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Catalysing Innovation

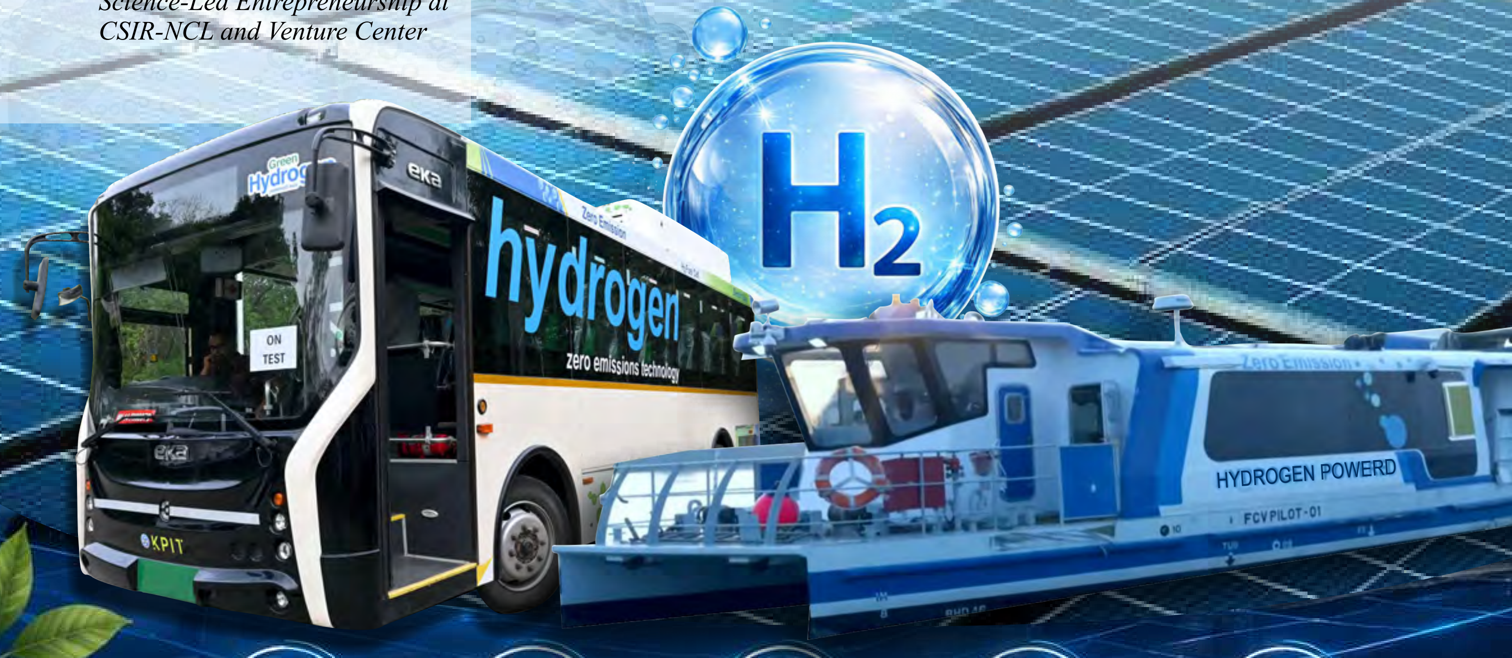
NCL'S HYDROGEN FUEL CELL JOURNEY AND INDIA'S CLEAN ENERGY FUTURE

Building What Lasts: The Journey of Dr Sreekumar Kurungot

Green Hydrogen and India's Energy Transition

Engineering Catalysts at the Atomic Scale for Efficient Ammonia Fuel Cells

The Architecture of Translation: Science-Led Entrepreneurship at CSIR-NCL and Venture Center



CLEANER TODAY

ZERO EMISSION

RENEWABLE ENERGY

INNOVATION FOR TOMORROW

STRONGER INDIA

EDITORIAL

At CSIR-NCL, science moves across boundaries, from fundamental discovery to technology, from the laboratory to industry and from individual ideas to solutions for society. This issue of *Allotrope* brings together stories that capture this journey of scientific translation and impact.

Our Cover Story, ***"NCL's Hydrogen Fuel Cell Journey and India's Clean Energy Future,"*** traces more than two decades of research that has taken indigenous fuel-cell technology from laboratory studies to cars, buses, passenger vessels and, today, the emerging Pune Hydrogen Valley. It is a story of sustained research, collaboration and the ambition to build India's clean-energy capabilities.

In *Our Curious Minds*, we feature Dr Sreekumar Kurungot, whose work across fuel cells, hydrogen, batteries and advanced materials reflects a career shaped by curiosity and a commitment to building what lasts. His greatest legacy, however, may lie in the students and scientific capabilities he has nurtured along the way. *From the Podium* brings perspectives from Dr Ashish Lele's lecture on the potential role of green hydrogen in India's energy transition, exploring the realities of cost, technology, infrastructure and industrial adoption.

The *Reader's Forum* features a guest article that examines science-led entrepreneurship and the pathways that translate research into ventures. Drawing on the experience of CSIR-NCL and Venture Center, the article explores how mentorship, infrastructure, funding and institutional support can help bridge the gap between discovery and deployment.

Together, these stories reflect the many *Allotropes of Science* at NCL: discovery, innovation, mentorship, collaboration and entrepreneurship. Above all, they show that the journey of science does not end in the laboratory; *it begins there*.

We hope you find this issue insightful and inspiring.

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PATRON

Dr Ashish Lele
Director, CSIR-NCL

EDITORIAL

Dr Nikhlesh Yadav
Head, Publication and Science Communication Unit, CSIR-NCL

Dr Harshawardhan V. Pol
Chief Scientist, Polymer Sci. & Engr. Division, CSIR-NCL

CONTENT AND COMPILATION

Ms Anjali Singh
Publication and Science Communication Unit, CSIR-NCL

LAYOUT AND DESIGN

Mrs Manisha Tayade

CONTRIBUTORS

Knowledge Resource Centre/ Library
Intellectual Property Group
Technology Management Group
NCL- SDP NCL-SciLogy

OTHERS

Dr Sreekumar Kurungot
Dr Pradip Maity
Dr Amol A. Kulkarni

INVITATION FOR ARTICLES

We invite your contributions for Allotrope in the following capacities:

Research stories

Explain your research/ ongoing experiment in a simplified manner.

Science articles

Describe a contemporary science topic, a scientific concept, technology, or a scientist of interest.

Individual experiences

Write about your personal field research/ travel experiences, conferences, paper/ poster presentations, PhD journey, or others. Senior scientists and staff members are invited to share their work experiences and insights.

Visual narrations

Showcase your research or technology with the help of a schematic or a graphic. Photographs related to NCL are also welcome.

The word limit for writing stories and articles is 500 words.

Kindly send your entries to: allotrope.ncl@csir.res.in

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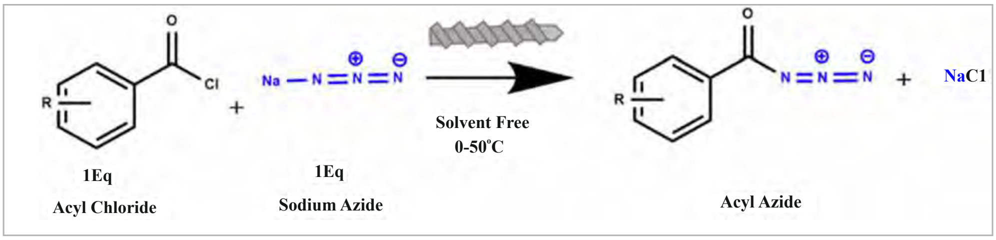


CONTENT

NCL'S HYDROGEN FUEL CELL JOURNEY AND INDIA'S CLEAN ENERGY FUTURE

At a time when the world is grappling with the twin challenges of climate change and energy security, hydrogen has emerged as one of the most promising clean energy carriers. Among the many technologies competing to define the post-carbon era, hydrogen fuel cells stand out for their efficiency and environmental credentials: converting the chemical energy of hydrogen directly into electricity, with water as the only by-product.

At **CSIR-National Chemical Laboratory (CSIR-NCL)**, this pursuit has driven more than two decades of research into hydrogen fuel cells. What began as fundamental investigations in materials chemistry and electrochemical systems has evolved into one of India's most significant indigenous clean-energy success stories; powering cars, buses and even the country's first hydrogen fuel cell-powered passenger vessel and now advancing integrated hydrogen ecosystems through the Pune Hydrogen Valley. This remarkable journey reflects the power of sustained scientific research, multidisciplinary collaboration and successful translation of laboratory innovations into real-world technologies.

> "More than two decades ago, scientists at CSIR-National Chemical Laboratory set out to determine whether India could develop its own hydrogen fuel cell technology rather than depend on imported systems. Today, that vision has become a reality, powering cars, buses and even India's first fuel cell passenger vessel."

Building the Scientific Foundation

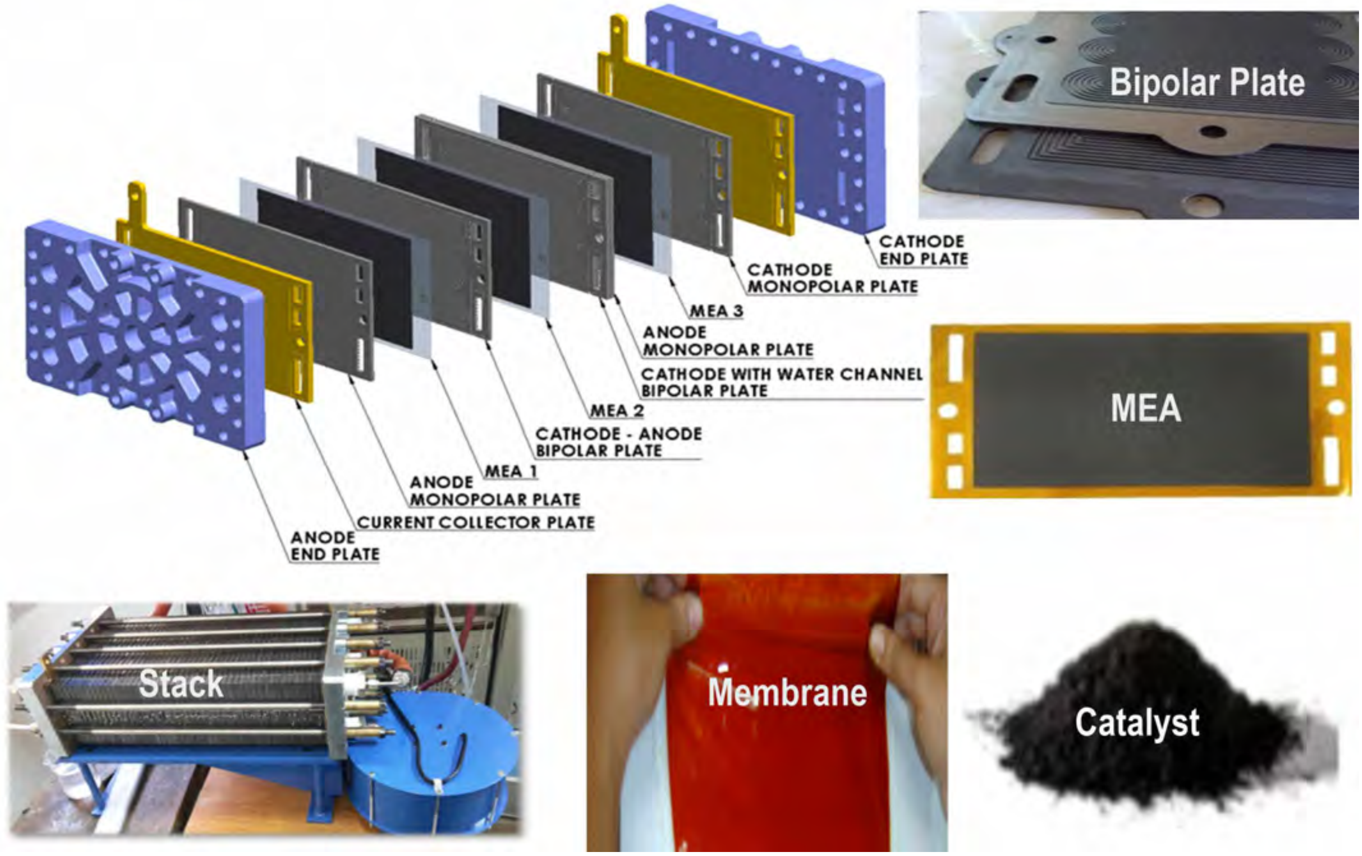
The foundation of India's hydrogen fuel cell programme was laid under the **CSIR New Millennium Indian Technology Leadership Initiative (NMITLI)**, a flagship programme established to bridge long-term scientific research with industrial relevance.

Under this initiative, several CSIR laboratories, including **CSIR-NCL**, **CSIR-Central Electrochemical Research Institute (CSIR-CECRI)**, **and CSIR-National Physical Laboratory (NPL)**-, came together to develop indigenous **Proton Exchange Membrane Fuel Cell (PEMFC)** technology suitable for Indian conditions. As they are compact, lightweight and capable of rapid start-up, PEM fuel cells stand out as a premier technology for transportation applications.

A PEM fuel cell generates electricity through an electrochemical reaction rather than combustion. Hydrogen supplied to the anode is split into protons and electrons. While the electrons travel through an external generate electricity, the protons migrate through a proton-conducting membrane. At the cathode, they combine with oxygen from the air to produce water, making the process highly efficient and virtually emission-free.

At the heart of every PEM fuel cell lies the **Membrane Electrode Assembly (MEA)**, where these electrochemical reactions take place. Although physically compact, the MEA largely determines the efficiency, durability and power output of the entire fuel cell system. Recognising its importance, CSIR-NCL emerged as the scientific anchor for developing this critical technology.

