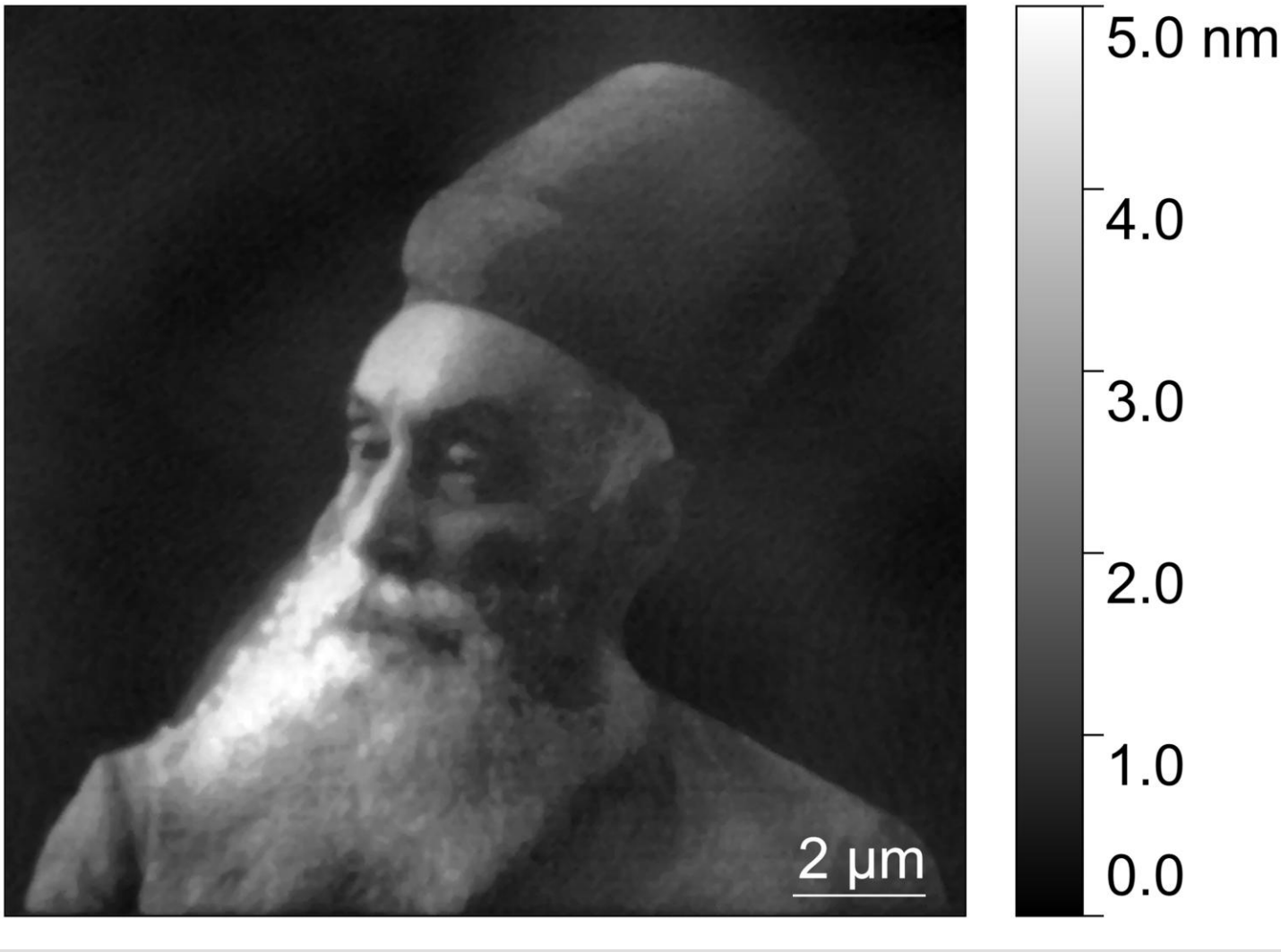
PressCeNSE

Issue: Q2 2025



Pic Credits: Mr. Sanket Jugade, PhD Student, CeNSE

A tiny nanoscale portrait of Shri Jamsetji Tata was created using local anodic oxidation lithography with an atomic force microscope (AFM). By applying voltage through a sharp tip near a silicon surface, a controlled chemical reaction forms silicon dioxide layers of varying thickness. These height differences produce a pattern that replicates the light and dark areas of the original image at the nanoscale.

Message from the Chair

As I complete my term as Chair of CeNSE, I want to take a moment to express my deepest gratitude to all members of our vibrant community—faculty, students, staff, and partners—whose dedication and passion have made these years so rewarding. Together, we have strengthened CeNSE's position as a leader in nanoscale science and engineering, advancing both fundamental research and technologies with real-world impact.

It gives me great pleasure to welcome Prof. Ambarish Ghosh as the next Chair and Prof. Shankar Kumar Selvaraja as the Associate Chair of CeNSE. I am confident that under his leadership, the Centre will continue to grow in new and exciting directions, building on our strong foundation and pioneering work. I wish him and the CeNSE community the very best as they embark on this next chapter.

- Srinivasan Raghavan, Professor, Chair, CeNSE

As we reflect on this quarter, it is heartening to see how CeNSE continues to thrive as a hub of innovation, collaboration, and impact. From opening our doors to thousands of visitors during IISc Open Day 2025, to showcasing transformative technologies at Sci560 and the Nano Electronics Roadshow, our community has been deeply engaged in sharing knowledge and advancing science. We are proud of our faculty, students, and startups whose achievements - from pioneering sensor technologies and remote epitaxy studies to award-winning research presentations highlight CeNSE's role at the forefront of nanoscale science and engineering. Our collective efforts underscore CeNSE's commitment not just to excellence in research, but also to translating ideas into real-world solutions that address critical challenges in healthcare, environment, defense, and beyond. I thank all members of the Centre—faculty, students, staff, and partners—for their dedication and enthusiasm, and look forward to the continued journey as we push the boundaries of what is possible at the nanoscale.

