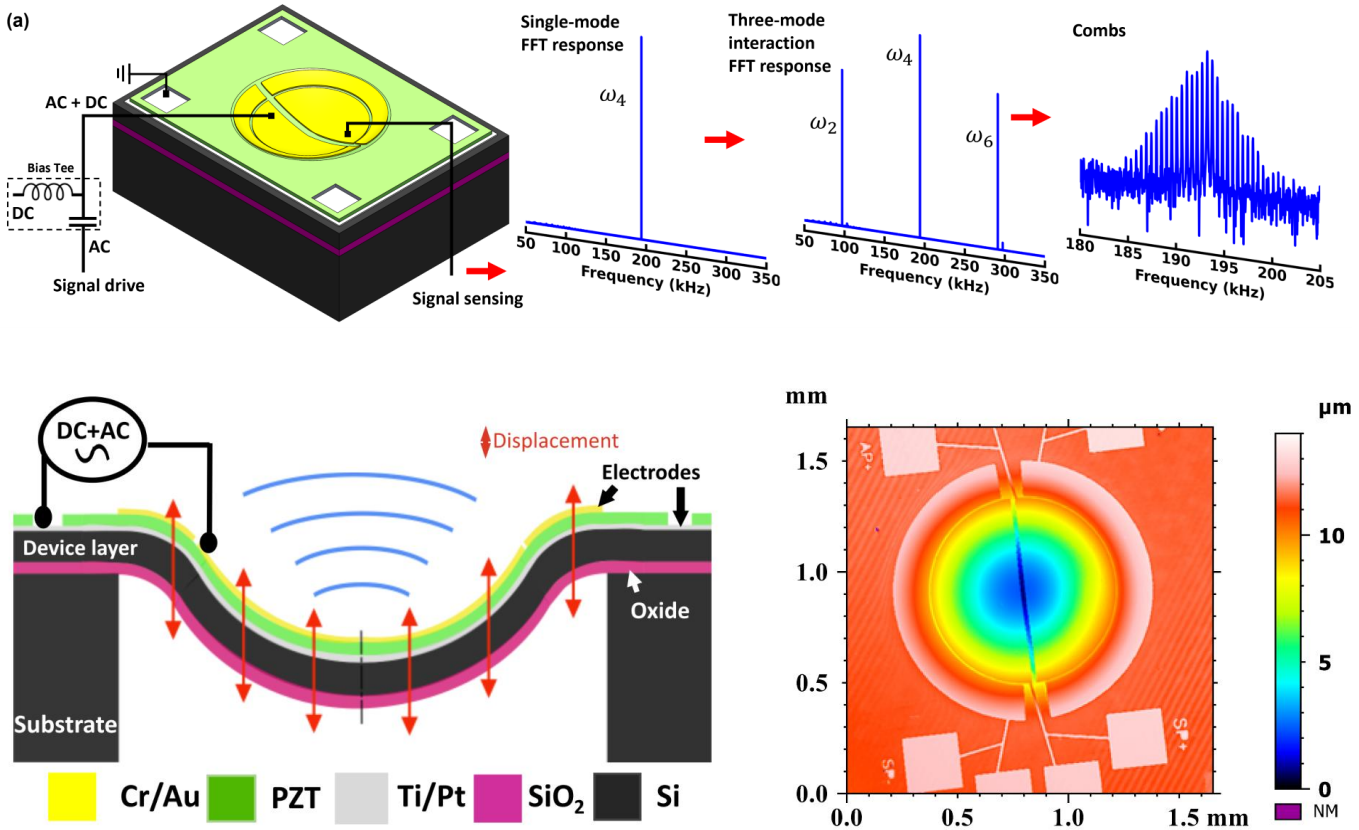
Mechanical and electrical frequency responses up to the sixth mode, accompanied by their corresponding mode shapes. (above) The spectral characteristics and the temporal signature of the frequency combs (below)

Building on this foundation, their follow-up study delves deeper into the physics of nonlinear modal coupling and how factors such as bias voltage, actuation amplitude, and driving frequency shape the resulting combs. By developing a detailed theoretical model based on nonlinear plate dynamics, the researchers captured the essence of these interactions and mapped out pathways for engineering next-generation phononic devices with programmable frequency control.