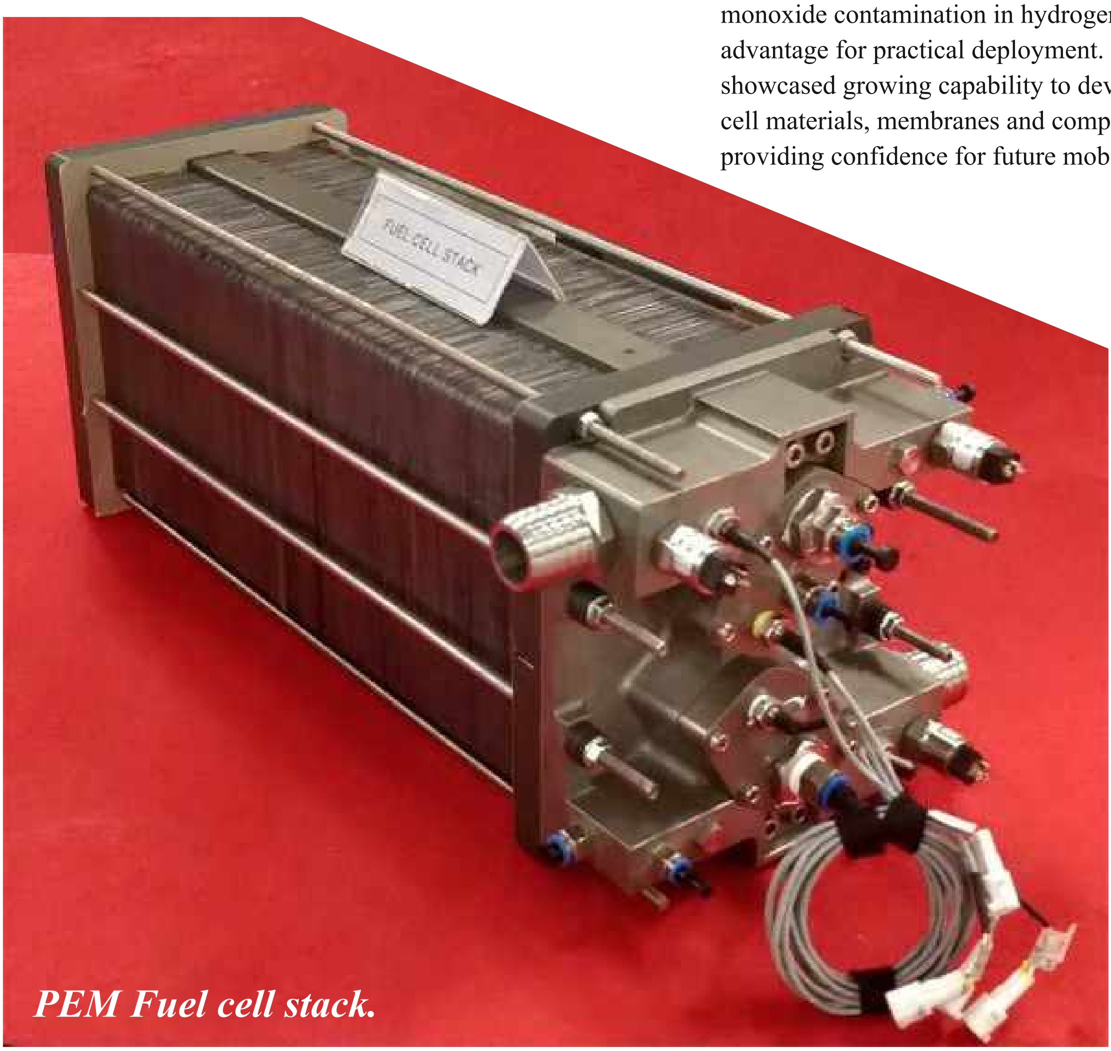
Working closely with partner laboratories, researchers at NCL built expertise across the entire fuel cell value chain, including electrocatalyst development, polymer electrolyte membranes, MEA fabrication, electrochemical modelling, diagnostics, durability studies and fuel cell stack optimisation. These capabilities formed the scientific foundation upon which India's indigenous hydrogen fuel cell programme was built.



Schematic representation of a Proton Exchange Membrane Fuel Cell (PEMFC) stack and its key components, including bipolar plates, membrane electrode assembly (MEA), proton exchange membrane, catalyst and the assembled fuel cell stack.

From Laboratory Research to Prototype Systems

As scientific understanding alone is not sufficient to create technological impact, the next challenge was to transform laboratory discoveries into reliable engineering systems capable of operating under real-world conditions. This phase led to the development of 3 kW and 5 kW prototype fuel cell systems, with research focusing on catalyst optimisation, improved materials and enhanced durability under realistic operating conditions. These prototype systems represented an important transition from laboratory-scale investigations to application-oriented engineering and laid the technological foundation for all subsequent hydrogen fuel cell projects undertaken by CSIR.



PEM Fuel cell stack.

Demonstrating Indigenous Fuel Cell Technology

Years of research culminated in one of India's earliest public demonstrations of indigenous fuel cell technology during **FUCETECH 2009**, held in Mumbai. Scientists from NCL, NPL and CECRI showcased multiple fuel cell systems. A **1 kW hydrogen-air PEM fuel cell stack** successfully powered twenty-four household bulbs, while a **20 W direct methanol fuel cell** demonstrated an alternative fuel cell configuration suitable for portable applications.

The highlight of the exhibition was a **350 W high-temperature PEM fuel cell** employing a **polybenzimidazole (PBI)** membrane developed at NCL. Operating at nearly 140°C, the system demonstrated improved efficiency and greater tolerance to carbon monoxide contamination in hydrogen fuel, an important advantage for practical deployment. The demonstration showcased growing capability to develop indigenous fuel cell materials, membranes and complete stack systems, providing confidence for future mobility applications.

Shri Ram Nath Kovind, President of India, unveiling the first indigenous High Temperature Fuel Cell System during the CSIR Foundation Day celebrations at Vigyan Bhawan, New Delhi.

From Laboratory Demonstrations to Stationary Power

The success of the early fuel cell demonstrations also opened new opportunities beyond mobility. While low-temperature PEM fuel cells were being developed for transportation, CSIR laboratories simultaneously pursued high-temperature Proton Exchange Membrane Fuel Cell (HT-PEMFC) technology for stationary power generation.

A major milestone was achieved in September 2019 when the **President of India, Shri Ram Nath Kovind**, unveiled India's first indigenous **5 kW High Temperature Proton Exchange Membrane (HT-PEM) Fuel Cell System** during the CSIR Foundation Day celebrations at Vigyan Bhawan, New Delhi. Developed under the CSIR-NMITLI programme through a unique public-private partnership involving CSIR-NCL, CSIR-NPL and CSIR-CECRI, together with **Thermax Limited** and **Reliance Industries Limited**, the system represented another significant step in translating laboratory research into practical technology.

Unlike fuel cells designed for transportation, the HT-PEMFC system was developed for distributed stationary power applications. Operating on hydrogen that can be generated from methanol or bio-methane, an HT-PEMFC can generate electricity with an overall efficiency exceeding 70 percent while simultaneously producing useful heat and water. The technology offers a clean alternative to diesel generator sets for commercial establishments, telecom towers, data centres and remote installations where reliable power is essential.

The successful development of both low-temperature and high-temperature PEM fuel cells demonstrated the breadth of CSIR's hydrogen research programme and established India among the few countries possessing indigenous expertise across multiple fuel cell technologies.

Industry Collaboration under NMITLI

Industry partnerships under the CSIR-NMITLI programme played a crucial role in advancing indigenous hydrogen fuel cell technology. Collaborations with Reliance Industries Limited, Thermax Limited and KPIT Technologies enabled the development of fuel cell systems for telecom backup power, stationary power generation and automotive mobility respectively.

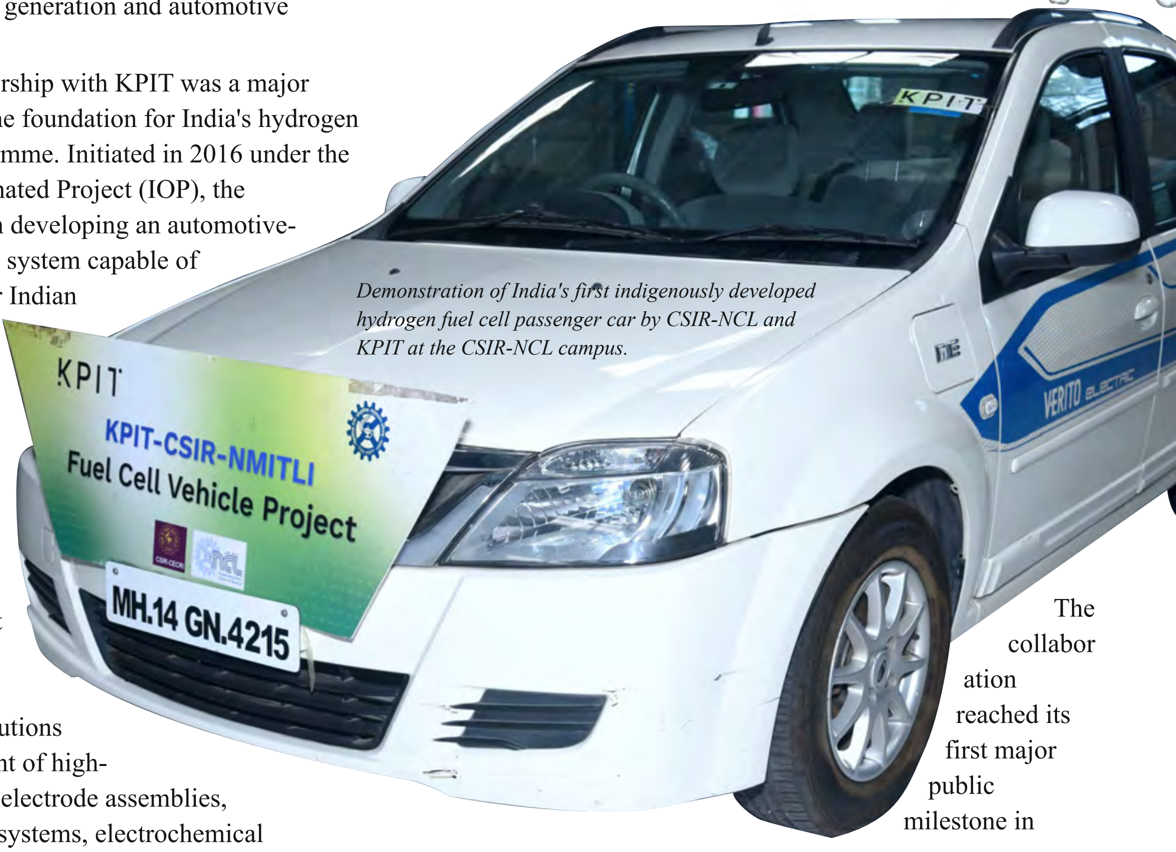
Among these, the partnership with KPIT was a major turning point as it laid the foundation for India's hydrogen fuel cell mobility programme. Initiated in 2016 under the NMITLI Industry Originated Project (IOP), the collaboration focused on developing an automotive-grade hydrogen fuel cell system capable of powering vehicles under Indian driving conditions, marking the transition from laboratory prototypes to practical mobility applications.

Within this partnership, CSIR-NCL served as the scientific anchor, leading the development of the core electrochemical technologies. Its contributions included the development of high-performance membrane electrode assemblies, optimisation of catalyst systems, electrochemical modelling, durability and degradation studies and validation of fuel cell performance for mobility applications. These efforts ensured that the fuel cell system met the demanding requirements of transportation, including rapid start-up, dynamic load response and long operational life. The laboratory also played a central role in conceptualising the project, coordinating scientific contributions across participating CSIR laboratories and serving as the principal interface with the industry partner.

Complementing these efforts, KPIT brought expertise in automotive engineering, power electronics, lightweight metallic bipolar plates, thermal management and system integration. By integrating the fuel cell stack with hydrogen storage, battery systems, electric motors and vehicle controls, the collaboration transformed laboratory-developed technology into a practical transportation platform.

The partnership resulted in the development of India's first **10 kW automotive-grade Low Temperature PEM fuel cell stack**, representing a major milestone in indigenous clean energy technology.

India's First Indigenous Hydrogen Fuel Cell Car



Demonstration of India's first indigenously developed hydrogen fuel cell passenger car by CSIR-NCL and KPIT at the CSIR-NCL campus.

The collaboration reached its first major public milestone in October 2020, when CSIR-NCL and KPIT demonstrated India's first indigenously developed hydrogen fuel cell passenger car at the NCL campus in Pune.

Powered by a **10 kW automotive-grade PEM fuel cell stack**, the demonstration vehicle stored **1.75 kg of hydrogen** at **350 bar**, achieved a driving range of approximately **250 kilometres** and operated at typical road speeds of **60-65 km/h**. Instead of burning fuel, the vehicle converted hydrogen directly into electricity to power an electric motor, producing only water during operation. This demonstration represented a successful vehicle prototype and validated decades of indigenous research. It also established that fuel cell technology developed in Indian laboratories could operate reliably under real transportation conditions.

Hydrogen Fuel Cell Bus

The success of the passenger car demonstrated that the underlying fuel cell platform could be adapted for larger mobility applications. In 2021, the same technology ecosystem evolved into India's first indigenously developed hydrogen fuel cell bus through collaboration between CSIR-NCL, CSIR-CECRI and Sentient Labs. The nine-metre, air-conditioned bus was designed with an operating range of approximately 450 kilometres, illustrating the scalability of the indigenous fuel cell platform.

Hydrogen fuel cells offer particular advantages for buses and heavy commercial vehicles, where longer driving ranges, rapid refuelling and reduced battery requirements make them an attractive alternative to battery-electric systems. The project also demonstrated the flexibility of the technology, showing that the same scientific principles and core fuel cell architecture could be successfully adapted to higher-power transportation applications.

Dr Ashish Lele, Director, National Chemical Laboratory, Mr Ravi Pandit, Chairman of Sentient Labs, and Dr. Raghunath Mashelkar, Member of Board of Directors, Sentient Labs at the inauguration of Hydrogen Fuel Cell technology.

Hydrogen Fuel Cell Passenger Catamaran

The success of hydrogen-powered road vehicles naturally led to a more ambitious question: *could the same technology power marine transportation?*

That question was answered in 2024 with the launch of **India's first indigenously designed and built hydrogen fuel cell-powered passenger catamaran** in Kochi by the Hon'ble Prime Minister. Developed by Cochin Shipyard Limited in collaboration with multiple partners, the vessel incorporates the hydrogen fuel cell drivetrain developed through the CSIR-NMITLI Industry Originated Programme.

Built under the Harit Nauka initiative, the 24-metre catamaran carries around 50 passengers and operates on a

hydrogen fuel cell-battery hybrid system with zero operational emissions. Now deployed on the Varanasi-Namo Ghat route, it demonstrates the potential of indigenous hydrogen fuel cell technology for sustainable inland water transport.

The fuel cell powertrain, developed by KPIT in collaboration with CSIR-NCL and CSIR-CECRI, demonstrates how technologies originally conceived for road transport can be successfully adapted for marine propulsion. Hydrogen is converted onboard into electricity that powers electric propulsion motors, enabling clean passenger transport on inland waterways.

Towards a Hydrogen Ecosystem

Today, the global energy landscape is undergoing a structural shift driven by climate change, energy security concerns, volatile fossil fuel markets and increasing geopolitical competition for clean energy technologies.

In this context, hydrogen is emerging not merely as an environmental solution but as a strategic energy carrier. Unlike batteries, which depend heavily on mining and charging infrastructure, hydrogen offers rapid refuelling, longer operating ranges and high energy density; particularly important for long-haul transport, buses, trucks, marine applications, defence and off-grid energy systems.

For India, hydrogen technologies also offer the opportunity to reduce dependence on imported

India's first indigenous hydrogen fuel cell-powered passenger catamaran, launched in Kochi by the Hon'ble Prime Minister.

petroleum while strengthening domestic technological capabilities. Recognising that the successful deployment of hydrogen technologies requires more than individual innovations, attention is now shifting towards building an integrated hydrogen ecosystem encompassing production, storage, distribution and end-use. Demonstrating these interconnected technologies at scale is essential for improving their commercial readiness, attracting investment and accelerating adoption.