CeNSE NEWS

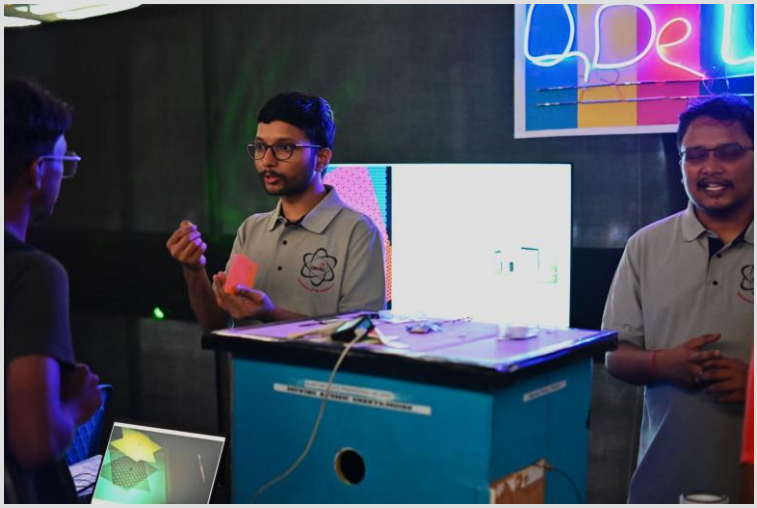
IISc Open Day 2025 at CeNSE

01 March 2025

At the IISc Open Day 2025 on March 1st, the Centre for Nano Science and Engineering (CeNSE) opened its doors to thousands of enthusiastic visitors, offering a vibrant glimpse into the world of nanoscale science and cutting-edge technology. From live demos and hands-on experiments to interactive quizzes, science films, and an exclusive cleanroom tour, CeNSE researchers brought complex scientific concepts to life in fun and accessible ways. School students, college-goers, researchers, and families engaged with exhibits that ranged from visualizing atoms and growing diamonds to exploring brain-inspired circuits, and flexible solar cells. The event was a celebration of curiosity, learning, and innovation—making it a truly unforgettable experience for all !


1 cm = 0.01 m
1 mm = 0.001 m
100 µm = 0.0001 m
1 µm=0.000001 m
100 nm=0.0000001 m
1 nm = 0.000000001 m
1Å = 0.0000000


Pyroelectric Fire detection system



CeNSE NEWS

SOI-MEMS Hackathon: Pioneering Innovations in Microelectromechanical Systems

Candidates across India participated in the SOI-MEMS Hackathon to design, simulate and propose innovative solutions using SOI-MEMS for cutting-edge applications in healthcare, robotics, aerospace and IOT

Winning Projects:

1) Development of MEMS Pressure Sensors Intended for Subsonic Wind Tunnel Applications
   i. Vinod Belwanshi, CSIR-National Metallurgical Laboratory
   ii. Neela Chattoraj and Richa Mishra, BITS, Mesra
   iii. Rahul Kumar Singh, Lovely Professional University
   iv. Sachin Kumar Singh, MITS, Mesra

2) Design of a Tactical Grade MEMS Vibrating Ring Gyro
   i. Vinay Venkataram, BITS Pilani
   ii. Pradnya Chabbi, BITS Pilani
   iii. Dr. Venkatesh K.P. Rao, Mechanical Engineering, BITS Pilani

3) Design and Development of MEMS-based Magnetometer
   i. Dr. Aditi, CSIR-CEERI

CeNSE at Sci560, Science Gallery Bengaluru

15 Nov 2024 to 30 June 2025

Flexible Solar cells

Portrait at the Nanoscale

Pressure Sensors

Nanorobots for Targeted Therapy

CeNSE was proud to participate in Sci560 at Science Gallery Bengaluru (SGB)—a celebration of innovation, creativity, and scientific curiosity in the heart of the city. Through a series of engaging exhibits, CeNSE showcased the future of nanoscale science and engineering, from flexible solar cells for wearable tech to nanorobots for targeted medical therapy, MEMS pressure sensors used in aerospace, and a breathtaking nanoscale portrait of J.N. Tata created with atomic force microscopy. The event brought together pioneering ideas and inspiring minds, offering the public a chance to experience how cutting-edge research is shaping real-world applications.

Visit SGB, Bengaluru, to see our exhibits displayed before 30th June 2025.

Made in India: Next-Gen IR Sensors for Fire Safety

Transfer of Technology to Antigone Solutions Pvt Ltd. at the Nano Electronics Roadshow 27 March 2025

Researchers at the Heterojunction Lab have developed a fully indigenous pyroelectric infrared (IR) photodetector optimized for the critical 4.2 µm "fire-band," enabling advanced fire sensing and automated suppression systems. This Made-in-India innovation has been successfully transferred to Antigone Solutions Pvt. Ltd., aiming to replace the 40,000 imported units currently used in a key defense application—a market valued at ₹40 crore. With a global market potential of $220 million by 2025, this marks a significant step in strengthening India's self-reliance in high-tech sensor technologies.

Nano Electronics Roadshow

March 27, 2025

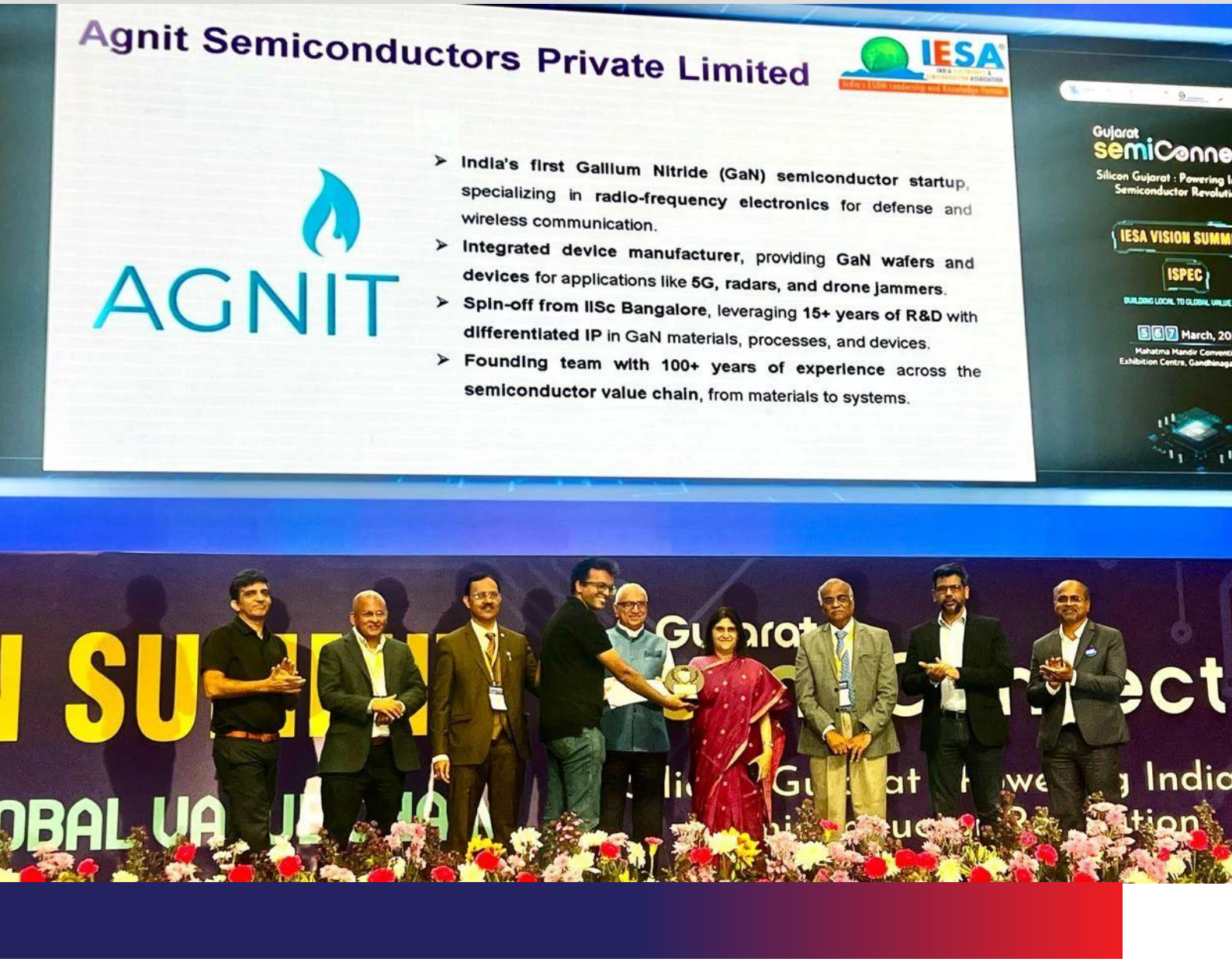
इलेक्ट्रॉनिकी एवं
सूचना प्रौद्योगिकी मंत्रालय
MINISTRY OF
ELECTRONICS AND
INFORMATION TECHNOLOGY