Together, these studies mark a significant advance in nonlinear phononics, where the complex interplay of mechanical vibrations can be harnessed for practical applications. Tunable phononic frequency combs could enable new classes of miniaturized sensors, on-chip signal processors, and ultrasound technologies that operate with higher precision and efficiency.

In essence, CeNSE researchers are learning to "tune" sound the way optical scientists tune light—opening the door to a new realm of acoustic innovation at the nanoscale.

Published in J. Appl. Phys. 138, 104502 (2025) and Sci Rep 15, 16105 (2025).



3D schematic of a curved PMUT along with electrical measurement connections for electrical drive and sense. The principle of comb evolution from a single-tone drive in the presence of nonlinear intermodal coupling via three-mode combination internal resonance (above) A cross-section view of curved PMUT along the diameter with stack details. (below)

CeNSE RESEARCH NEWS

Neuromorphic pathways for transforming AI hardware

- By the research group of Dr. Sreetosh Goswami

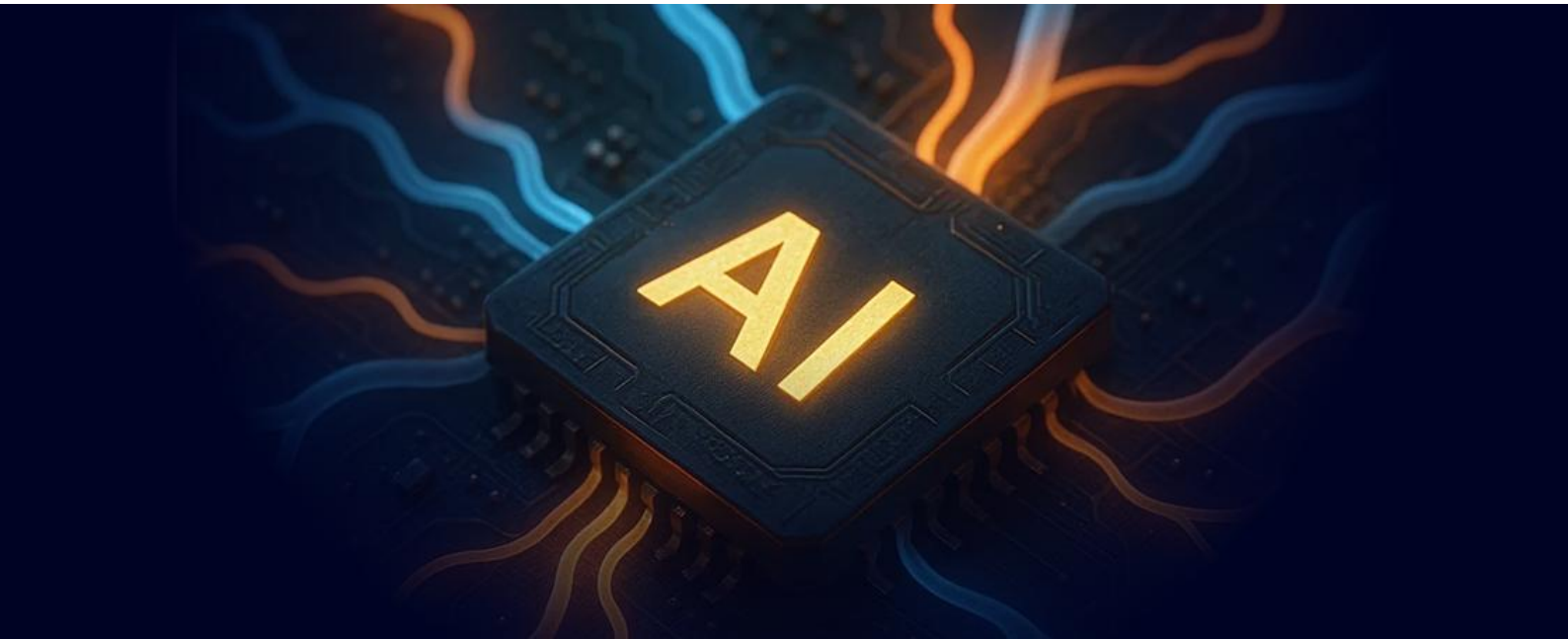
Harivignesh S

Prof. Navakanta Bhat

Dr. Sreetosh Goswami

Artificial intelligence (AI) has achieved extraordinary progress—but at an enormous cost. The chips that power today's AI models—CPUs, GPUs, and TPUs—consume staggering amounts of energy and depend on massive cloud data centers. Training a single large AI model can use as much electricity as hundreds of homes in a year and require vast amounts of cooling water. As AI continues to scale, its environmental footprint is beginning to resemble that of entire nations.

A new perspective from CeNSE, IISc—by Harivignesh S, Prof. Navakanta Bhat, and Prof. Sreetosh Goswami—calls for a radical rethinking of how we build AI hardware. Published in Nature Electronics, their article argues that improving today's chips is not enough; instead, we need a fundamental redesign of computing itself—one that aligns intelligence with efficiency.