Hydrogen valleys have consequently emerged as an important global model for demonstrating complete hydrogen value chains within defined geographical regions. Under the Hydrogen Valley Innovation Cluster (HVIC) programme of the Department of Science and Technology (DST), which forms an integral part of India's National Green Hydrogen Mission, CSIR-NCL has conceptualised the **Pune Hydrogen Valley**: one of India's first integrated hydrogen valley projects.Led by CSIR-NCL in partnership with two institutional collaborators and eleven industry partners, the Pune Hydrogen Valley will demonstrate the complete hydrogen value chain, from green hydrogen production to its utilisation by industry.

A distinctive feature of the project is its focus on replacing grey hydrogen currently used by the fine and speciality chemicals sector with green hydrogen, thereby reducing carbon emissions while enhancing industrial competitiveness. Supported jointly by government and industry through a public-private partnership model, the initiative represents an important step towards creating commercially viable hydrogen ecosystems in India.

Looking Ahead

The journey from laboratory prototypes to operational vehicles and passenger vessels reflects the value of sustained investment in long-term scientific research.

The next phase is focused on large-scale commercialisation. Future efforts extend well beyond the development of individual fuel cell systems. They include reducing costs through indigenous catalysts and advanced materials, scaling fuel cell technologies from kilowatt to megawatt capacities, establishing integrated hydrogen ecosystems such as the Pune Hydrogen Valley, expanding hydrogen-powered public transportation and accelerating commercial deployment through strong industry partnerships. These initiatives are expected to contribute significantly to India's National Green Hydrogen Mission while strengthening indigenous manufacturing capabilities.

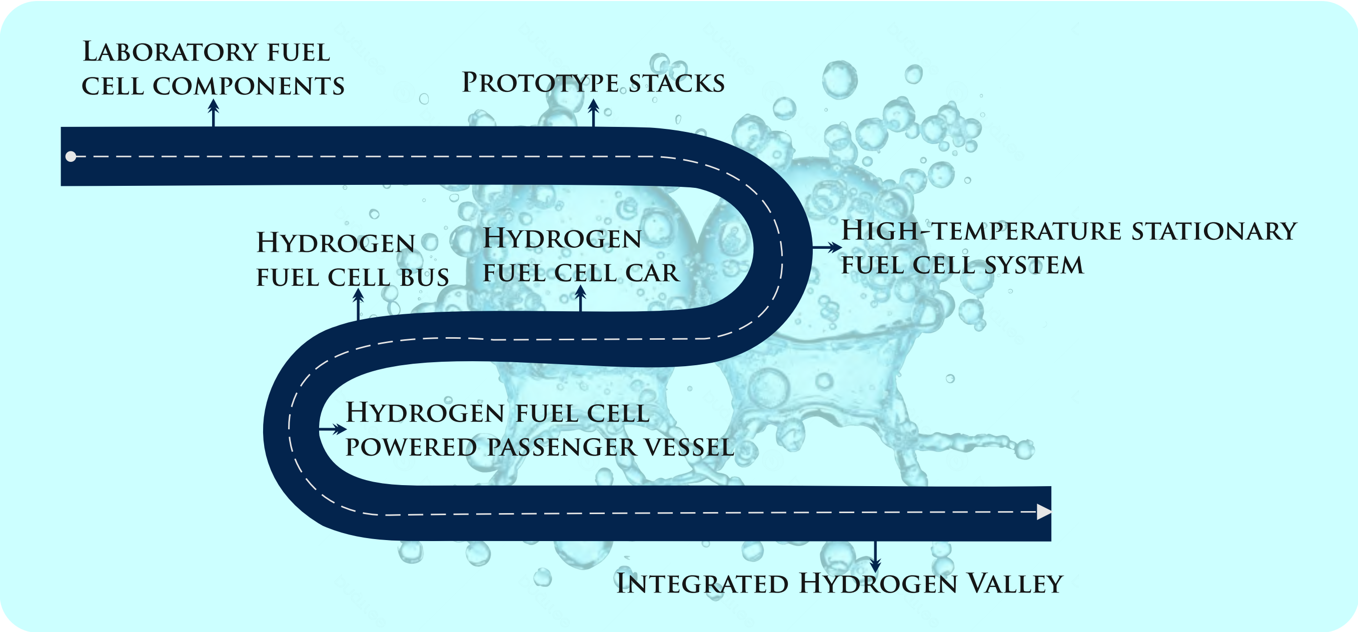
As the technology advances towards commercialisation, a parallel effort is focused on the indigenisation of critical fuel cell components, including catalysts, high-temperature membranes, bipolar plates, electrodes and membrane electrode assemblies.

Developing these key components within the country is essential for reducing dependence on imported materials, improving cost competitiveness and strengthening India's hydrogen technology ecosystem.

The evolution of the technology over two decades illustrates the remarkable progression from laboratory science to real-world applications.

The objective has now evolved beyond proving the concept to driving industrial transformation and accelerating the adoption of clean hydrogen mobility.

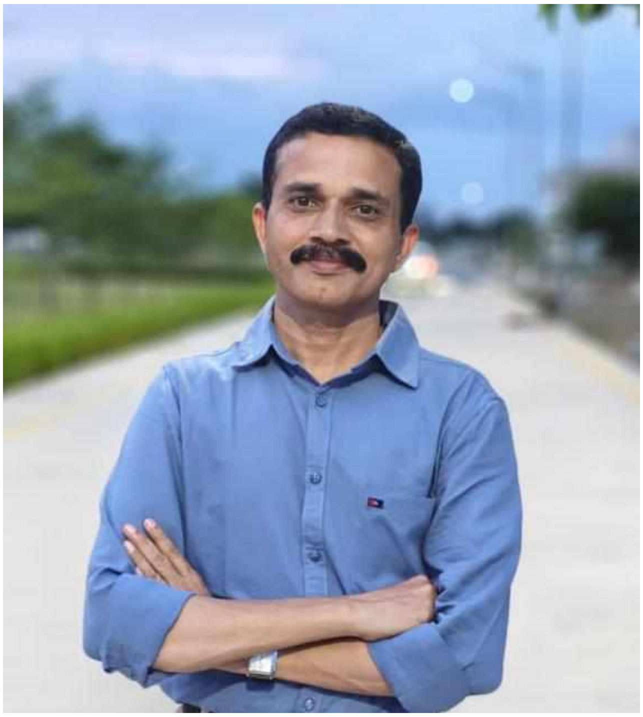
For CSIR-NCL, the focus remains on deepening the science while enabling industrial translation. What began as fundamental research into electrochemical materials has grown into a nationally significant programme spanning stationary power, clean mobility and integrated hydrogen ecosystems.



From laboratories where membrane electrode assemblies are engineered at the nanoscale to hydrogen-powered cars, buses, passenger vessels and the emerging Pune Hydrogen Valley, the story reflects the transformative power of sustained scientific research. As India advances towards a hydrogen economy, the laboratory continues to contribute to a cleaner, more sustainable and technologically self-reliant energy future.

-Allotrope Team *(allotrope.ncl@csir.res.in)*

“Building What Lasts: The Journey of Dr Sreekumar Kurungot”



Curiosity is the spark that ignites discovery. At the heart of our work are brilliant minds driven by knowledge and a deep desire to understand, innovate, and transform the world through research and innovation. These are the explorers of the unseen - the ones who see possibility in every molecule and progress in every reaction.

On the surface, Dr Sreekumar Kurungot appears to be a scientist chasing some of the most ambitious questions of our time - how to make clean energy affordable, how to build India's hydrogen ecosystem, how to create technologies that can move from laboratories into society.

But speak to him for a while and another picture emerges. A scientist who has spent decades working on fuel cells, hydrogen, batteries and advanced materials still finds joy in the simplest things. A walk along a beach. The memory of village life in Kerala.

There is a quiet contradiction at the heart of Dr Kurungot's personality. He is ambitious but is ambitious for his work. He has worked relentlessly towards building technologies for the future, yet he remains deeply connected to where he began. He has built laboratories, trained scientists and contributed to national energy programmes, yet when asked about his greatest achievement, he does not mention awards, publications or patents.

“My students are my real award,” he says. That one sentence perhaps captures the essence of Dr Kurungot, a scientist who measures success not by how far he has travelled, but by what continues after him.

As a Chief Scientist at CSIR-National Chemical Laboratory (NCL), Dr Kurungot has spent much of his career working towards a sustainable energy future for India. His research has contributed to fuel-cell development, hydrogen generation, zinc-ion batteries, ammonia fuel cells and green ammonia technologies. But his journey has never been about a single technology. It has always been about building systems.

Curiosity as a Way of Life

Growing up in a village in Kerala, he was surrounded by fields and the coastline. He enjoyed clay modelling and painting and even won state-level prizes for painting and sculpture as a schoolboy. The teachers around him played an important role in shaping his interest in science. They encouraged questions and created the environment where curiosity could grow. That curiosity remained his defining trait. *“I wanted to do something new every day,”* he says.

After completing school, he found himself choosing between physics and chemistry for his undergraduate studies.

A chance meeting with a chemistry professor during a bus journey changed everything. Acting on the professor's advice, he enrolled in chemistry - a decision that would shape the rest of his career. *"I was never particularly inclined towards chemistry in the beginning,"* he recalls. *"The passion came because of the way my teachers taught us."*

Choosing Science over Stability

After completing his master's degree, Dr Kurungot briefly entered the pharmaceutical industry. The experience was valuable, but routine quality-control work left him restless. He resigned, returned home, immersed himself in books at his college library and prepared for the CSIR-NET examination. He cleared it on his very first attempt and joined the Cochin University of Science and Technology for doctoral research.

Another defining chapter unfolded when he came to CSIR-NCL as a guest researcher under Dr B. S. Rao in the Catalysis Division. *"That was the real turning point in my research life."* Working in an environment where fundamental chemistry met industrial relevance opened a completely new world. The experience taught him an invaluable lesson, that impactful science often extends beyond research papers.

Dr Kurungot at Korea Institute of Science Technology

Learning to Think Beyond the Laboratory

Some of the most influential experiences in Dr Kurungot's career came during his time in South Korea and Japan. He observed scientific cultures where research was closely connected to engineering, manufacturing and industrial needs. The Japanese approach particularly influenced him: the discipline, attention to detail and emphasis on systems thinking.

"Where will this material go?" A catalyst must eventually become part of a device. A material must solve a problem. This question became the invisible thread connecting all his research.

The Toyota Way

His years at Toyota would give him an even more important lesson: how to think about technology. In academic research, scientists often begin with a material and ask what they can do with it. Toyota approached the problem from the other end. It started with the application. If a material was ultimately intended for a fuel-cell electrode, researchers first asked what the final device needed to achieve.

Toyota also taught him the value of knowing when to stop. If a project was not going anywhere, it was stopped. There was no emotional attachment to an idea simply because time had already been invested in it. *"If something will not work, stop it."* For a scientist accustomed to uncertainty and experimentation, it was an important lesson: perseverance does not mean pursuing every idea indefinitely.

Dr Kurungot at Tokyo University.

Our Curious Minds

Building Rather than Buying

When Dr Kurungot returned to NCL, India's fuel-cell programme was still developing. Fabricating electrodes was a painstaking process, often involving manual brush-coating. Reproducibility was difficult and scaling up was a challenge.

Drawing on his experience at Toyota, Dr Kurungot and his colleagues worked towards more systematic fabrication methods. Manual processes evolved into semi-automated approaches based on decal transfer techniques, improving consistency and enabling the development of larger, more application-oriented systems.

But what appears to matter most to him is not any single technology. It is the ability to build it in India. In the early years, critical fuel-cell components had to be imported. Catalysts, membranes, gas diffusion layers, bipolar plates and specialised testing systems often depended on overseas suppliers. Gradually, that changed. Catalysts were developed in-house. Membranes were fabricated within Indian laboratories. Bipolar plates were manufactured domestically. Test stations were designed locally. *"Now, for the high-temperature fuel cell, everything is indigenized."*

Connecting the Pieces of the Energy Puzzle

Fuel cells became the centre of his scientific identity, but Dr Kurungot soon realised that the energy challenge was much larger. A fuel cell alone cannot create a hydrogen economy. Hydrogen must be generated, stored, and transported. This led him to AEM electrolyser systems and then to the next challenge, storage. Hydrogen is light, difficult to store and infrastructure-intensive. Ammonia offered a potential solution as a hydrogen carrier and direct fuel. But it brought a new challenge: developing efficient catalysts for ammonia oxidation.

For Dr Kurungot, that challenge represented an opportunity. The research expanded towards green ammonia, producing ammonia without carbon emissions through electrochemical approaches. At the same time, he explored zinc-ion batteries as affordable alternatives for applications where extremely high-performance lithium-ion batteries may not be necessary. His work on flexible and self-healing zinc-ion batteries focused not only on improving performance but understanding the science behind better interfaces and materials. Different technologies but one vision: A sustainable energy ecosystem.

The Real Award

When asked about awards, Dr Kurungot although grateful for recognition, does not see it as the measure of a scientist. What matters more is whether the work continues and his students represent that continuation.

Over the years, many of his students have gone on to become scientists, academics and industry professionals around the world.

His mentoring style is demanding. Students often describe him as a strict guide. He insists on discipline, time management and scientific questioning. He believes students need guidance because a PhD is not only about completing experiments; it is about learning how to think. Sometimes that requires pushing them beyond their comfort zones.

"Students may tell you I am a harsh guide," he says with a smile. But he believes that is part of the process. A mentor's role is not always to make the journey easy. It is to prepare students for what comes next.