Committed to advancing India's self-reliance in the electronics sector, the Centres of Excellence in Nanoelectronics, established by the Ministry of Electronics and Information Technology (MeitY) since 2005, came together to showcase groundbreaking indigenous technologies at the Nano Electronics Road Show.

Hosted by IISc Bengaluru, IIT Bombay, IIT Madras, IIT Delhi, IIT Kharagpur, and IIT Guwahati, this initiative—organized in association with MeitY—aimed to bring together key stakeholders from government, industry, academia, strategic sectors, startups, and the VC ecosystem.

The event provided a platform for knowledge sharing, networking, and showcasing state-of-the-art research and innovation in nanoelectronics. The event sparked powerful discussions, with leaders sharing key insights on industry-academia collaboration, innovation-driven manufacturing, and a resilient supply chain—crucial for India's self-reliance.

AgNIT Semiconductors Pvt Ltd wins the Technovation Award 2025



Hearty congratulations to Hareesh Chandrasekar , AGNIT Semiconductors and team on winning the Technovation Startup Award 2025 issued by IESA.

AgNIT Semiconductors Pvt Ltd, design and manufacture GaN semiconductors in Karnataka for the world. It is a deep-tech startup from IISc, offering Gallium Nitride (GaN) components for next generation communication networks for 5G and efficient power switches for electric vehicle fast charging, etc. The AGNIT team has more than 100 years of experience in developing GaN solutions from materials-to-device-to-systems. Only Indian GaN device company and one of a handful world-wide with patent protected GaN technology.

Theranautilus Pvt Ltd wins Elevate 2024

ELEVATE 2024

THERANAUTILUS

84	TETRANE SOFTWARE PRIVATE LIMITED	ITITES, FASHION & APPAREL	BENGALURU URBAN
85	THERANAUTILUS PVT LTD	HEALTHCARE, MEDTECH AND WELLNESS	BENGALURU URBAN
86	THINGS ALIVE SOLUTIONS PVT LTD	AUTOMOTIVE AND TRANSPORTATION	BENGALURU URBAN

Theranautilus Pvt Ltd wins the Elevate 2024 issued by the IT BT Department, Government of Karnataka.

This incredible recognition from the Karnataka Government fuels their mission to revolutionize global healthcare right here in Namma Bengaluru.

Theranautilus Pvt Ltd is a hardware company specializing in instruments for fabricating nanorobots, safe deployment of nanorobots in living systems, and mechanism to maneuver them to their target inside the body remotely. Their system would be capable of reaching greater depths within the dentinal tissues to target bacterial colonies that are out of reach with the current state of the art tools.

Faculty and Student Achievements

Congratulations to Dr. Saurabh Chandorkar on receiving the CeNSE Award for Excellence in teaching for the year 2024

Congratulations to Shubham Parate on being awarded the "Best Oral Presentation Award" International Conference on Laser & other deposition techniques iCOLD-25
IIT Hyderabad, 06-08 March 2025

Congratulations to Phani Shankar on being awarded the "Best Poster Presentation Award" in the International Conference on Laser & other deposition techniques iCOLD-25
IIT Hyderabad, 06-08 March 2025

Congratulations to Deepak Sharma for winning the Best Poster Award in the Interdisciplinary category at the PMRF Symposium 2025*IIT Hyderabad, 16-17 March 2025*