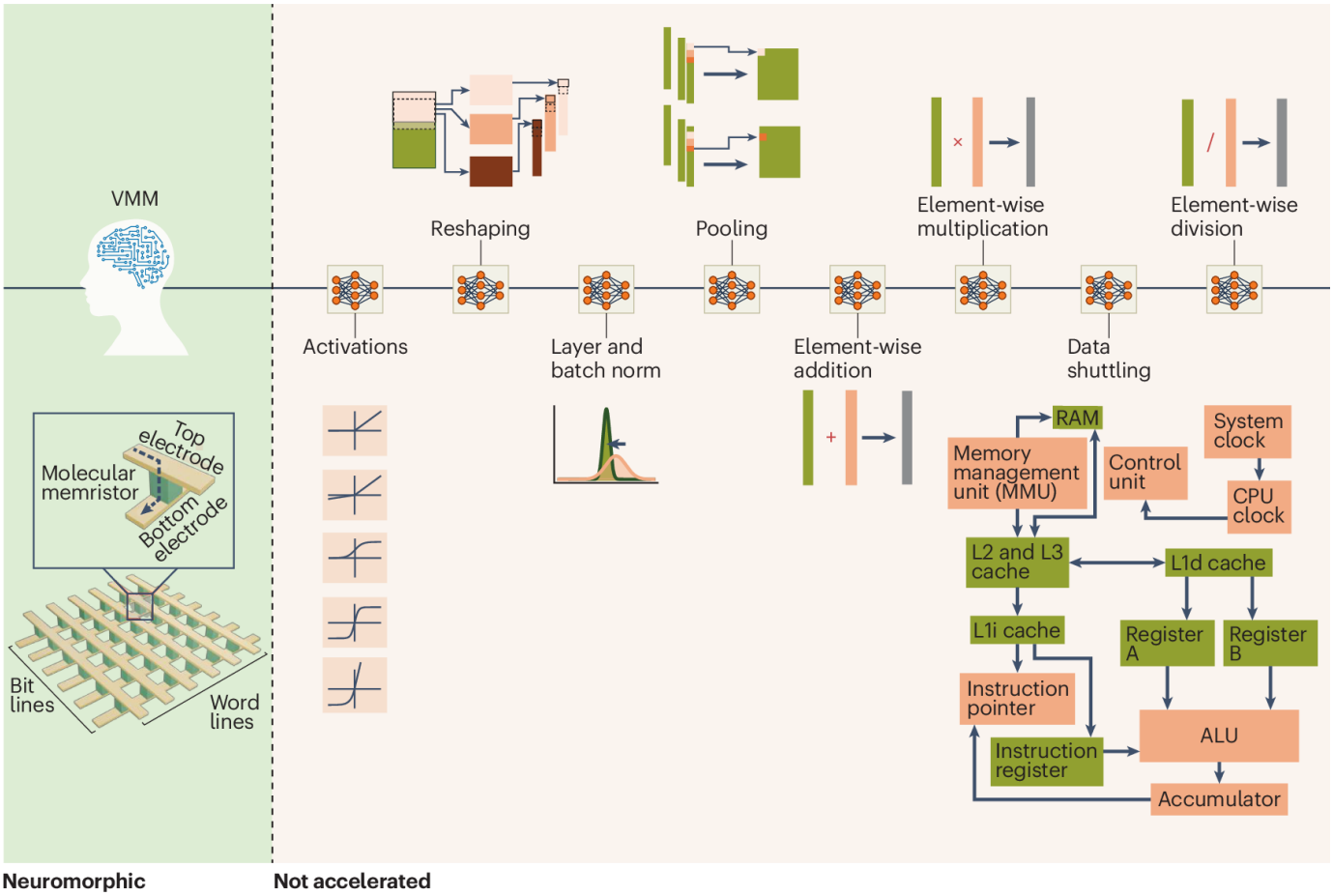


The Promise of Brain-Inspired Computing: Neuromorphic computing takes inspiration from the brain, where memory and computation are seamlessly integrated. In contrast, traditional chips separate the two, forcing data to travel constantly between memory and processors—an energy-hungry process known as the von Neumann bottleneck.

Neuromorphic systems use special devices called memristors that can both store and process information. This allows them to perform key mathematical operations, such as vector–matrix multiplications—the backbone of AI models—in a single step, reducing energy use and latency dramatically.

Why Acceleration Alone Isn't Enough: While neuromorphic chips can speed up certain computations, the researchers point out a critical oversight in most hardware efforts: the majority of energy is still spent outside the accelerator. Even in advanced architectures, tasks like data reshaping, normalization, and repeated digital-to-analogue conversions dominate power consumption. In some systems, as much as 94 percent of the total energy is consumed just by memory access, not by the actual computation.

The message is clear—building faster neuromorphic elements won't solve AI's energy problem unless the entire computing stack is redesigned to minimize data movement and digital overhead.