Building What's Next, Growing What Lasts

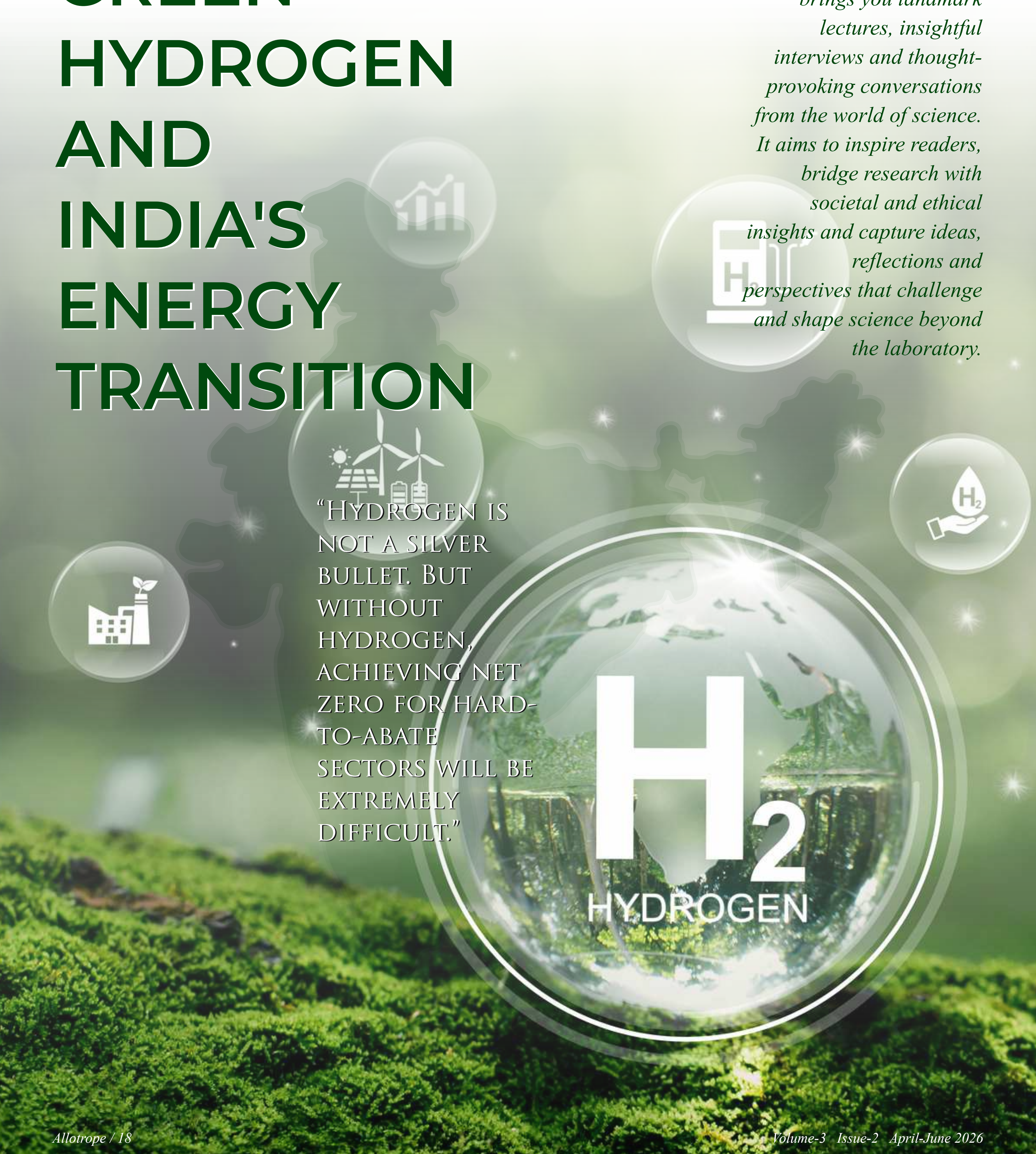
As he looks towards the final years of his career at NCL, Dr Kurungot is thinking about one more challenge. Smart systems. The future, he believes, will not belong only to better materials but to integrated technologies. Instead of separately manufacturing catalysts, membranes and electrodes and assembling them later, can systems be designed where multiple functions happen together? *Can technology become simpler, smaller and cheaper?* It is a difficult question. Perhaps an impossible one. But difficult questions have always attracted him. Away from science, Dr Kurungot is drawn to simpler things: beaches, villages, soft music and Malayalam literature. He still remembers his early love for painting and sculpture. After decades spent working on some of the most advanced areas of science, Dr Kurungot's vision of retirement is unexpectedly simple. He wants to return to village life, to agriculture and to grow things. The boy who grew up surrounded by nature became a scientist who spent his life cultivating ideas, technologies and people.

Whether he is developing a catalyst, guiding a student or planting something in the soil, the instinct is the same: to nurture something that will continue growing beyond him. Perhaps that is the legacy he values most. Not a number of publications. Not the awards. Not the inventions. But a contribution, however modestly he describes it, towards building a cleaner energy future for India and the people who will carry that vision forward.

GREEN HYDROGEN AND INDIA'S ENERGY TRANSITION

A special recurring feature brings you landmark lectures, insightful interviews and thought-provoking conversations from the world of science. It aims to inspire readers, bridge research with societal and ethical insights and capture ideas, reflections and perspectives that challenge and shape science beyond the laboratory.

"Hydrogen is not a silver bullet. But without hydrogen, achieving net zero for hard-to-abate sectors will be extremely difficult."



> "We already have sunlight, biomass, engineering capability and a unified grid. The challenge is how intelligently we integrate them."

India's transition towards a cleaner energy system requires more than renewable electricity alone. While solar and wind power, along with battery technologies, can address many energy needs, sectors such as steel, chemicals, fertilisers, shipping and heavy transport remain difficult to decarbonise through direct electrification. This is where green hydrogen could play an important role.

As India develops its hydrogen ecosystem, questions around cost, technology, infrastructure, resource availability and industrial scale are becoming increasingly important. Against this backdrop, the *Green Hydrogen-Clean Energy* Talk Series at CSIR-NCL provided a platform to examine where hydrogen can make the greatest contribution to India's energy transition and what it will take to translate this potential into reality.

The series was launched on 24 March 2026 by the Center of Excellence in Green Hydrogen Ecosystem Development at CSIR-NCL with a lecture by Dr Ashish Lele, Director, CSIR-NCL, titled *"Potential Contribution of Green Hydrogen in India's Energy Transition."* The lecture brought together researchers, students, faculty members and industry professionals to explore the opportunities and challenges shaping India's hydrogen future.

Going beyond the technical aspects of hydrogen technologies, the discussion examined how hydrogen intersects with renewable energy, transportation, industrial decarbonisation, logistics, infrastructure, economics and national strategy. Drawing on emerging policies and technological developments, Dr Lele presented hydrogen not as a standalone solution, but as one component of a broader energy transition already taking shape in India.

Hydrogen in the Energy Transition

India's climate commitments require deep reductions in carbon emissions across sectors that remain difficult to electrify directly. For these applications, hydrogen, particularly green hydrogen produced through electrolysis using renewable electricity, could provide an alternative pathway.

This is where hydrogen, particularly green hydrogen produced through electrolysis using renewable energy, becomes important. Dr Lele explained that India's National Green Hydrogen Mission aims to accelerate this transition by creating enabling policies, supporting infrastructure and encouraging large-scale industrial adoption.

He highlighted that producing millions of tonnes of green hydrogen would require massive renewable energy deployment, substantial electrolyser manufacturing capacity and large capital investments. Yet he emphasised that these numbers remain achievable when viewed against India's broader energy and industrial growth trajectory.

He also noted the importance of renewable-energy assessment, including wind-resource mapping and the role of India's unified power grid in integrating renewable energy with hydrogen production. The discussion also touched upon the challenges associated with expanding hydropower and integrating different renewable-energy sources into the national energy system.

The Cost of Green Hydrogen

A key theme of the lecture was the levelised cost of hydrogen (LCOH), often considered the key determinant of commercial viability. Today, green hydrogen remains significantly more expensive than conventional grey hydrogen produced from natural gas.

According to Dr Lele, the *"magic number"* for widespread adoption is approximately two dollars per kilogram. Reaching this target would unlock viability across several sectors including steelmaking, refining and transportation.

The largest contributor to cost is electricity itself. Electrolysis is fundamentally energy intensive because splitting water into hydrogen and oxygen requires substantial energy input. Current electrolyser systems typically operate at efficiencies around 70-75 percent. Improving these efficiencies while reducing capital costs remains one of the major scientific challenges in the field.

Dr Lele also highlighted major electrolyser technologies, including alkaline, proton exchange membrane, anion exchange membrane and solid oxide electrolysis, noting that each technology has its own advantages and is suited to different applications.

> "Why should electrolyser efficiency stop at 75 percent? Can we design catalysts and membranes that push it toward 90 percent."

The lecture also discussed several emerging technologies that can help reduce the cost of producing hydrogen. These included improved electrolyser designs, high-pressure electrolysis, solid oxide electrolysers, better catalysts and systems that directly connect renewable energy with electrolysers. These technologies can increase efficiency, reduce energy loss and make hydrogen production cheaper.

One particularly interesting insight was the comparison between transporting electricity and transporting hydrogen molecules. Dr Lele emphasised that transmitting renewable energy in molecular form may, in some cases, prove economically more attractive than long-distance electricity transmission through the grid.

Hydrogen Beyond Energy Production

Rather than portraying hydrogen as a universal replacement for all fuels, Dr Lele carefully distinguished sectors where hydrogen makes strategic sense from those better suited to direct electrification.

For instance, Indian Railways has already achieved large-scale electrification across most routes. In such cases, using electricity directly remains more efficient than converting electricity into hydrogen and then back into power. However, hydrogen may still play a role in niche railway applications such as shunting operations or non-electrified scenic routes.

Dr Lele mentioned that the strongest opportunities for hydrogen lie in sectors where batteries face limitations. These include heavy-duty freight transport, shipping, industrial heating, ammonia production, steel manufacturing and speciality chemicals.

A significant part of the discussion focused on India's National Logistics Policy and the planned Multi-Modal Logistics Parks (MMLPs). These logistics hubs could potentially integrate hydrogen production, storage and refuelling infrastructure for long-haul trucking applications.

> "If hydrogen production and consumption happen within the same logistics ecosystem, many infrastructure challenges become much easier to solve."

Dr Lele also discussed emerging opportunities in data centres, where solid oxide fuel cells operating on biogas could provide both electricity and cooling with exceptionally high overall efficiencies.

India's Unique Opportunity: Biomass to Hydrogen

One of the key themes of the lecture was India's potential advantage in biomass-based hydrogen production. While some international frameworks hesitate to classify biomass-derived hydrogen as green, India has chosen to recognise it within its national framework due to favourable lifecycle emissions calculations.

India's agricultural scale and biomass availability create opportunities that differ significantly from European energy systems.

Dr Lele discussed technologies such as biomass gasification and reforming pathways capable of producing hydrogen at commercially attractive costs. India cannot simply replicate Western decarbonisation models. Instead, it must develop solutions grounded in its own resource base, industrial realities and energy demands.

Building an Ecosystem, Not Just Technology

A key takeaway from the audience interaction was that successful energy transitions rely not only on scientific innovations but also on the development of strong industrial ecosystems. Dr Lele also pointed to the rapid development of India's hydrogen ecosystem, including growing domestic electrolyser manufacturing capabilities and emerging applications in transportation.

Discussions around fuel cells and hydrogen internal combustion engines highlighted the importance of manufacturing supply chains, component ecosystems, standards and large-scale deployment. While fuel cell technology itself is highly advanced globally, India still lacks large domestic manufacturing ecosystems for membranes, catalysts, bipolar plates and associated infrastructure.

> "Technology alone does not reduce cost. Scale, manufacturing ecosystems and policy support do."

Dr Lele argued against prematurely choosing a single *"winning"* technology pathway. Instead, he advocated large-scale piloting under Indian conditions, systematic data collection and evidence-based decision-making across multiple energy technologies including batteries, hydrogen and biofuels.

Science, Policy and Industrial Transformation

The lecture also highlighted how closely science and public policy are intertwined. Technological progress alone is no longer enough; carbon markets, green certification systems, MRV (Monitoring, Reporting and Verification) frameworks and industrial emissions regulations are increasingly influencing which technologies industries adopt and how they compete. Dr Lele also stressed the importance of reliable hydrogen certification and validation systems to establish the environmental credentials of hydrogen and support its wider adoption.

India's emerging green steel taxonomy and carbon market mechanisms are early examples of this transition. Industries are now being required not only to reduce emissions, but also to measure, report and validate them through formal regulatory systems. In this context, hydrogen extends far beyond being an energy solution; it also serves as a link between industrial competitiveness, global exports, logistics, infrastructure and national resilience.

A Realistic but Optimistic Vision

What made the lecture particularly compelling was its realism.

Dr Lele repeatedly acknowledged that hydrogen today remains expensive, infrastructure remains limited and large-scale deployment will require sustained investment, experimentation and policy support.

Yet the broader message was optimistic. India possesses the renewable resources, scientific talent and engineering capability needed to become a major player in the hydrogen economy, provided it begins building expertise and infrastructure now rather than waiting for complete certainty.

> "We should not wait for perfect answers before building capability. We must experiment, validate and learn at scale."

By the end of the session, the discussion had evolved far beyond hydrogen itself. It emphasised how countries develop new technologies, how scientific knowledge grows and how technology, government policies and society work together to shape the future.

Much like the best scientific conversations, the lecture did not offer simplistic conclusions. Instead, it encouraged students and researchers to understand the challenges from different perspectives, including science, business, infrastructure, sustainability and people.

Engineering Catalysts at the Atomic Scale for Efficient Ammonia Fuel Cells

Ammonia is increasingly being explored as an energy carrier because it can be stored and transported more readily than hydrogen and does not contain carbon. Direct ammonia fuel cells (DAFCs) can convert ammonia directly into electricity. However, their efficiency is limited by the slow ammonia oxidation reaction (AOR) at the anode. During the reaction, nitrogen-containing intermediates bind strongly to the catalyst surface, block active sites and reduce performance.

At CSIR-National Chemical Laboratory (NCL), Dr Kurungot and his team have developed a catalyst designed to overcome these limitations. The study combines **atomic-scale engineering** with mesoscale control of mass transport to improve ammonia oxidation and fuel-cell performance.

The catalyst, called Pt_3Ir-skin@Pt_6IrCo, consists of a platinum-iridium-rich outer layer, or 'skin', surrounding a core made of platinum, iridium and cobalt. The researchers introduced controlled strain into the outer atomic structure.

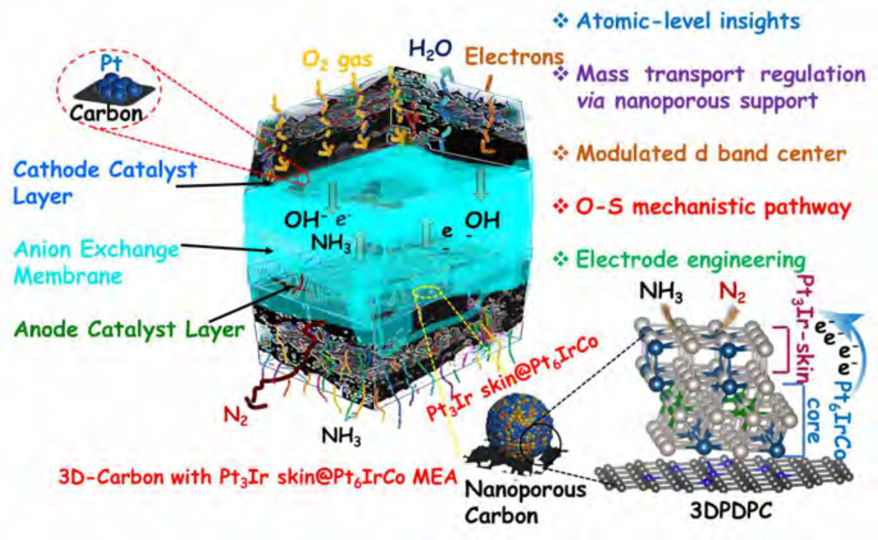


Fig: The atomic-level engineered strained Pt_3Ir-skin@Pt_6IrCo with mass transport regulation by the porous support (3DPDPC) as a performance-modulated integrated system for the Direct Ammonia Fuel Cell.

Atomic-scale engineering involves deliberately controlling the arrangement and chemical environment of atoms on a material's surface to influence how chemical reactions occur.

Lattice strain refers to a change in the spacing or arrangement of atoms within a crystal structure. Even a small change in atomic spacing can alter the electronic properties and chemical behaviour of a catalyst.

This changes the spacing and electronic properties of the surface atoms and in turn, affects how ammonia and its reaction intermediates interact with the catalyst.