CeNSE RESEARCH NEWS

Revolutionizing SO_2 Detection with quantum dots assembled on Mxene nanosheets

- Research by Prof. Navakant Bhat's group


Ayan Pal

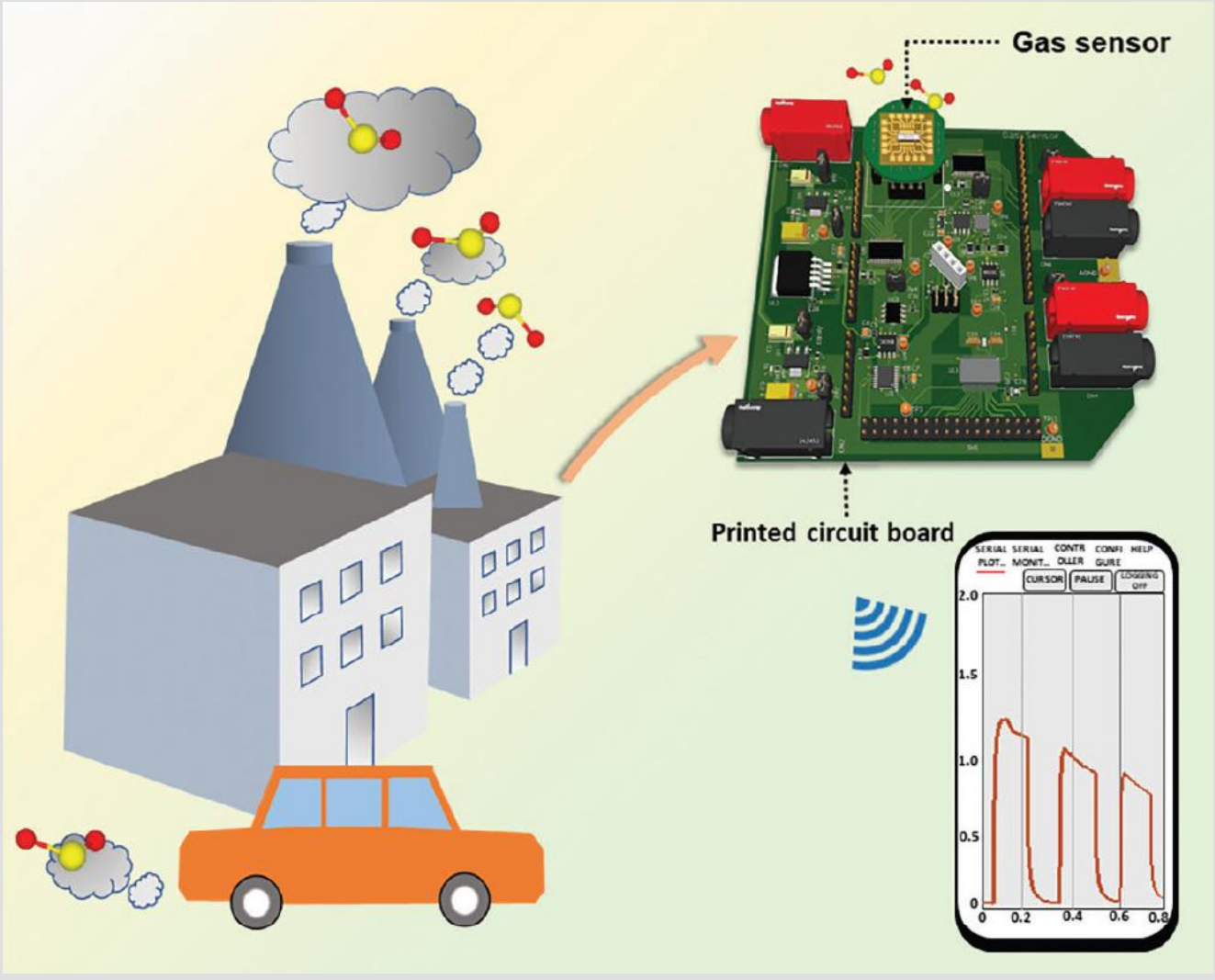

Deepak S


Pragyan T


Upanya K


Abhishek KS


Navakanta Bhat



Leveraging heterostructures and boron doping, this innovation addresses air quality challenges, offering a promising solution for advanced, field-deployable sensors to monitor and regulate SO_2 levels, hence environmental pollution.

The innovative design of mixed-dimensional heterostructures has opened new avenues in material science, showcasing unique physical and chemical properties unattainable in single-dimensional systems. In a groundbreaking study, researchers have developed a highly sensitive sulfur dioxide (SO_2) gas sensor using heterostructures of boron-doped molybdenum disulfide quantum dots (B-MoS_2 Qdots) integrated with $Ti_3C_2T_x$ MXene. This novel composite achieves exceptional performance, demonstrating the potential of advanced nanomaterials for real-world applications.

The $Ti_3C_2T_x$/B-MoS_2 sensor leverages the synergy between its two components. $Ti_3C_2T_x$ MXene nanoflakes provide high charge transfer capability, while the B-MoS_2 Qdots, with abundant edge sites and boron-doped active sites, enhance gas adsorption and response dynamics. This results in unprecedented sensitivity (28,998.3% response at 3 ppm SO_2) and a record-low detection limit of 10 parts per billion (ppb). Additionally, the sensor exhibits ultra-fast response rates (23.1% s^{-1}), excellent selectivity, and reliable reversibility at room temperature.

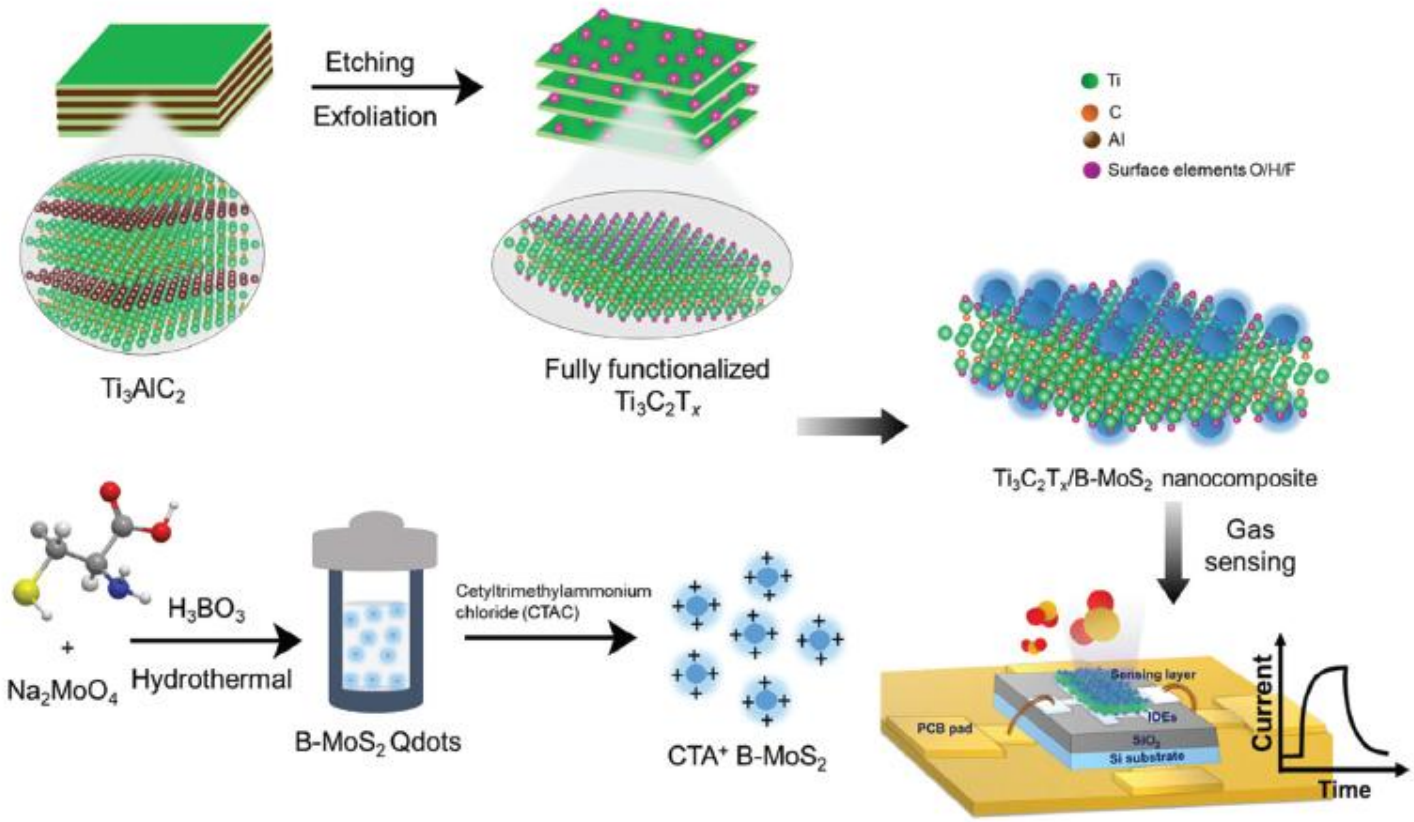


Fig. Schematic illustration of the preparation of Ti3C2Tx/B-MoS2 nanocomposite for highly-responsive SO2 detection

The researchers achieved these breakthroughs by employing electrostatic interactions to functionalize the MXene surface with Qdots, significantly enhancing surface area and charge migration pathways. Density functional theory calculations revealed that boron doping further improves SO_2 adsorption and promotes rapid charge transfer, making this heterostructure particularly effective for gas sensing.