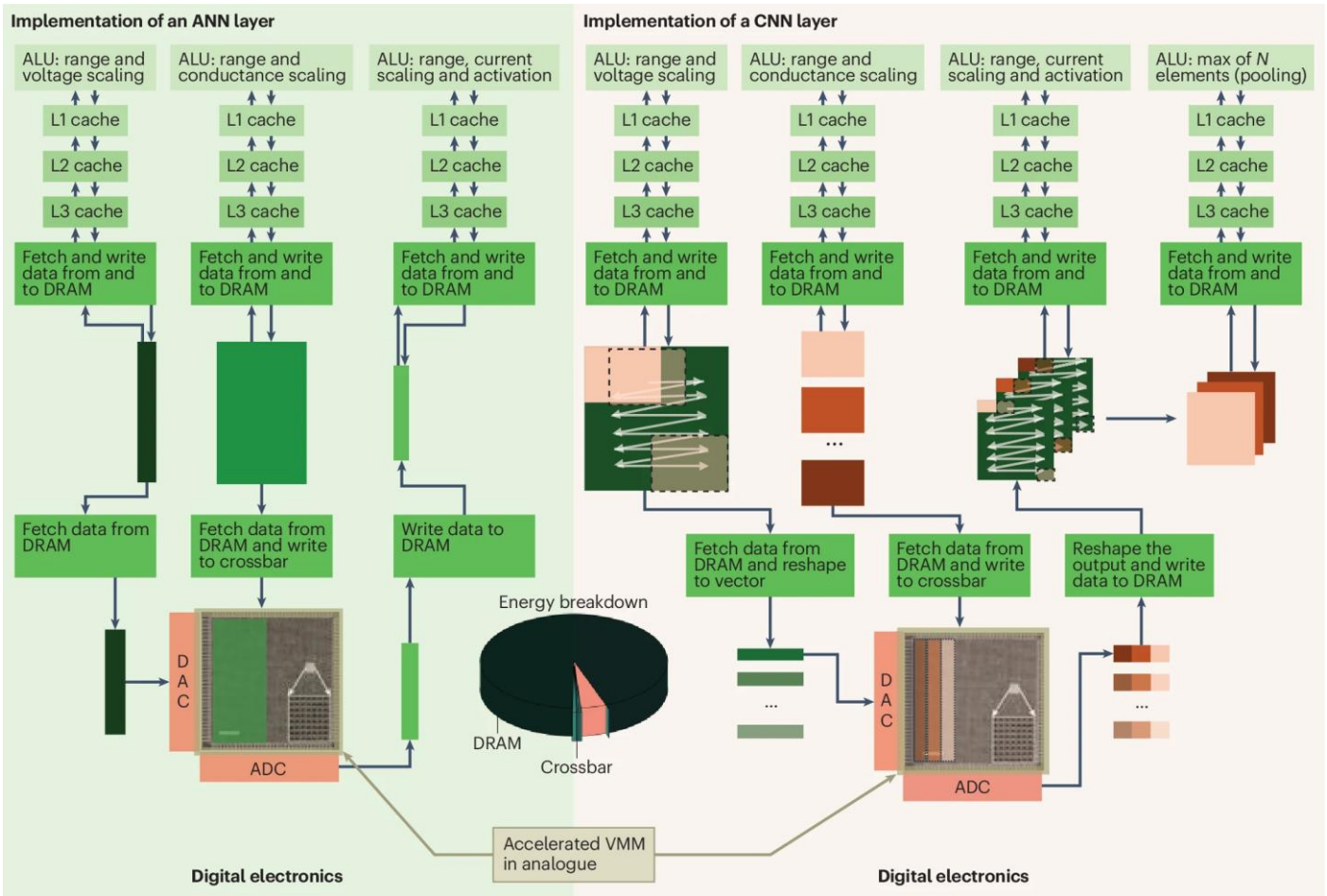
Underlying mathematical operations in neural network implementations

Toward On-Chip Learning: The next leap will come from enabling AI systems to learn directly on the chip, rather than relying on distant cloud servers. On-chip training would make AI faster, more private, and far more energy-efficient—an essential capability for edge applications such as healthcare devices, autonomous systems, and defense technologies. Memristors could be the key to this transformation, serving as analogue, non-volatile memory elements that unite storage, computation, and learning within the same hardware. In principle, they could enable compact "systems-on-a-chip" that train and infer locally, reducing both data transfer and carbon cost by several orders of magnitude.