The optimum catalyst showed a **lattice strain** of 1.79% and an ammonia adsorption energy of -1.73 eV. These properties helped tune the catalyst's electronic structure and reduce poisoning by the N* intermediate. This is important because N* can remain strongly attached to the catalyst surface and prevent new ammonia molecules from reaching the active sites. The engineered surface provides a better balance between adsorption and removal of reaction intermediates.

The researchers added another level of control by supporting the catalyst on three-dimensional polydiaminopyridine-derived nanoporous carbon (3DPDPC). The porous carbon contains interconnected pathways that help ammonia reach the active catalyst sites and allow reaction products to move away. In this way, the atomic structure controls the chemical reaction, while the three-dimensional support improves mass transport.

The combination of these two approaches is a key feature of the work. Rather than focusing only on the chemical composition of the catalyst, the researchers controlled both the local atomic environment and the movement of molecules through the electrode.

To understand the structure of the catalyst, the team used X-ray absorption spectroscopy (XAS). The measurements showed that platinum and iridium interact directly with nitrogen atoms in the 3DPDPC support, while cobalt mainly remains in an alloyed form. These different local environments help explain the roles of the individual elements in the catalyst.

The researchers also used density functional theory (DFT) calculations to investigate the reaction mechanism. The calculations showed that the strained Pt_3Ir-skin@Pt_6IrCo surface favours the Oswin-Salomon (O-S) pathway, whereas the asymmetric Pt_6IrCo surface follows the Gerischer-Maurer (G-M) pathway. This shows that changing the atomic arrangement can influence not only adsorption but also the pathway through which ammonia oxidation occurs.

The improved catalyst also showed better reaction kinetics. Temperature-dependent experiments revealed an apparent activation energy of 31.28 kJ mol^{-1}, compared with 58.5 kJ mol^{-1} for commercial PtIr/C. The lower value indicates that ammonia oxidation can occur more readily on the engineered catalyst. They also tested the material in a membrane electrode assembly (MEA). The resulting direct ammonia fuel cell achieved a maximum power density of 101.27 mW cm^{-2}, outperforming the PtIr/C and Pt/C benchmark catalysts used in the study.

The study demonstrates that catalyst performance depends not only on which elements are used, but also on how their atoms are arranged, how they interact with their support and how efficiently reactants can move through the material.

By combining a strained Pt-Ir surface, a Pt-Ir-Co core and a three-dimensional nanoporous carbon support, the team has developed a promising strategy for improving ammonia oxidation. The work highlights the potential of hierarchical catalyst design, in which atomic-scale engineering and mesoscale mass transport work together to create more efficient energy-conversion technologies.

Atomic-Level Engineering in Lattice Strain-Driven Pt3Ir-Skin@Pt6IrCo with Mesoscale Mass Transport Regulation for Ammonia Oxidation Reaction in Direct Ammonia Fuel Cells

Sidharth Barik; Pragnya Paramita Samal; Geeta Pandurang Kharabe; Rajashri R. Urkude; Swapnil Jadhav; Yogesh Kumar; Biplab Ghosh; Kirti Dahiya; C. P. Vinod*; Sailaja Krishnamurty*; Sreekumar Kurungot*

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ANRF SARAL AI Video

Featured Research

A New Molecular Strategy for Precise Pyridine Functionalisation

Pyridine is a small but important chemical building block found in many pharmaceuticals, agrochemicals, catalysts and functional materials. Yet modifying a pyridine molecule at a specific position can be surprisingly difficult. Conventional methods often require multiple steps, harsh reagents or pre-functionalised starting materials.

A team at CSIR-National Chemical Laboratory (NCL), led by Dr Pradip Maity, have now developed a milder and more broadly applicable strategy for directly modifying pyridines. The study introduces specially designed alkyl halide activators that allow pyridines to undergo site-selective **C–H functionalisation** under visible-light photochemical conditions.

The key idea is to temporarily activate the nitrogen atom of a pyridine by converting it into a stable N-alkylpyridinium salt. This makes the aromatic ring more receptive to nucleophiles, allowing them to add at a defined position. The same alkyl group then serves another purpose: under light-driven, redox-neutral conditions, it leaves as a radical, enabling the aromatic system to regain its structure without requiring an additional oxidation or elimination step.

This design addresses major limitation of earlier methods.

Previous strategies for nucleophilic pyridine functionalisation often depended on highly reactive activating groups, such as pyridine N-oxides or required separate installation and removal steps. Others worked well with only a narrow range of nucleophiles. This approach instead uses a single activator and mild reaction conditions to accommodate a broader range of useful chemical groups.

C–H functionalisation is a strategy for modifying a molecule by directly replacing a hydrogen atom attached to carbon with another chemical group, avoiding the need to pre-functionalise that position.

Late-stage functionalisation involves modifying an already complex molecule near the end of its synthesis. It can allow chemists to rapidly create new molecular variants without rebuilding the entire structure from the beginning.

The team first demonstrated the method through phosphonation, introducing phosphorus-containing groups directly onto pyridine and isoquinoline. A range of phosphites could be used, including dialkyl, alkoxy-aryl and diaryl phosphites. Importantly, the reaction could distinguish between different positions on the pyridine ring, providing predominantly or exclusively the desired product depending on the substrate and reaction conditions. The method also enabled direct amination of pyridines, an especially valuable transformation because aminopyridines are common structural motifs in pharmaceutical and agrochemical compounds.

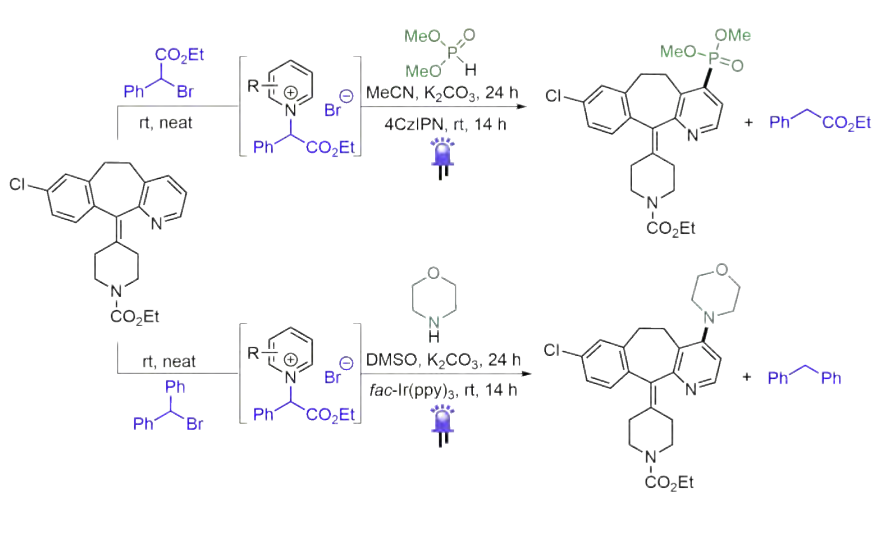

Fig: Scheme illustrating the photocatalytic functionalisation.

Secondary amines such as piperidine and morpholine could be introduced under mild photochemical conditions. The researchers found that changing the solvent could influence which position of the pyridine ring was functionalised, providing an additional means of controlling selectivity.

Beyond phosphites and amines, the strategy could also be extended to other nucleophiles, including cyanide and methoxide.

This shows that the approach is not limited to a single chemical transformation and can be applied more broadly to the modification of heteroaromatic molecules.

A particularly important feature of the work is its potential for **late-stage functionalisation**. Rather than constructing a complex molecule through a long sequence of reactions, chemists can modify an existing drug-like structure near the end of a synthesis. The researchers successfully applied the method to several bioactive and drug-related molecules, including loratadine, abiraterone acetate and fasudil derivatives.

The study also provides mechanistic insight into why the strategy works. Experiments confirmed the formation of N-alkylated intermediates and showed that visible light and a photocatalyst are essential for the subsequent transformation.

They also detected products consistent with the involvement of alkyl radicals, supporting their proposed redox-neutral pathway.

Another notable aspect is the fate of the activating group. The reaction generates relatively benign, recoverable alkane by-products, some of which can potentially be converted back into useful activators. This offers an attractive feature from the perspective of material efficiency and sustainability.

Overall, the work presents a practical way of making pyridine chemistry milder, more direct and more selective. By combining rational activator design with visible-light photochemistry, the researchers have expanded the range of nucleophiles that can be introduced directly onto pyridine frameworks. The strategy could provide a useful new tool for rapidly diversifying pharmaceutical molecules and other complex compounds, while reducing the number of steps traditionally required for these transformations.

A Mild and Site-Selective Nucleophilic C–H Functionalization of Pyridines via Its Stable N-Alkylated Salts

Nilofar Baral; Pinku Saikia; Sabir Ali Molla; Devendra Kumar Dewangan; Pradip Maity*

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ANRF SARAL AI Video

Featured Research

Continuous Mechanochemistry Enables Safer, Solvent-Free Synthesis of Acyl Azides

Acyl azides are intermediates in organic synthesis, widely used to prepare isocyanates, ureas, carbamates, amines and nitrogen-containing heterocycles. However, their high reactivity and thermal sensitivity make their synthesis challenging, particularly when conventional solvent-based methods are scaled up.

A team at CSIR-National Chemical Laboratory led by Dr Amol A. Kulkarni have developed a **continuous mechanochemical** process that synthesises acyl azides directly from acyl chlorides using sodium azide, without solvent or additives during the reaction.

Curtius rearrangement is a chemical reaction in which an acyl azide is converted into an isocyanate. The resulting isocyanate can then be transformed into useful compounds such as amines, carbamates and ureas.

Continuous mechano-chemical process uses mechanical force to drive chemical reactions, without relying on conventional solvents. In this study, mechanical energy continuously mixes the reactants and brings them into close contact inside the reactor.

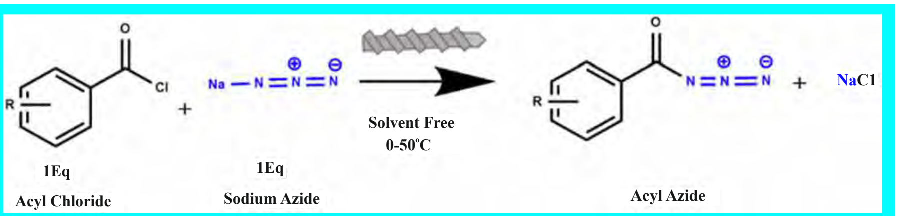

Fig: Acyl azide synthesis from acyl chloride.

Acyl azides are particularly important because of their role in the **Curtius rearrangement**, in which they are converted into highly reactive isocyanates. These intermediates can subsequently be transformed into valuable pharmaceutical, agrochemical and fine-chemical products. Conventional acyl azide synthesis, however, often requires organic solvents, extended reaction times and careful temperature control. The strongly exothermic nature of azide formation further increases the challenges associated with handling and scale-up.

The key to this approach is a custom-designed single-screw reactor, where mechanical energy continuously brings the reactants into contact. This improves mixing and heat and mass transfer while allowing precise control over residence time. Initial experiments showed that the reaction could be highly exothermic under solvent-free conditions, with benzoyl chloride and sodium azide producing a sharp temperature rise. These observations guided the design of the continuous process, where efficient heat dissipation and short residence times help control the reaction.

Under optimised conditions, complete conversion was achieved within approximately 2-5 seconds, at relatively mild temperatures of 0-50°C. This process was demonstrated using nine aromatic acyl chloride derivatives, giving isolated yields ranging from approximately 92% to 98%.

Rapid analytical monitoring was particularly important because of the very short reaction time. ATR-IR spectroscopy provided immediate confirmation of acyl azide formation through the characteristic azide stretching band in the 2050-2150 cm^{-1} region. GC, GC-MS and NMR were used for further quantitative and structural confirmation.

The process also integrates downstream handling.

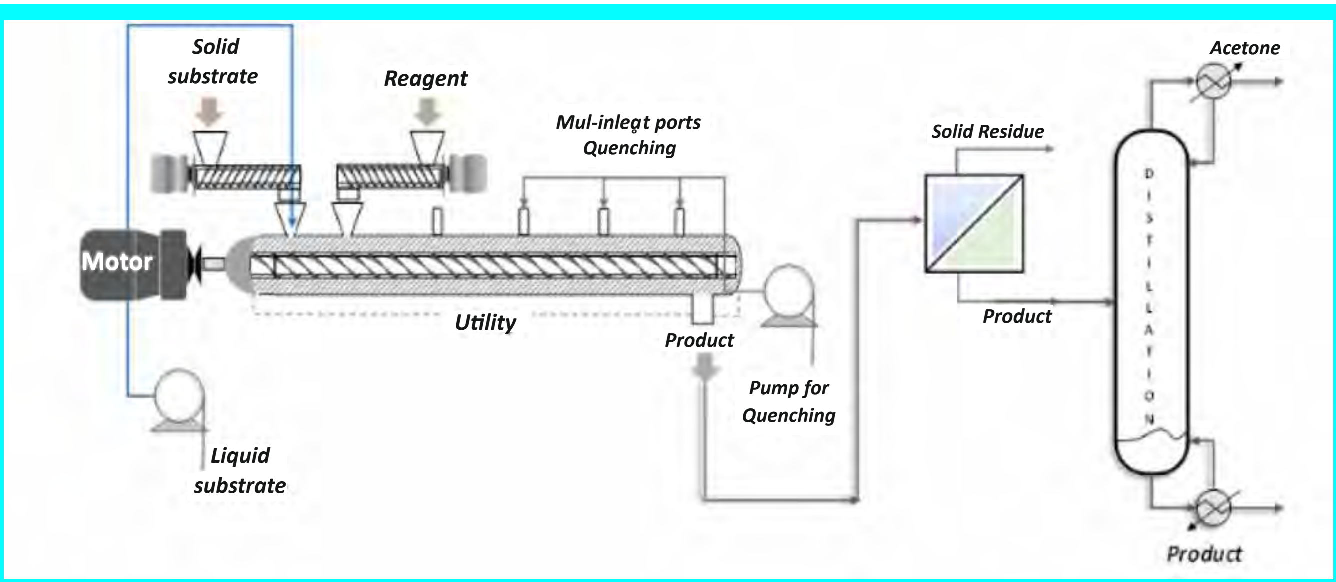

Fig: Schematic diagram of the reactor set-up.

Acetone is introduced towards the end of the reactor to quench the reaction mixture and facilitate separation. Inorganic salts are removed by filtration, followed by drying and vacuum distillation to isolate the acyl azide. This reduces the need for multiple batch operations and importantly, enables the reactive intermediate to be generated and processed continuously rather than accumulated.

The scalability of the approach was demonstrated with benzoyl azide. The system operated continuously for approximately one hour at a throughput of 180 g h^{-1}, producing benzoyl azide in approximately 97% isolated yield and with reported purity above 99%.

The sustainability advantages of the process were also evaluated against previously reported solvent-based continuous-flow methods. The solvent-free mechanochemical process showed substantial improvements in production rate, mass efficiency, solvent efficiency and reactor efficiency, highlighting the potential of mechanochemistry for process intensification.