The implications of this work extend beyond sensor performance. A prototype wireless monitoring system integrating the $Ti_3C_2T_x$/B-MoS_2 sensor demonstrates its suitability for real-time environmental surveillance and IoT applications. With its high sensitivity, selectivity, and practicality, this technology addresses critical challenges in environmental monitoring, particularly in detecting hazardous SO_2 emissions from industrial and vehicular sources.

This study highlights the transformative potential of MXene/Qdots heterostructures in advancing smart, field-deployable sensing technologies, paving the way for a new era in environmental safety and monitoring.

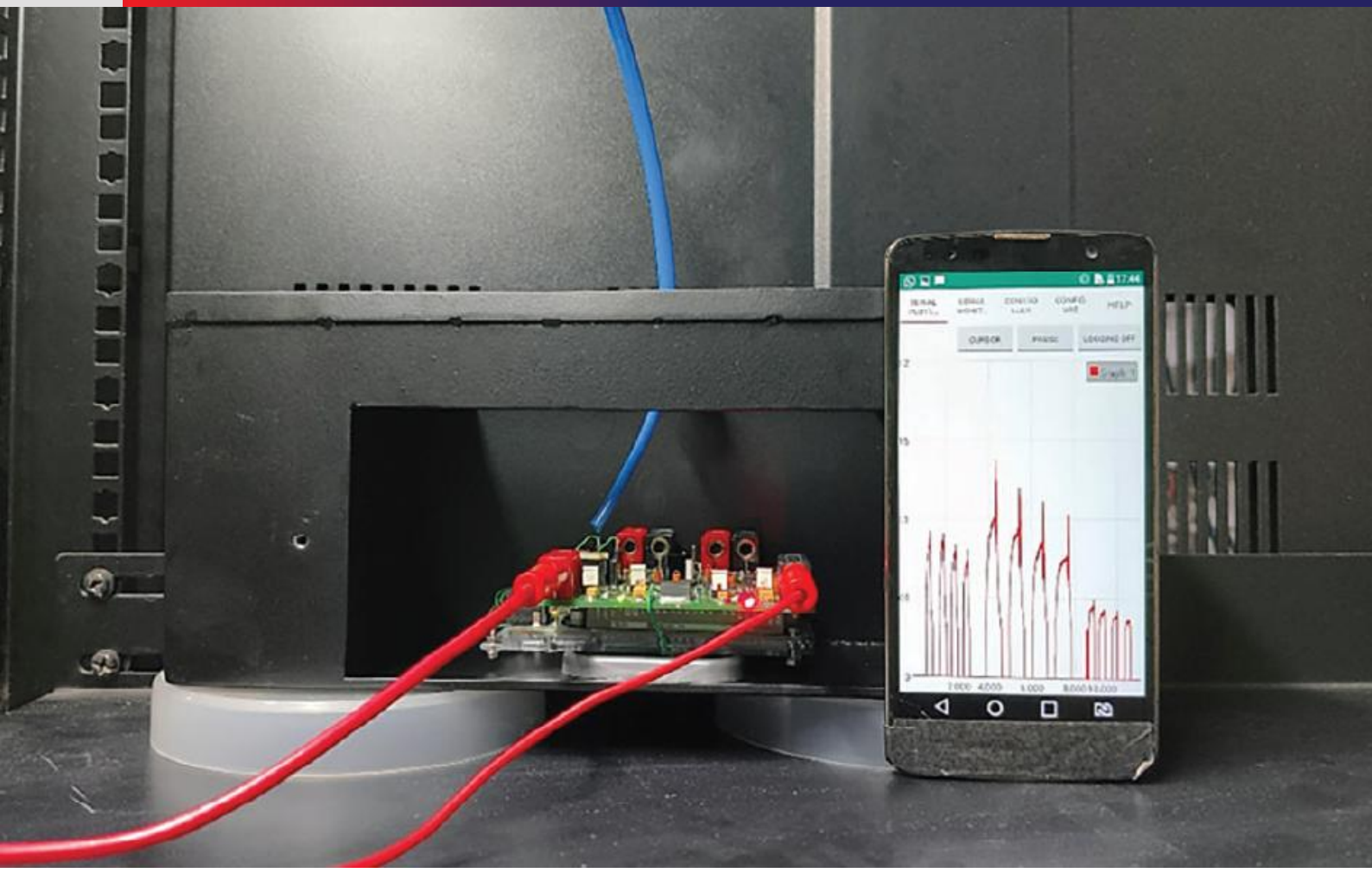


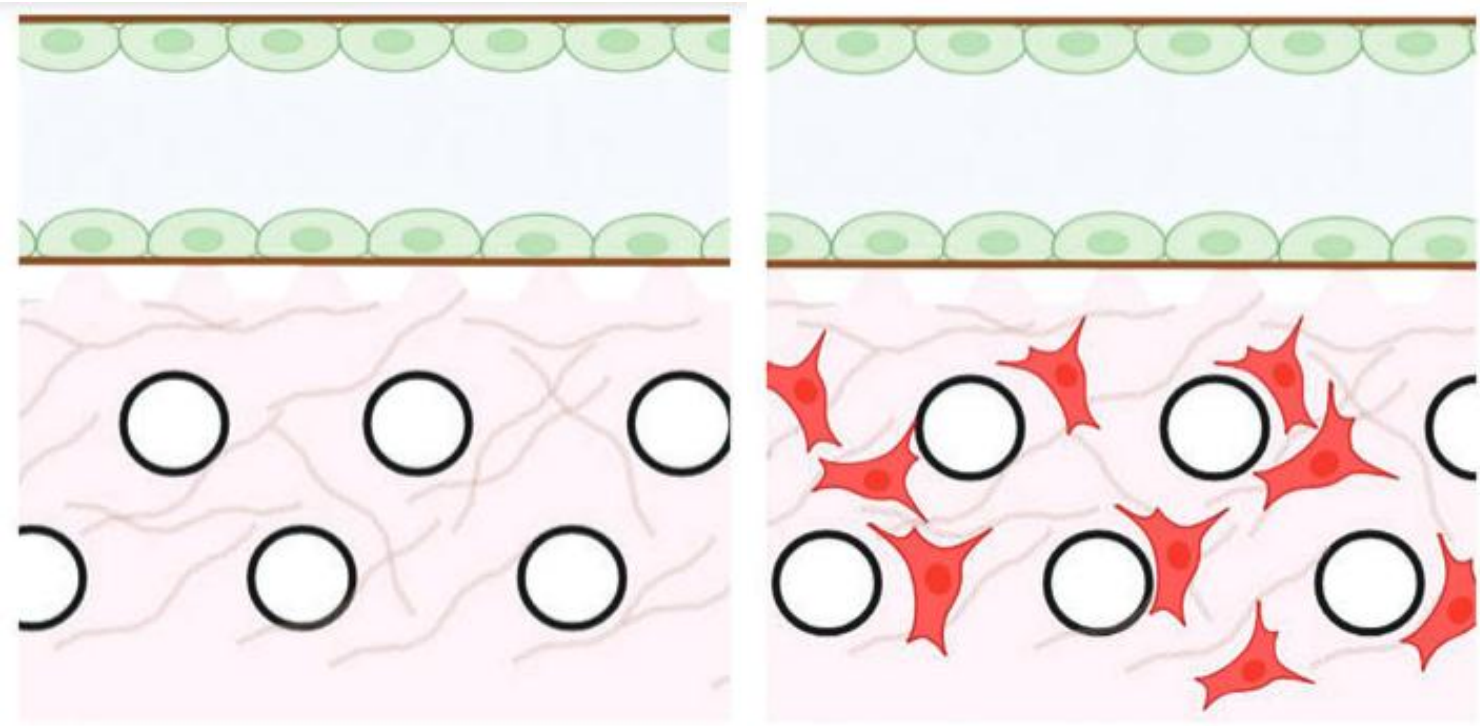
Fig. Real-time SO2 leakage detection and monitoring