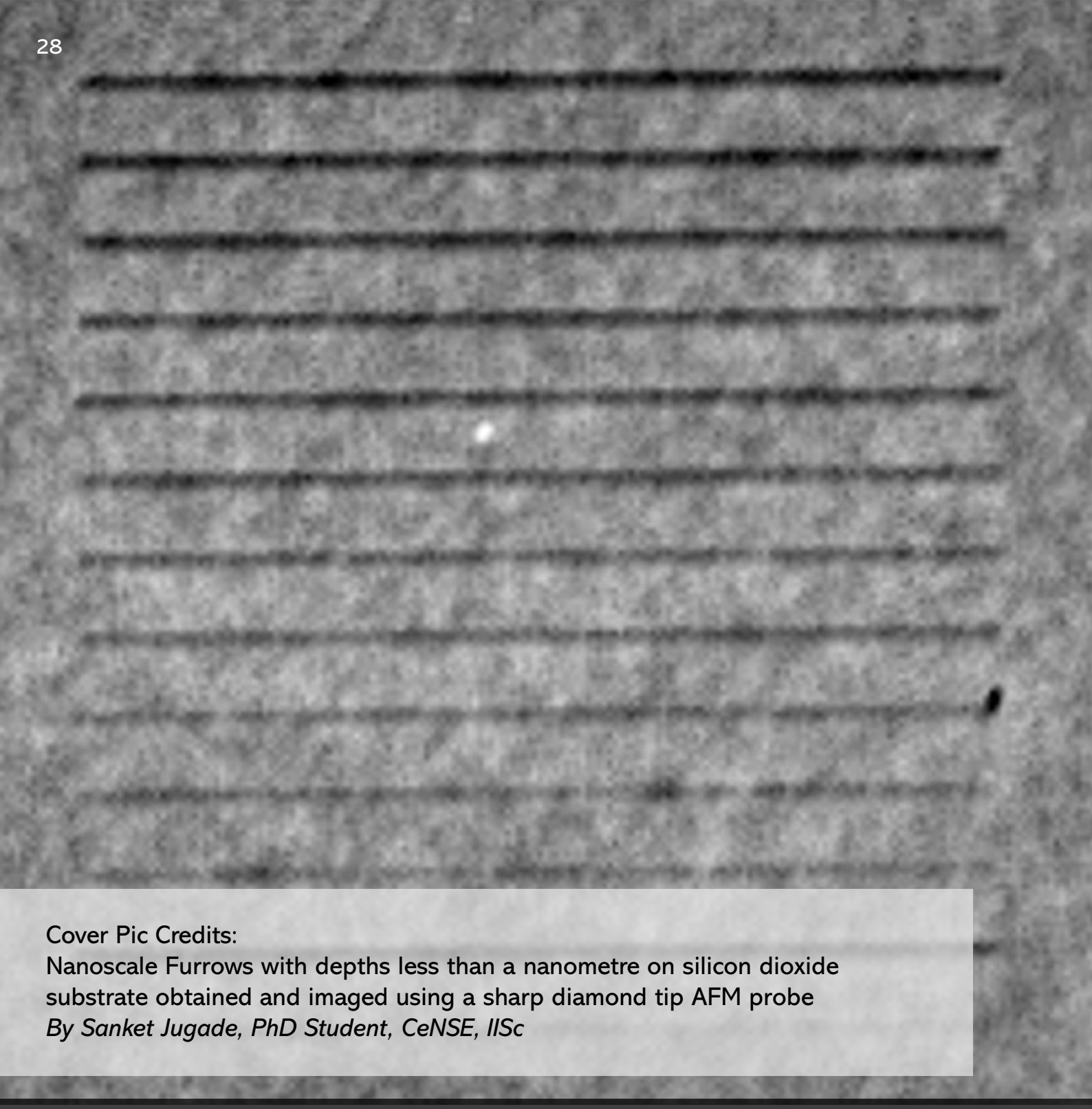
A Call for Holistic Innovation: Achieving this vision, the authors note, will require breakthroughs at every level—from the molecular design of memristor materials to new circuit architectures, compilers, and algorithms that co-optimize with hardware. It's not just about inventing a better device—it's about re-inventing the way devices, circuits, and software work together.

This forward-looking roadmap from CeNSE, IISc highlights India's growing leadership in neuromorphic research. As AI continues to reshape our world, such innovations may define a future where intelligence is not just powerful—but also sustainable.

Published in Nat Electron 8, 752–756 (2025).



Neural network implementation on a neuromorphic dot-product engine



Cover Pic Credits:
Nanoscale Furrows with depths less than a nanometre on silicon dioxide substrate obtained and imaged using a sharp diamond tip AFM probe
By Sanket Jugade, PhD Student, CeNSE, IISc

Acknowledgements: CeNSE acknowledges the support of IISc, MeitY, MoE, DST, DRDO, ISRO, our Industry partners and everybody, past, present and future who constitute the CeNSE family