Beyond its immediate application to acyl azide synthesis, the approach offers a broader safety advantage. Continuous generation reduces the amount of reactive intermediate present in the system at any given time, while short residence times and effective heat transfer provide greater control over an inherently energetic reaction. This strategy could be particularly valuable for reactive intermediates that are undesirable to isolate or store in large quantities.

The researchers also propose integrating acyl azide formation with subsequent Curtius rearrangement and nucleophilic reactions, enabling the continuous synthesis of amines, carbamates and ureas. Such integration could potentially provide streamlined routes to valuable pharmaceutical and agrochemical intermediates.

By combining mechanochemistry with continuous processing, this work demonstrates how a challenging chemical transformation can be redesigned around speed, safety and sustainability. The study establishes a promising solvent-free platform for acyl azide synthesis while highlighting the broader potential of continuous mechanochemistry in the development of safer and more efficient chemical manufacturing processes.

Safe, scalable and solvent-free acyl azide synthesis via continuous mechanochemistry

Tabrez R. Shaikh; Arshad Hussain; Amol A. Kulkarni*

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Patents Granted (April-June 2026)

Indian patents

Paresh Laxmikant Dhepe, Tufeil Sartaj Khan; One Pot Conversion Of Sugars Into Furans. India 586931. 2026 April 15

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Foreign patents

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Chinnakonda, Subramanian Gopinath, Kranti Nishikant, Salgaonkar; Continuous Process For Photocatalytic Co-Conversion Of CO_2 And H_2O To Value Added Products In Sunlight. United States of America 12629661. 2026 May 19

Lectures: *National Technology Day Celebration 2026*

Nuclear Energy Mission 2047 and Beyond

CSIR-National Chemical Laboratory (NCL) celebrated National Technology Day 2026 on 11 May 2026 with an insightful lecture by ***Dr Anil Kakodkar,*** *Chancellor, Homi Bhabha National Institute, who graced the occasion as the Chief Guest. The programme was organised at the CSIR-NCL Auditorium and was attended by scientists, researchers, students and laboratory staff members.*

In his lecture, titled ***"Nuclear Energy Mission 2047 and Beyond,"*** Dr Kakodkar highlighted the importance of energy security, technological self-reliance and sustainable energy solutions for India's future

Dr Anil Kakodkar has made outstanding contributions to India's atomic energy programme throughout his distinguished career. He served as the Director of the Bhabha Atomic Research Centre (BARC) and later as the Chairman of the Atomic Energy Commission and Secretary of the Department of Atomic Energy, Government of India. His pioneering work in nuclear reactor development, indigenous technology advancement, and promotion of thorium-based energy systems has significantly contributed to India's nuclear energy vision.

In his address, Dr Kakodkar emphasised that energy security is about eliminating vulnerabilities in meeting energy needs, and achieving energy independence should be the ultimate objective. He stressed the need for strategic collaborations that create mutual benefits for all stakeholders, stating that partnerships designed as *"win-win"* situations should be preferred over conventional vendor-buyer relationships.

Dr Kakodkar highlighted the growing global demand for energy and discussed the critical role of nuclear energy in ensuring long-term energy security while

addressing environmental challenges. He explained that nuclear energy, with its high energy density and ability to provide sustained power generation, has the potential to contribute significantly towards meeting future energy requirements.

During the lecture, ***Dr Kakodkar*** elaborated on the opportunities offered by advanced nuclear technologies, fuel recycling strategies, and the utilisation of thorium resources. He highlighted India's unique advantage of possessing significant thorium reserves and discussed the importance of developing innovative approaches to harness this resource as part of the country's long-term nuclear energy strategy.

Dr Kakodkar also shared insights from his extensive experience in India's nuclear energy programme and highlighted the importance of indigenous technological development. He spoke about the progress made in designing and developing nuclear reactor systems and the role of innovation in strengthening India's capabilities in the energy sector.

The lecture provided an excellent platform for scientific discourse and encouraged participants to reflect on the future of energy technologies and their role in national development. The engaging interaction following the lecture further enriched the learning experience for the audience.

Events: *Swachhata Pakhwada 2026*

"Commitment towards cleanliness, sustainability and environmental responsibility."

CSIR-National Chemical Laboratory (NCL), observed ***Swachhata Pakhwada 2026*** from 1 to 15 May 2026 with a series of activities aimed at promoting cleanliness, hygiene, environmental awareness and sustainable practices across the campus.

The observance began with the administration of the ***Swachhata Pledge,*** wherein members of the NCL fraternity pledged their commitment towards maintaining cleanliness, adopting responsible waste management practices and contributing towards a healthier and cleaner environment. The pledge reflected the collective responsibility of employees towards creating a sustainable and hygienic workplace.

As part of the campaign, various cleanliness drives and awareness activities were conducted across the campus. These initiatives focused on encouraging active participation, improving cleanliness standards and spreading awareness about the importance of maintaining a clean and green environment.

“एक पेड़ माँ के नाम”

In line with the vision of environmental conservation, CSIR-NCL also organised a **tree plantation drive under the initiative** ***“Plant4Mother”*** as part of Swachhata Pakhwada 2026. The initiative symbolised a commitment towards nurturing nature and creating a greener future while honouring the spirit of motherhood cover and promoting ecological sustainability.

The Swachhata Pakhwada activities at CSIR-NCL highlighted the importance of cleanliness as an integral part of everyday life and encouraged employees to adopt environmentally responsible practices.

Events:International Insect Day 2026

"MINIATURE MARVELS: THE HIDDEN WORLD OF ARTHROPODS"

On the occasion of International Insect Day, CSIR-National Chemical Laboratory (CSIR-NCL), in association with the Indian National Science Academy (INSA), New Delhi, the Indian National Young Academy of Science (INYAS) and the Maharashtra Academy of Sciences, organised a scientific outreach programme titled *"Miniature Marvels: The Hidden World of Arthropods"* on 4 June 2026 at the Biochemical Sciences Division, CSIR-NCL.

The programme aimed to create awareness about insects, arthropods and their importance in our daily lives, agriculture and the environment. Students, research scholars, faculty members and science enthusiasts attended the event. The invited speakers, Dr Pankaj Koparde, MIT-WPU, Pune, and Dr Sachin Anil Punekar, Biospheres, Pune, spoke about the diversity, behaviour and ecological importance of insects and other arthropods. They explained how these small organisms play a major role in maintaining the balance of nature.

Dr Rakesh Joshi
Principal Scientist,
Biochemical Sciences Division
rs.joshi.ncl@csir.res.in

The speakers explained that insects play an important role in maintaining the balance of ecosystems. They help in pollination, decomposition, nutrient recycling and natural control of crop pests. These activities are important for healthy ecosystems as well as agriculture.

The programme also highlighted the role of insects in understanding climate change. Insects are closely linked to their surroundings and are affected by changes in temperature, rainfall, food availability and habitats. Changes in their numbers, distribution and behaviour can therefore provide useful information about changes in the environment. Studying insects regularly can help scientists understand how ecosystems are responding to climate change.

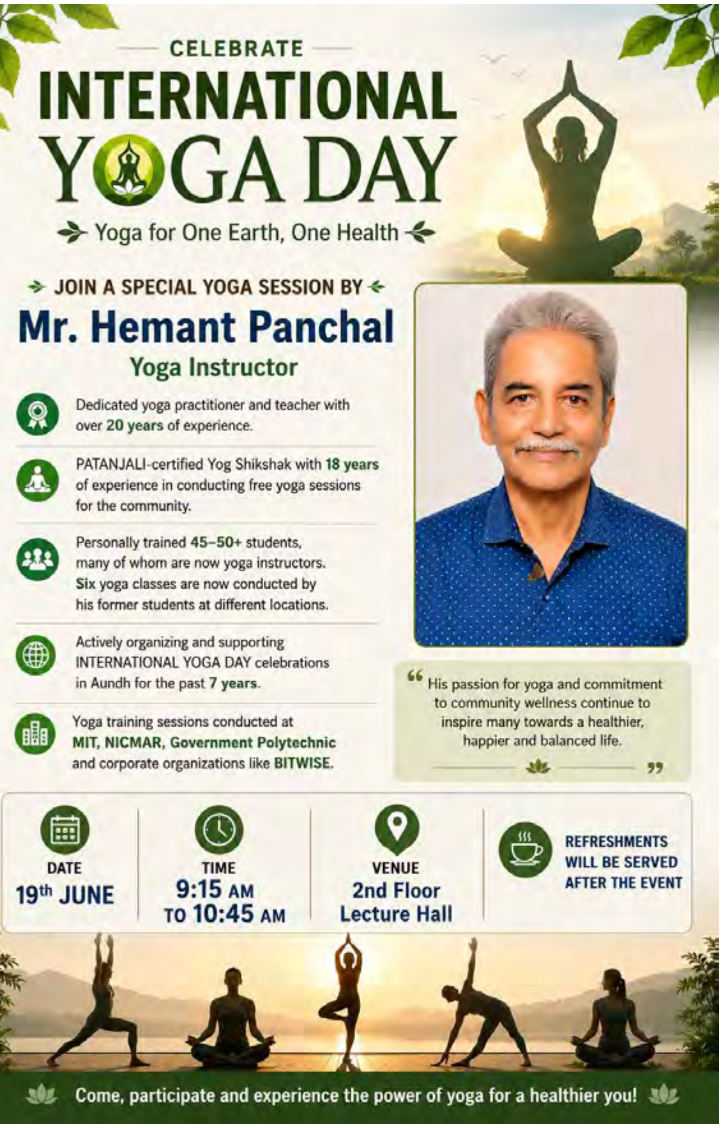
The speakers also discussed the importance of insects in sustainable agriculture. Pollinators and natural predators of crop pests can help farmers reduce the use of chemical pesticides. Understanding these natural processes can support safer and more sustainable farming practices.

The talks were followed by an interactive discussion, during which participants asked questions and exchanged ideas with the speakers. The discussions also opened opportunities for future interaction and collaboration in areas such as insect biology, biodiversity, climate change and sustainable agriculture.

Overall, the programme was informative and well received by the participants. It helped highlight the importance of insects beyond their commonly perceived role as pests and showed how the study of these tiny organisms can contribute to a better understanding of biodiversity, ecosystem health and climate change, while supporting a greener and more sustainable future

Events: International Yoga Day 2026

"Promoting health, wellness and mindful living."



On the occasion of ***International Yoga Day***, observed on 21 June 2026, CSIR-National Chemical Laboratory (NCL) conducted an engaging and rejuvenating yoga session on 19 June 2026, aimed at promoting physical fitness, mental well-being, and a healthy lifestyle among employees.

The session was conducted by **Mr Hemant Panchal**, a certified Patanjali Yog Shikshak with over 18 years of experience in the field of yoga and wellness. During the session, he highlighted the importance of maintaining a balance between physical and mental health and shared insights into the benefits of incorporating yoga into daily life. He emphasised that dedicating even 30 minutes each day to yoga can contribute significantly towards disease prevention, improved well-being and a healthier lifestyle.

The session featured a blend of ***Power Yoga and various asanas***, focusing on enhancing flexibility, building strength, improving posture and promoting overall fitness. Participants actively engaged in the activities, experiencing the positive impact of yoga practices on both body and mind.

The programme concluded with a guided meditation session, allowing participants to relax, rejuvenate and experience a sense of calm and mindfulness. The session provided an opportunity for everyone to take a break from their routine and reconnect with the importance of self-care and wellness.

The celebration of International Yoga Day at CSIR-NCL was an energetic, informative and enriching experience that encouraged participants to embrace yoga as an integral part of their daily routine. The programme was a step towards encouraging a healthy, balanced and productive work environment for its employees.

***Events:** Skill Development Centre Inauguration*

"CSIR-NCL Inaugurates Revamped State-of-the-Art Skill Development Centre."

CSIR-National Chemical Laboratory (NCL), inaugurated its newly renovated and upgraded Skill Development Centre on 30 June 2026, marking an important milestone in its continued efforts towards strengthening skill-based learning, technical training and capacity building in the chemical sciences and allied areas.

The state-of-the-art facility was inaugurated by Dr Ashish Lele, Director, CSIR-NCL, in the presence of Dr Vinay Kumar, Nodal Scientist for the CSIR-Integrated Skill Initiative (CSIR-HRDC, Ghaziabad), who graced the occasion as the Chief Guest. Representatives from the Envalior Team, whose CSR support enabled the modernisation of the facility, were also present. Other dignitaries attending the event included Dr Rajesh Gonnade, NCL Skill Nodal Officer and Mrs Kanika Goel, Controller of Administration (COA), NCL.

The Skill Development Programme (SDP) at CSIR-NCL is an integral component of the CSIR Integrated Skill Initiative (CSIR ISI), envisioned to provide world-class high-end skilling opportunities. The programme aims to create a highly skilled workforce equipped with relevant knowledge and practical expertise to address current and emerging industry requirements in the core competency areas of the laboratory.

Through the active involvement of NCL's experienced scientific staff and the availability of advanced research infrastructure, the Skill Development Programme has been contributing significantly to technical training, hands-on learning, and industry-relevant skill enhancement.

The revamped Skill Development Centre has been developed as a dedicated, fully integrated facility to centralise and enhance all skill development and technical training activities at NCL. The modernised infrastructure includes technologically advanced classrooms equipped with interactive smart displays, a digital podium, a dedicated computer

classroom, an advanced digital conference room, analytical laboratories and a centralised Skill Development Programme (SDP) office.

Speaking at the inaugural ceremony, Dr Ashish Lele highlighted the importance of strengthening practical training infrastructure and stated that the enhanced facilities would provide participants with valuable exposure to specialised instruments, improve industrial competencies and encourage innovation-driven learning. Dr Vinay Kumar appreciated the upgraded infrastructure and emphasised its alignment with the objectives of the CSIR Integrated Skill Initiative. He highlighted the role of such facilities in enhancing scientific capabilities, nurturing technical talent and building sustainable technological capacity. The inauguration of the revamped Skill Development Centre reflects CSIR-NCL's continued commitment for promoting innovation, skill enhancement and knowledge dissemination.

Dr Rajesh G. Gonnade
Chief Scientist,
Physical & Materials Chemistry Division
rg.gonnade.ncl@csir.res.in

Symposium, Conference, Workshop

Workshop and Expert Lecture on "Mastering DSC for Smarter Material Decisions: From Thermal Transitionsto Processing Performance"

The **Centre for Advanced Functional Materials (CAF), CSIR-National Chemical Laboratory (CSIR-NCL),** organised a one-day workshop and expert lecture on **"Mastering DSC for Smarter Material Decisions: From Thermal Transitions to Processing Performance"** on **19 May 2026**. The programme was conducted at CSIR-NCL, in association with **Anton Paar**.

The expert session was delivered by **Mr Ankit Joshi from Anton Paar**, who provided comprehensive insights into the fundamentals, applications and practical aspects of **Differential Scanning Calorimetry (DSC)**. The lecture highlighted the importance of DSC as a powerful analytical technique for understanding thermal transitions, material characterisation and processing behaviour.

The session was particularly beneficial for researchers, faculty members and students engaged in the areas of polymers, materials science and thermal analysis. Through detailed discussions and practical perspectives, participants gained a deeper understanding of how DSC-based analysis can support informed material selection and optimisation of processing parameters.