CeNSE RESEARCH NEWS

Microfluidic organ-on-a-chip used to demonstrate effects of aging and diabetes on cancer

- Research Led by the group of Prof. Prosenjit Sen, CeNSE, IISc and Prof. Ramray Bhat, Biological Sciences, IISc

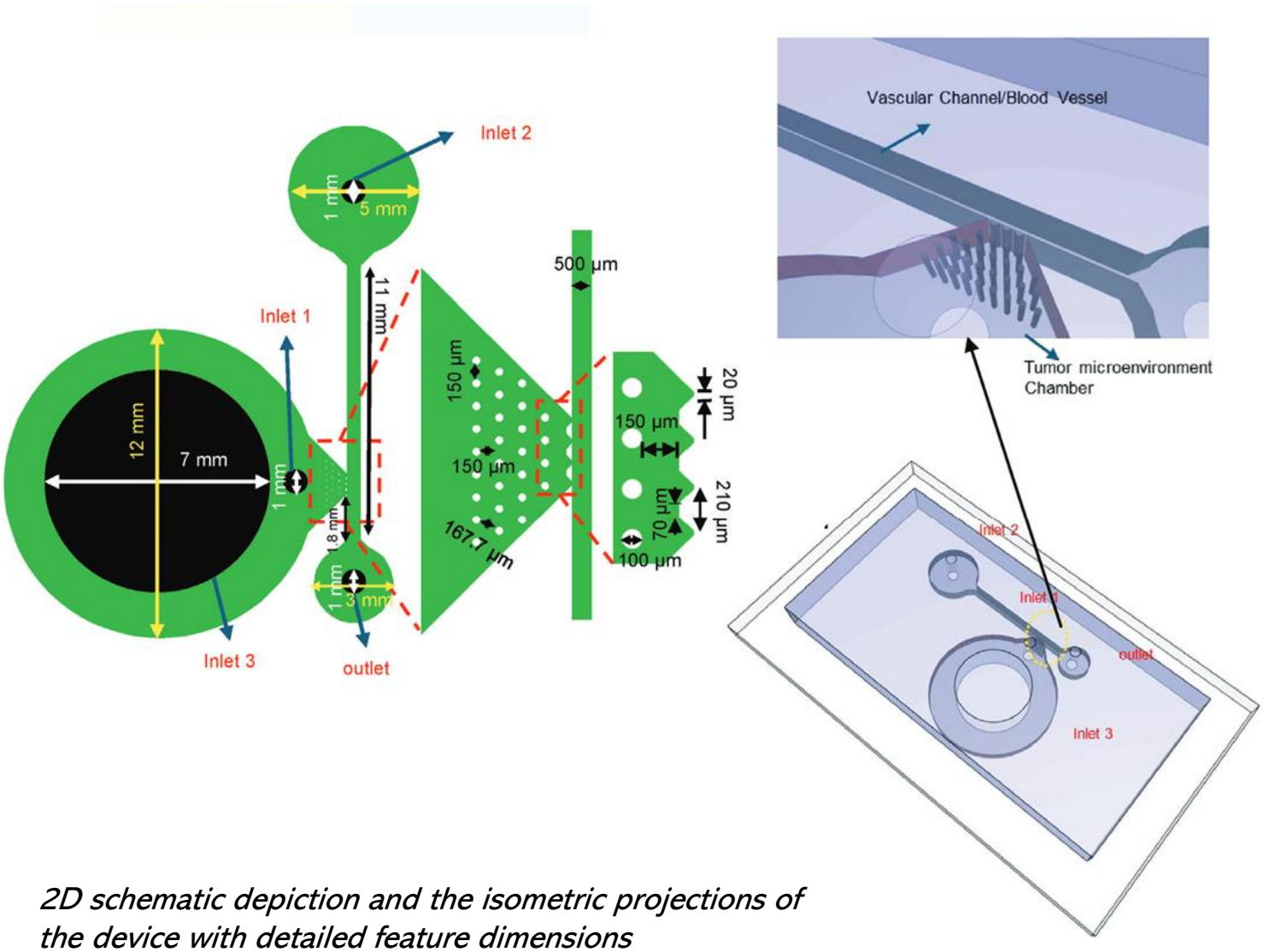
Cancer metastasis, the spread of tumor cells from a primary site to distant organs, hinges on a process called intravasation. This critical step involves cancer cells breaching the extracellular matrix (ECM) and endothelial barriers to enter vascular channels. Despite its significance, the influence of factors like chronic inflammation, aging, and diabetes on intravasation remains underexplored. A novel microfluidic multi-organ-on-chip platform has now shed light on this complex process, revealing how diabetic conditions exacerbate cancer cell entry into the bloodstream.



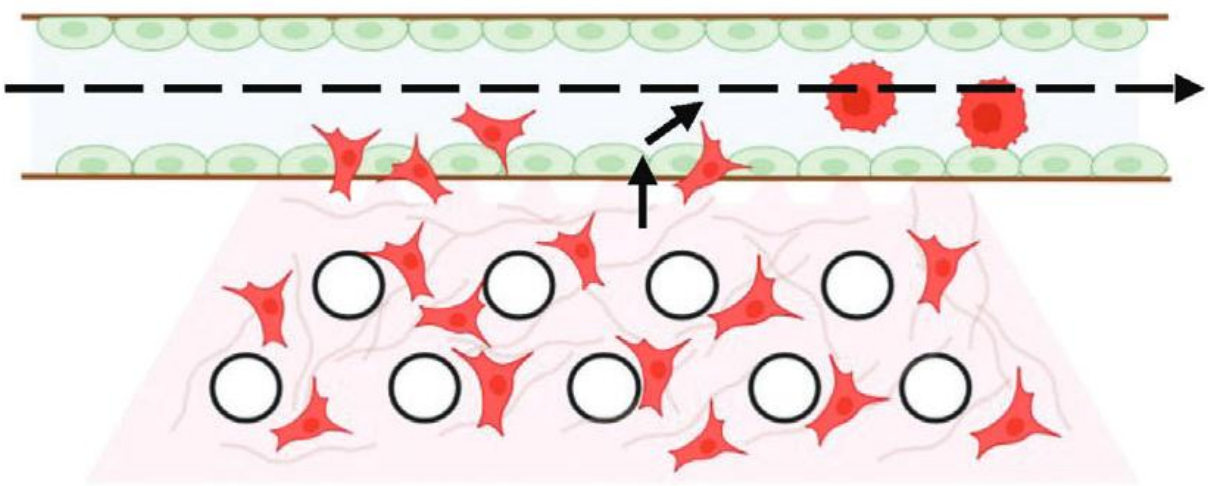
No Cancer Cells vs Cancel Cells

The platform mimics the tumor microenvironment by integrating a breast cancer cell-laden 3D collagen scaffold with a vascular channel lined by endothelial cells on a laminin-rich basement membrane. This setup replicates the dynamic interactions between cancer cells and vascular tissues during intravasation. The study found that cancer cells and endothelia cooperatively form structures that facilitate vascular entry. Once inside, cancer cells adhere to the vascular walls and flow through the channel.