The workshop witnessed enthusiastic participation from faculty members, researchers and students, with active interactions and knowledge exchange throughout the programme. The engaging format of the session encouraged discussions on real-world applications and enhanced the overall learning experience for the participants.

The organisers expressed their sincere gratitude to **Dr Rajesh G. Gonnade, Head, CAF**, for his continuous support and encouragement in facilitating this academic initiative. Special appreciation was extended to **Dr Ratnesh Kumar Jha, Senior Technical Officer,** and **Mrs Poorvi Purohit, Senior Technical Officer**, for their valuable coordination, technical assistance, and dedicated efforts in ensuring the successful execution of the programme.

The successful completion of the workshop reflects the commitment of **CSIR-NCL and Anton Paar** towards promoting advanced scientific learning, knowledge dissemination and stronger industry-academia interactions. Such initiatives continue to provide researchers and students with opportunities to enhance their technical expertise and stay connected with advancements in analytical science and materials research.

Dr Rajesh G. Gonnade
Chief Scientist,
Physical & Materials Chemistry Division
rg.gonnade.ncl@csir.res.in

Featured Technology Of The Quarter

CSIR-NCL's Solution: Scalable Process for Segregation and Recycling of Bioplastics Waste

Background

Bioplastics are engineered materials that combine biodegradable polymers with natural fibres such as hemp, flax or wood. Bioplastics such as PLA (Polylactic Acid), PBAT (Polybutylene Adipate Terephthalate), PBS (Polybutylene Succinate), PHA (Polyhydroxyalkanoates) and starch-based materials are widely used in packaging, consumer goods and agriculture due to their renewable origin and potential biodegradability. These bioplastics are made from various sources, including Lignocellulosic bio-waste, food industry biomass waste, effluents, and miscellaneous waste. Most of the bioplastics rarely degrade in the natural environment, and their degradation depends mainly on temperature, microbial activity and humidity. Current disposal of mixed bioplastic composites fails to retain material value, and composting often causes resource loss.

The Problem

The use of bioplastics (PHA & PLA fabrics) in the medical and pharmaceutical sector is emerging as a high-value growth area for future biopolymers. From a regional perspective, demand for bioplastics is expanding rapidly across North America, Europe, Asia Pacific, Latin America, and the Middle East & Africa. Despite increasing adoption, bioplastics remain poorly integrated into waste management systems. Improper segregation as well as mixing with conventional plastics creates challenges for recycling and complicates waste treatment processes. One of the major challenge is the selective recovery of individual polymers from waste while preserving the quality.

The Solution

The technology developed at CSIR-NCL enables efficient separation and recovery of these polymers as well as conversion of recovered fractions to valuable monomers. Selective solubilization approach plays a crucial role in the segregation and recycling of bioplastic composites and/or polymer blends. The process facilitates the separation and recovery of individual biopolymers, such as PLA, PBAT, PBS, and starch-based materials, from composite and blended bioplastic waste streams. The recovered polymers retain their molecular integrity and can be directly reprocessed and reused in new applications after suitable modification. The developed process integrates selective separation, reuse, depolymerisation, and solvent recovery, facilitating a practical pathway toward the circular utilization of bioplastic composites and/or blends.

Details of Technological Offerings:

- Laboratory scale validation: The proposed technology has been validated at the laboratory scale (1 kg batch) and involves the selective and sequential dissolution of individual biopolymers, such as PLA, PBAT, PBS, and starch, from composite and blended bioplastic waste streams.
- Recycled Polymer Quality: The process preserves the molecular integrity of the polymers, thereby enabling their direct reuse and reprocessing.
- Sequential Dissolution: The process employs a controlled dissolution sequence to prevent co-dissolution and minimize cross-contamination.
- Lactic Acid Production: Catalyst-free depolymerization of recovered PLA enables the production of high-purity lactic acid (purity >85%).
- Deploymerization and Repolymerization: PBAT and PBS are depolymerized into monomers or oligomers and subsequently repolymerized to regenerate virgin-grade polymers.
- Solvent Recovery: The process incorporates closed-loop solvent recovery and reuse to improve sustainability and resource efficiency.
- Scalability and Industrial Relevance: The process operates under scalable conditions suitable for industrial implementation.

Value Proposition

- **Recovery of Value-Added Chemicals:** Enables recovery of value-added polymers or monomers from composite and blended bioplastics
- **Separation Efficiency:** Facilitates high separation efficiency and product purity
- **Solvent Reusability:** Supports solvent recycling and multiple reuse cycles, improving process sustainability
- **Catalyst-free Recovery:** Catalyst-free process for recovery of monomers with high purity from bioplastics
- **Low emissions:** Minimal emissions (<5%) and solid waste
- **Industrial Scalability:** Industrial scalability and integration with existing recycling infrastructure
- **Sustainable Alternative:** Environmentally friendly alternatives to harmful petroleum-based plastics.
- **Circular Economy:** The technology promotes circular economy practices by converting composite and blended bioplastic waste into reusable polymers or valuable monomers.

Application

- Bioplastic manufacturers: The developed process enables recovery and reuse of high-value polymers for manufacturing new bioplastic products.
- Packaging industries: The process supports recycling of multilayer and blended bioplastic packaging waste into reusable materials.
- Compostable product manufacturers: The technology facilitates recovery and recycling of compostable bioplastic products, reducing material loss and waste generation.
- Waste management companies: The process enables efficient segregation and valorization of mixed bioplastic waste streams.
- Recycling and resource recovery facilities: The technology supports recovery of reusable polymers, monomers, and other value-added materials from bioplastic waste.
- Building and construction companies: The recycled biopolymers can be utilized in sustainable construction materials with recyclable and environmentally friendly properties.
- Pharma and medical sector: The process enables recycling and recovery of bioplastic-based medical and pharmaceutical waste for sustainable material utilization.

Market Potential:

- The global bioplastics Market was estimated at $6.3 billion in 2021 and is projected to rise upto $18.7 billion by 2031, with a CAGR of 11.7%
- As of 2022, bioplastics represented ~2.2 million tonnes of production capacity with projections of 5.73 million tonnes by 2029.
- Bioplastics accounted for approximately 0.6% of the 414 million tonnes of plastic produced globally in 2025. Driven by a CAGR of 16%, their production capacity is expected to more than double, reaching nearly 5.7 million tonnes by 2029.
- Fastest growing market: India and Asia-Pacific >20% capacity/Yr

Current Status and Future Prospective:

The developed process is at TRL-4, showcasing its feasibility for large-scale production. With filed national patents, the technology is available for licensing and co-development opportunities.

In summary, CSIR-NCL offers a complete recycling process for Bioplastics waste, ensuring selective Solubilization and steps towards the circular economy. The technology addresses environmental concerns and offers a sustainable solution to the CO_2 footprint. The process has the potential to reduce the ecological effects of conventional plastics, with wide-ranging applications across electroacoustic devices, biomedical applications such as bone plates, screws, tissue engineering scaffolds, and drug delivery systems, Packaging industries, and recycling and resource recovery facilities. With a global market potential, this innovative approach promises significant economic and environmental benefits.

This technology is now available for licensing and co-development. For further information and enquiries, please write to md.vetal.ncl@csir.res.in or **asktmg.ncl@csir.res.in.**

MOUs/ MOAs SIGNED (April to June 2026)

Sr. No.	Client Name	Title of MoU/ MoA	Project Leader
1	The Maharaja Sayajirao University Baroda	Collaborative Research Work in the areas of Mutual Interest	Dr Sanjay Kamble

List of Technology Transfer (April to June 2026)

Sr. No.	Client Name	Title of MoU/ MoA	Project Leader
1	Himedia Laboratories Private Limited	High-Yield Biosynthesis of Bacterial Nano Cellulose (BNC) from Indigenous Bacteria Komagataeibacter Rhaeticus	Dr Syed Dastager
	Amar Equipments Private Limited	Miniaturized Mixers and Reactor Devices	Dr Amol Kulkarni

TECHNOLOGIES AVAILABLE FOR LICENSING

Sr. No.	Technology	Sector
1	Continuous catalytic process for the production of 4,4' Bisphenol-A (BPA)	Chemical
2	Novel, Eco-friendly & Autocatalytic process for the synthesis of Tributyl citrate (TBC)	Chemical
3	A patented catalytic process for making Diphenylmethane (DPM)	Chemical
4	Novel process platform for the manufacturing and purification of biosimilar rHu Ranibizumab	Biopharma
5	Novel process platform for the manufacturing and purification of Anakinra	Biopharma
6	Targeted glycosylation modulating process for recombinant proteins (Including monoclonal antibodies)	Biopharma
7	High-yield production of high-value Bacterial Nano Cellulose (BNC) films from low-cost crude glycerol feed	Health
8	Efficient manufacturing process For Na-LSX (13 X) & Li-LSX Zeolite	Specialty materials
9	Continuous process for manufacturing precision Silver Nanowires at scale	Specialty materials
10	Continuous & tunable process for the large-scale synthesis of Mesoporous & Nanoporous Silica	Specialty materials
11	Simple, eco-friendly catalytic delignification process for sugarcane bagasse (SB)	Biomass valorisation
12	Dietary Supplement Formulation of Probiotic Strain for Organic Poultry Production	Agriculture/ poultry
13	Efficient catalytic process & novel reactor design for hydrogen sulfide (H2S) removal from different gas streams	Gas separation
14	Process for the novel thermostable Biosurfactant production	Environmental
15	Efficient recovery process for metals from Spent Li-ion batteries (LIBs)	Environmental
16	Novel Process for the Production of IMEGLIMIN	Biopharma
17	Novel process for manufacturing p-Aminophenol (PAP) from p-Chloronitrobenzene (PCNB)	Chemical

Contact:
Dr Mangesh Vetal
Head, Technology Management Group
md.vetal.ncl@csir.res.in (020-2590-2125)

Awards And Excellence

Faculty recognitions

Name of Faculty
Dr Manjusha Shelke was awarded the CRS Research Partnerships and Translation Award.
Dr Rakesh Joshi was recognised as the INSA Young Associate (2026).
Dr Koteswara Rao was invited to serve as a member of the Rapid Analytical Food Testing (RAFT) Committee of the Food Safety and Standards Authority of India (FSSAI).

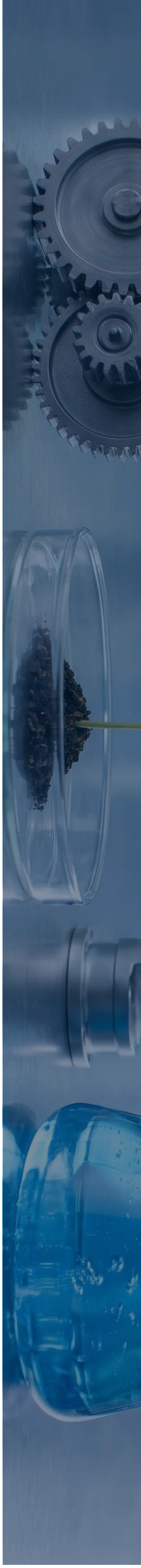
Reader's Forum brings together voices from across the scientific community and beyond, exploring ideas, experiences, perspectives and conversations that shape science and share insights.

The Architecture of Translation: Science-Led Entrepreneurship at CSIR-NCL and Venture Center

At a Glance : *What does it take for a laboratory discovery to become something that works in the real world? This article examines how scientific research moves beyond controlled environments to become viable, scalable ventures. Through the lens of CSIR–NCL and Venture Center, it explores the systems, institutional pathways, and decisions that shape this transition—from early-stage experimentation and de-risking to validation, commercialization, and sustained adoption.*

The CSIR–National Chemical Laboratory (CSIR-NCL) has long stood as a cornerstone of Indian scientific discovery. Since its inception in 1950, NCL has operated with a mandate that distinguishes it from purely academic institutions: the application of chemistry to industrial growth. For seven decades, it has built a legacy of strategic technology development — from pioneering the indigenous production of pesticides to ensure India's food security, to developing the complex catalysts and polymers that fueled the nation's chemical industry.

This deep-rooted focus on utility is reflected in its formidable intellectual property record. CSIR-NCL has long been recognized as one of the most prolific contributors to India's public-sector patent output, consistently maintaining a portfolio that is among the most expansive in the national laboratory network. This massive repository of protected knowledge is not merely a metric of productivity; it is a testament to a long-standing culture of creating "industrial-grade" science-research designed from the outset to be protected, scaled, and deployed. Historically, NCL has commercialized this science into industrial impact through technology licensing to established companies, a pathway that remains central to its mission.



In recent years, this has been complemented by a growing venture creation approach that creates a new avenue for taking laboratory research to real-world application. Together, these pathways reflect an evolving approach to technology translation at NCL.

This shift stands in defiance of the dominant global narrative of innovation. Over the last twenty years, the startup ecosystem-from Silicon Valley to the emerging corridors of the Global South-has been dictated by a requirement for pure velocity. Sectors such as e-commerce, fintech, and the more recent phenomenon of quick-commerce have come to define the public imagination of what a startup looks like and, by extension, the aggressive growth metrics it is expected to fulfill. These sectors prioritize rapid iteration over the patient, heavy requirements of physical and chemical infrastructure.

Science-led entrepreneurship, however, faces challenges distinct from these high-velocity sectors.

Unlike digital platforms where products can be rapidly tested and scaled, scientific innovations require longer development cycles, specialized infrastructure, and repeated validation before they are ready for application.

Within this prevailing narrative, the notion that a rigorous laboratory discovery could evolve into a scalable enterprise remains counterintuitive. It exists outside the default frame of the "startup" because it demands a different kind of discipline-one that prioritizes meticulous de-risking over rapid iteration. To bridge this gap, CSIR-NCL and Venture Center have moved beyond traditional academic boundaries to build resilient, structured pathways for science-led entrepreneurship.

Venture Center stands at the cusp of this transformation. Located within the NCL Innovation Park, it functions as a tactical host designed to nucleate and nurture technology-based enterprises at their most embryonic stages. By providing the essential infrastructure, mentorship, and resources to bridge the gap between research and application, it ensures that the transition from a benchtop experiment to a commercial product is not a matter of serendipity, but of deliberate institutional design.

How does a scientific idea actually make that shift?

The decision to move from the lab bench to the boardroom is often a response to an unrealized scientific potential. For **Dr Anuya Nisal**, the inspiration for Serigen Mediproducts was rooted in the *"intricate web"* of natural materials-specifically silk. While silk has extraordinary regenerative potential, there was no precedent for taking it from the lab to a clinically accepted product. The *"leap"* occurred when she realized that her lab-scale scaffolds could address a clinical void in bone-grafting.