A key finding was the impact of methylglyoxal (MG), a byproduct of glucose metabolism linked to diabetes and aging. MG exposure increased cancer cell intravasation and adhesion, primarily by inducing endothelial senescence and degrading the ECM. MG also caused pathological cross-linking of Collagen I, weakening cell-ECM adhesion and promoting cancer cell migration. These changes transformed cancer cells into a more mobile, amoeboid form, accelerating their movement through the stroma.



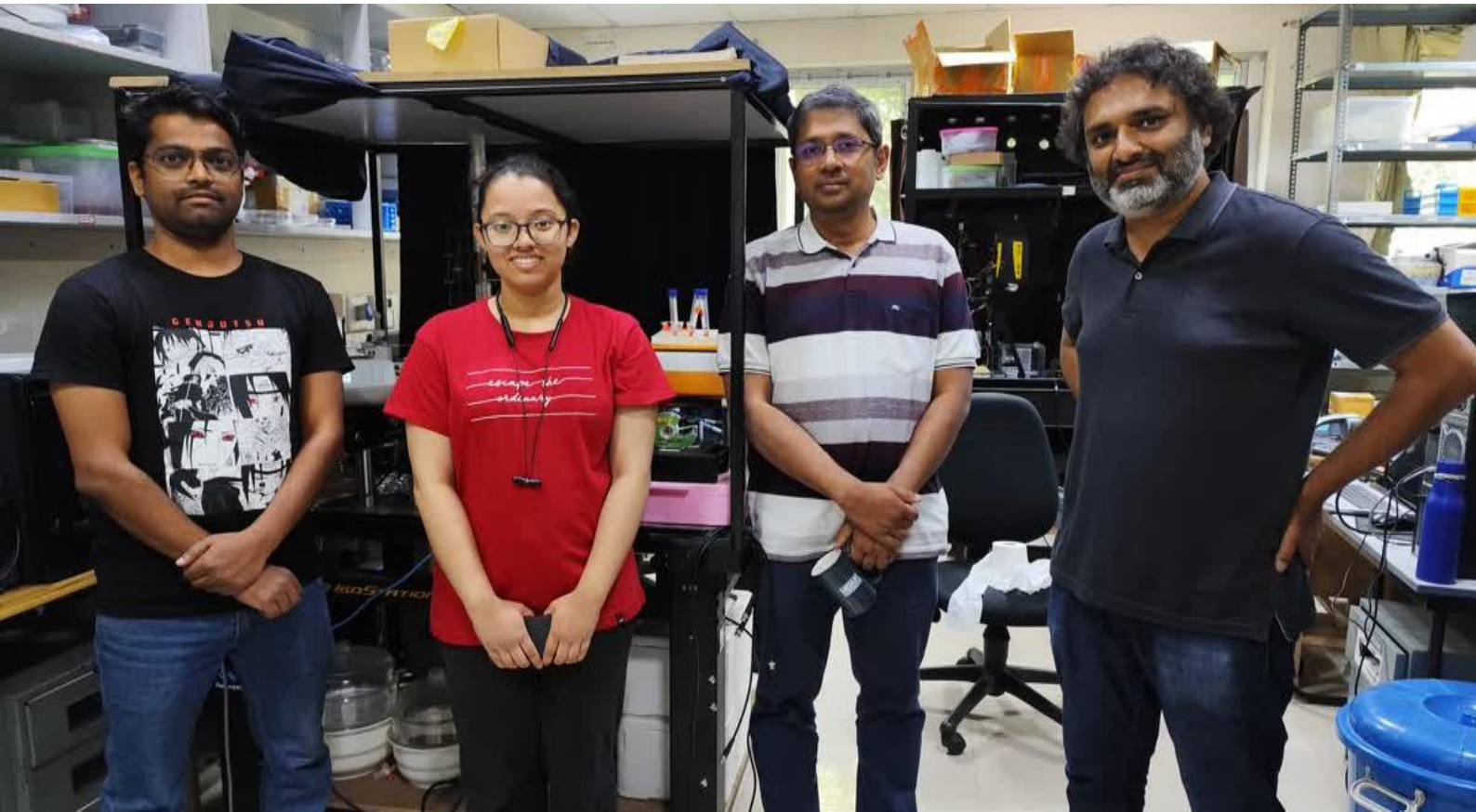
2D schematic depiction and the isometric projections of the device with detailed feature dimensions



Schematic representation of the components of the intravasation-on chip platform comprising endothelia (green), endothelial basementmembrane matrix (brown), Collagen I matrix (pink) and invasive breast cancer cells (red

The study underscores the role of dicarbonyl stress in compromising endothelial and ECM barriers, thereby enhancing tumor spread. While the chip provided valuable insights, its limitations include simplified vascular designs and a lack of components like pericytes. Future iterations aim to address these gaps, exploring additional factors such as shear stress, immune cell interactions, and tumor heterogeneity.

This breakthrough demonstrates how advanced bioengineering can unravel the mechanisms of cancer metastasis, paving the way for targeted therapies to inhibit tumor spread, particularly in patients with diabetes or aging-related vulnerabilities.



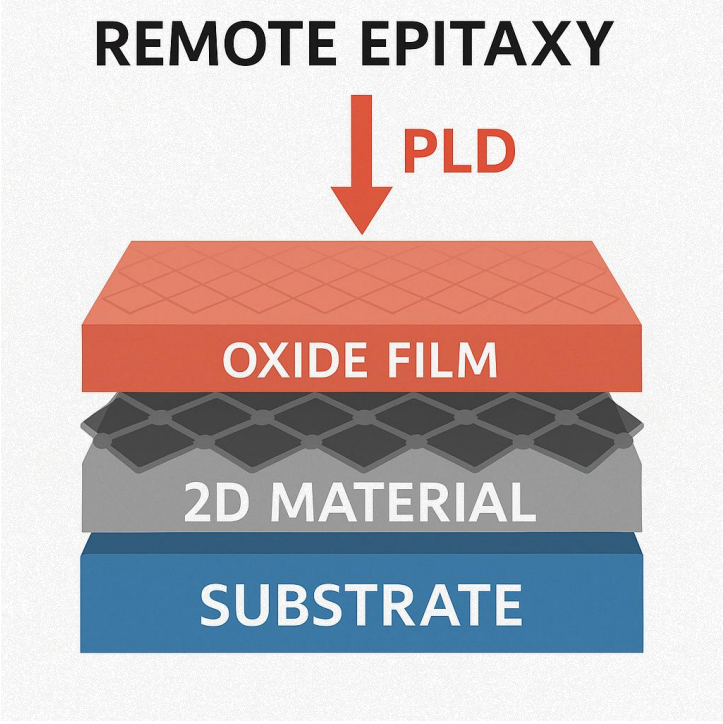
CeNSE RESEARCH NEWS

Remote Epitaxy: Advancing Oxide Film Growth and Integration

- By the research groups of Dr. Pavan Nukala and Prof. Srinivasan Raghavan

Remote epitaxy, a cutting-edge method leveraging two-dimensional (2D) materials like graphene, offers a pathway to grow crystalline thin films replicating the substrate's characteristics while enabling film exfoliation and substrate reuse. This technique holds promise for advancing perovskite oxides' integration into silicon-based CMOS and flexible electronics. However, the process is fraught with challenges, particularly the susceptibility of graphene to damage during film growth using pulsed laser deposition (PLD).

In a pioneering study, researchers demonstrated a direct correlation between graphene's microstructure, its damage under PLD conditions, and the resulting quality of $BaTiO_3$ (BTO) films. The team employed a controlled aperture method to mitigate damage and observed that graphene with large grain sizes (>300 μm) sustained less damage than smaller-grain graphene, producing higher-quality epitaxial films. Furthermore, bilayer graphene interfaces facilitated the successful exfoliation of large (4 mm × 5 mm) oxide layers while retaining their ferroelectric properties, highlighting the method's potential for scalable applications.



This study also showcased the significant impact of graphene's pre-growth microstructure and post-growth conditions on the epitaxy quality. A two-step PLD process minimized graphene damage and optimized film growth. The findings underscore the critical role of using large-grain wet-transferred graphene and advanced deposition techniques in achieving high-quality, freestanding oxide films.

Remote epitaxy's ability to integrate crystalline oxides onto diverse substrates without sacrificial layers is transformative. It reduces material waste, reuses expensive substrates, and supports the integration of oxides into both rigid and flexible platforms. This innovative approach opens new frontiers in functional device development, from sensors to memory, enabling a leap toward next-generation electronics.

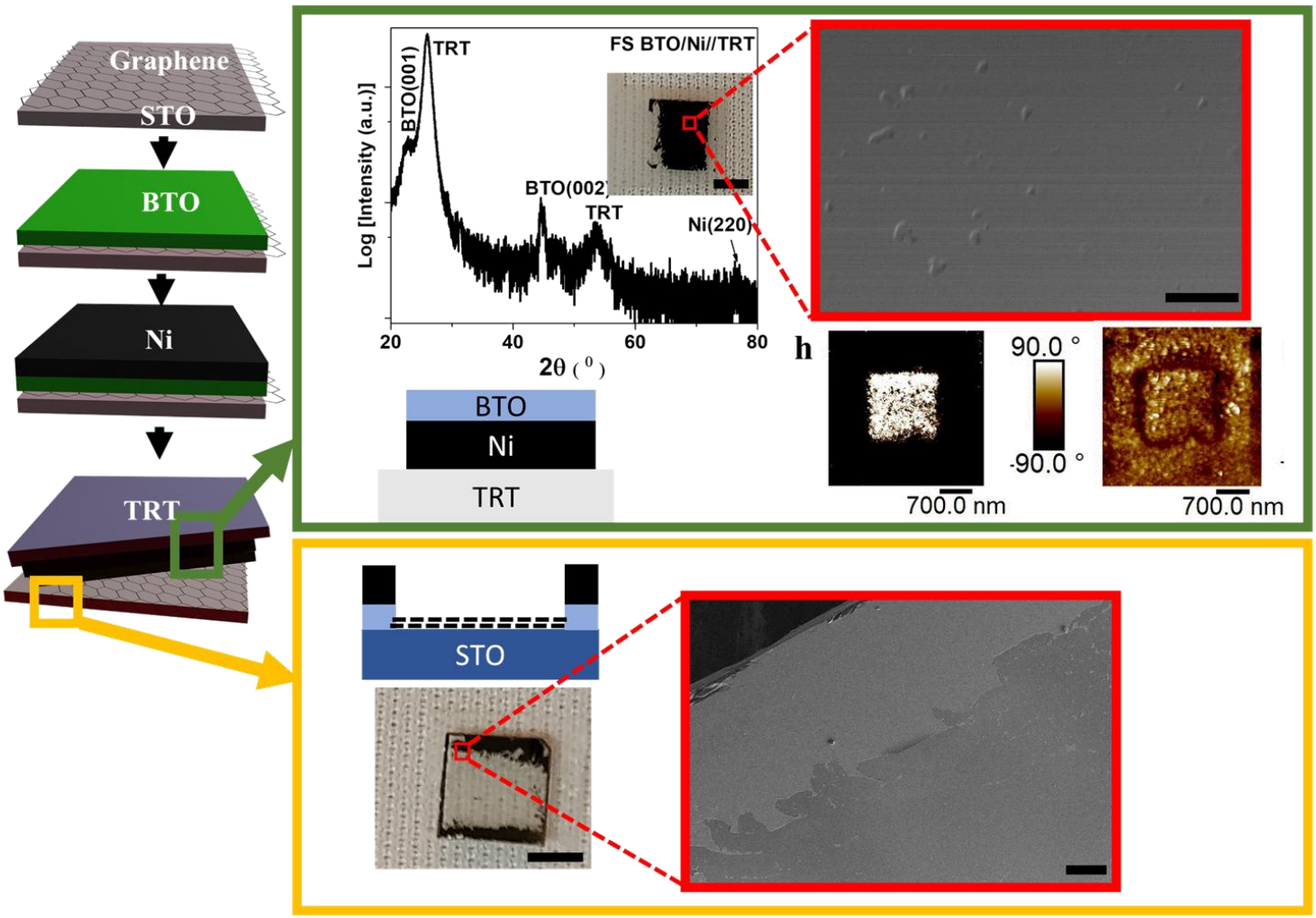


Fig. Exfoliation of $BaTiO_3$ (BTO) membranes using a Ni stressor layer and thermal release tape (TRT), with structural and ferroelectric characterization confirming clean separation, intact crystallinity, and clear domain contrast in the exfoliated BTO.

Cover Pic Credits:
This project showcases a stunning array of gold air bridges patterned with µPG501 system. These 3–4 µm structures are vital interconnects in RF devices and a beautiful example of advanced microfabrication.
The team skillfully used a dual lithography approach with resist reflow and gold electroplating to achieve this micron-scale feat.
By Shonkho Shurvo, 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