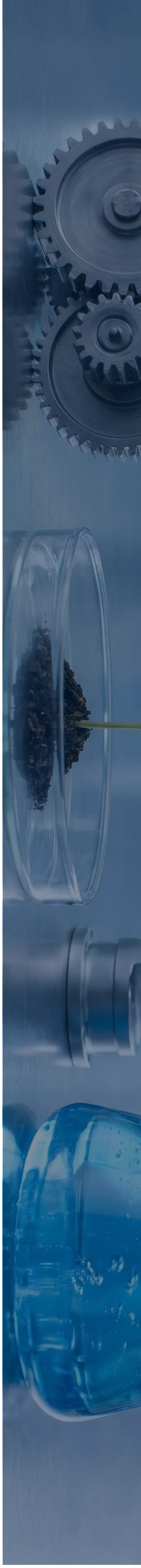
Similarly, for **Manjusha Shelke**, the transition was driven by a growing realization that work on sodium-ion cell chemistry could address a *"very real and pressing need of affordable and sustainable energy storage for India."* She notes, "*The defining moment came when it became clear that sodium-ion cell systems... could play a meaningful role in improving energy access and supply chain resilience. At that point, continuing purely as an academic exercise felt insufficient."*

The Transition from Research to Enterprise

For a researcher stepping into the world of entrepreneurship, the immediate challenge is rarely one of rapid scale, but rather the daunting task of sustaining the work beyond the sterile, controlled environment of the laboratory. What was once contained within predictable parameters must now be developed with the expectation that it will hold up under the unpredictable conditions of the real world.

“The shift was from solving problems to creating value—moving from accuracy and depth to thinking about usability, timelines, and impact,” says **Dr Anuya Nisal** from Serigen Mediproducts. This shift fundamentally alters how performance itself is understood and measured.

For **Manjusha Shelke**, Co-Founder of Rechargion, this change was immediate: “*In a research environment like CSIR-National Chemical Laboratory, success is about proving a concept, demonstrating that something can work under controlled conditions. But when we began building Rechargion as a real-world energy solution, the question shifted from 'Does it work?' to 'Will it work every single day, under unpredictable conditions, at scale?' Perhaps most importantly, the definition of success evolved. It was no longer about publishing results, it was about delivering value to users.”*



At Venture Center, this progression is supported through access to laboratory space, advanced instrumentation, and shared facilities, enabling repeated cycles of experimentation, prototyping, and validation—an essential requirement in science-led ventures. This support goes beyond Venture Center's own walls; it acts as a formal gateway to the advanced resources of CSIR-NCL. Through this arrangement, resident startups can access NCL's high-end analytical equipment and scientific services at special discounted rates.

The Chasm between Discovery and Deployment

As development advances, the work begins to extend beyond the technical realm, requiring a level of documentation and coordination that lies outside traditional research. In this phase, office spaces and specialized infrastructure become essential for iterative development and advancing the technology. **Anuya Nisal** notes that access to specialized labs and regulatory guidance was *"as important, if not more, than funding in the early years,"* allowing Serigen to reduce its learning curve by years in an industry where mistakes are disproportionately expensive.

This proximity ensures that intellectual property and regulatory pathways are addressed alongside development, rather than after it. For **Manjusha Shelke**, this essential handholding provided the stability needed to transition from a research environment to a startup framework, de-risking a scaling process that would have otherwise been "considerably slower and risk-prone."

However, de-risking a technology requires more than just a lab and a patent; it requires a cold, hard look at the economics of the idea. This is where the bridge between research and industrial reality is built through **Techno-Economic Analysis (TEA)**. At Venture Center, this vital "reality check" is operationalized through the **Rajendra Lagu Fellowship**, which engages young graduates to evaluate whether a lab breakthrough can actually survive in the market.

One such fellow, **Sohum Ranade**, a recent BS-MS graduate from IISER Bhopal, experienced this shift firsthand. Working within the **Early Translation Accelerator (ETA) Project at Venture Center,** Sohum was able to "tinker" with modeling process flows at an industrial scale, sourcing machinery, and projecting costs. This work, according to Sohum, affords an "*incredibly honest view*" of what a technology actually amounts to-identifying the initial investment required and the time-to-profitability. For Sohum, this exposure was *"instrumental in broadening horizons"* about how science can reach its end goal: application within society.

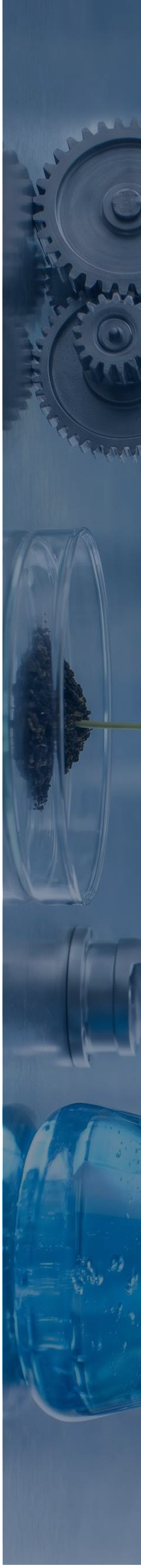
The Institutional Basis for Scientific Entrepreneurship

For a long time, the path from laboratory research to a formal enterprise was obscured by institutional complexity. This gap represents a significant systemic challenge in the Indian context. As **Dr Premnath Venugopalan** and his colleagues point out in their research, *"Improving technology commercialization at research institutes,"* nearly 70% of India's R&D expenditure occurs in public research organizations that are structurally removed from the industrial sector.

Addressing this "need of the hour"-a sentiment echoed in the **NITI Aayog** report on R&D culture-required the development of structured mechanisms designed to facilitate professional mobility. Central to this shift is the **Scientific Entrepreneurship Scheme (SES)**. Approved within CSIR in 2009, it established the first formal institutional basis for scientists to participate in venture creation, providing clear rules for technology transfer, equity-based licensing, and the legal right to move between research and enterprise.

The Lab-to-Market (Lab2Mkt) approach translates this policy framework into practice by helping bridge the gap between scientific research and commercial application. The journey often begins with creating a sense of what is possible. **Meghana Bhandari**, who works closely with the Venture Center and is a key driver of the student-led **NCL-TEC**, notes that this environment allows students to see their research through a different lens, creating a pathway where they can begin to explore commercialization first-hand.

However, once a student or researcher moves beyond exploration and decides to commit to a venture, the nature of the support changes. To ensure these fledgling ventures survive this high-stakes transition, the ecosystem relies on **“Spinout Clinics”**-intensive, one-to-one mentoring interactions anchored by a core group of practitioners: **Dr Premnath Venugopalan, Dr Vijayakumar Modepalli, Dr Vidula Walimbe, and Dr Kavita Parekh.**



For **Anuya Nisal**, the value of this immersion was a fundamental shift in perspective-moving away from a *"publication-centric mindset toward product-market fit."*

The impact of this shift is now tangible in the physical products emerging from the NCL Innovation Park. To date, this structured pathway has yielded 11 spin-out companies originating from CSIR-NCL, including ventures that are delivering indigenous alternatives to technologies previously sourced only from global markets. **Serigen Mediproducts** is a prime example; they have pioneered a platform that transforms natural silk into a diverse range of regenerative implants. Their portfolio addresses three distinct clinical needs: **Seriderm**, a silk-based dressing for chronic wounds like diabetic ulcers already available on Amazon and the GeM portal; **Serioss**, an osteoconductive bone void filler utilizing silk protein scaffolds to support bone cell proliferation and repair and **Serimat**, a soft-tissue regeneration matrix designed for complex procedures like breast and abdominal wall reconstructions.

Similarly, **Rechargion** is advancing a "100% safe" sodium-ion battery system built entirely from Indian raw materials. The company has moved beyond the lab, routinely producing 20 Ah capacity cells that have been validated by the Automotive Research Association of India (ARAI) to target the EV segment. This momentum extends to **Orthocrafts**, which is translating materials science into bioabsorbable implants. By creating a homegrown alternative to expensive permanent metal implants, they are reducing both the physical trauma of repeat surgeries and the financial burden on Indian patients. As **Piyush Joshi** observes, the intent is to *"democratize science,"* enabling researchers to see their work take form beyond the laboratory as something that can be built, tested, and used by actual beneficiaries.

De-risking the Transition: Public Funding as an Enabler

Even with institutional pathways in place, the decision to move from research to venture creation is rarely straightforward. **Shruti Devasthalli**, **Funding Head at Venture Center**, notes: *"Science-led innovative startups require significant funding to transition from proof of concept or prototype to commercialization. However, raising such high-risk capital at this stage remains a major challenge... This is where public funding-through various government-backed schemes—plays a critical role."*

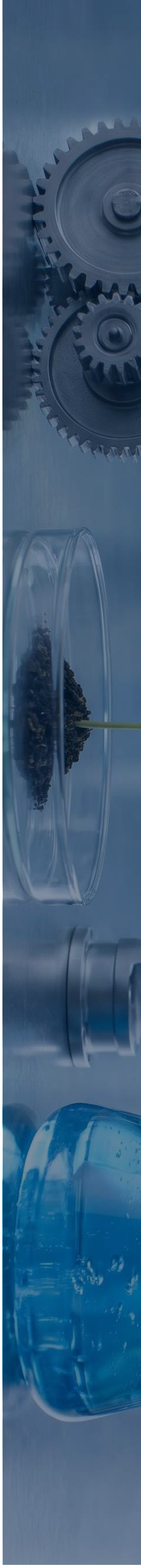
Founders are able to access a range of public funding mechanisms designed specifically for early-stage work. The **NIDHI Entrepreneur-in-Residence (EIR)** program exemplifies this approach, providing a monthly fellowship that allows them to work on their ideas without immediate financial pressure. Support from national agencies such as **BIRAC, DST, MeitY**, and allied innovation missions spans the lifecycle-from prototyping to validation and early commercialization—forming the backbone of India's public innovation ecosystem.

From Capability to Capacity: The Changing Tides

The movement of scientific work into application is contingent on access to infrastructure—mass spectrometry, advanced analytical platforms, and pilot-scale environments. For **Manjusha Shelke** and her team at Rechargion: "*Scaling our sodium-ion cell technology meant addressing challenges beyond electrochemistry such as process stability, supply chain readiness, and quality control at every stage. Third-party validation, especially against IEC standards, became a critical milestone."*

Yet, as **Meghana Bhandari** observes, the success of these systems depends on a fundamental shift in the people within them. "*The tides at NCL are gradually shifting"* toward job creation, she says. Central to this cultural evolution is **NCL-TEC (NCL Technology Entrepreneurship Club)**. As a student-led initiative, it provides a low-stakes environment for researchers to move beyond the bench.

This early-stage curiosity is then professionalized through the **Visvesvaraya PhD Fellowship Scheme**, which ensures that a student's R&D and intellectual property creation are benchmarked against international industry requirements from day one. A landmark event within this ecosystem is the **3MT (Three Minute Thesis) Competition**, where PhD students summarize their thesis as a potential business plan in under three minutes. Meghana describes this as a "transformative experience," where pairing students with Venture Center mentors enables them to view their research as a market-ready product. "*Students are now more consciously evaluating their post-PhD choices,"* Meghana says.



Beyond the System: The Challenge of Scale

What has been built at CSIR-NCL and Venture Center is a useful proof-of-concept for strengthening science-led entrepreneurship across the country. However, an important challenge remains in translating institutional success into wider national adoption. The transition of research into market-ready outcomes is often slowed by the structural need for "patient capital"-funding that understands the long, unhurried cycles of scientific validation.

By democratizing access to high-end science and fostering an entrepreneurial spirit early in the research lifecycle, this model serves as a vital blueprint. The success of ventures like Orthocrafts, Serigen, and Rechargion demonstrates that when you align specialized infrastructure, formal legal frameworks like the SES, and early-stage student fellowships, you create a resilient architecture that can survive the "valley of death." Wider adoption of such models can help translate more of India's laboratory research into technologies with meaningful real-world application.

Source :

https://www.venturecenter.co.in/pdfs/ISB-Conf-Paper-ver04.pdf

https://www.niti.gov.in/sites/default/files/2024-06/StateUniRnD_FinalReport-Designedv3%20%281%29.pdf

(NITI Aayog Report)

About the Authors

Anusha Kottapenta

Ms Anusha Kottapenta (anusha.kottapenta@venturecenter.co.in)
works in Marketing Communications at Venture Center, Pune, translating complex scientific ideas into clear, credible narratives. With interests spanning science communication, strategy, and media, she explores how communication can build trust, inform decisions, and connect science with society. She holds a Master's in Media and Communication from Nanyang Technological University, Singapore.

Dr Pinky Raychaudhuri

Dr Pinky Raychaudhuri (pinky@venturecenter.co.in)
leads Marketing and Communications at Venture Center, where she works on communicating science, innovation and entrepreneurship. A chemist by training, she holds a DPhil in Chemical Biology from the University of Oxford and has experience spanning scientific research, publishing, science communication and technology marketing.

SERIGEN MEDIPRODUCTS PVT. LTD.

Domain: Health

SERIGEN MEDIPRODUCTS PVT. LTD. is an innovative medical device company pioneering patented silk protein technology to facilitate repair and regeneration of damaged tissues/organs in patients' bodies. The flagship orthopedic product, Serioss, is the world's first clinically validated silk-based bone void filler, outperforming global leaders in repairing bone defects and is expected to be launched in India in 2026. Leveraging the silk protein technology platform, it has also developed Seriderm, an advanced wound care dressing launched in India, which accelerates healing of complex wounds like diabetic foot ulcers, burns and bed sores. Serigen's ISO 13485 (global medical device quality standard) certified facility in Pune, India holds government approvals for manufacturing and sales, with US-FDA 510K clearance anticipated in 2026.

RECHARGION ENERGY PVT. LTD

Domain: Energy, Environment

RECHARGION ENERGY PVT. LTD. is a spin-off based on CSIR-NCL's technology, created under Venture Center's “Lab2Mkt” program. Incorporated in 2021, the company aims to translate sodium-ion battery research from CSIR-NCL into commercially viable products for the global market. Rechargion has established a pilot manufacturing facility for sodium-ion pouch cells, inaugurated on June 6, 2024, and has progressed to the successful fabrication of 6-20 Ah cells, demonstrating the scalability of its technology. The company has also secured regulatory validation from the Automotive Research Association of India (ARAI) under IEC 62660/IS16893 safety standards, marking a key milestone toward commercialization. Focused on domestically available raw materials and building an indigenous supply chain, Rechargion is incubated at the Venture Center, Pune, and is advancing toward large-scale manufacturing of sodium-ion batteries.

VIVIRA PROCESS TECHNOLOGIES PVT. LTD.

Domain: Energy, Environment

VIVIRA PROCESS TECHNOLOGIES PVT. LTD. is a startup based on CSIR-NCL's proprietary technology. Vivira is developing and commercializing hydrodynamic cavitation devices and processes for a wide range of applications and products. The product, built on CSIR-NCL technology, is a novel vortex-based fluidic devices platform (VoDCa®) that offers tremendous opportunities for realizing new-age solutions in the water, energy & fuels, and specialty chemicals sectors. VIVIRA rebranded the technology product as VORTA in 2023. Under the brand VORTA, VIVIRA has included its industrial product VoDCa® to improve the sustainability of anaerobic digestion (AD) and increase the production of renewable biogas. VIVIRA is exploring several other industrial processes for a wide range of chemical processing applications, such as mixing, emulsification, extraction, and synthesis. The company also launched its website, www.vorta.com, in 2023.

GENRICH MEMBRANES PVT LTD

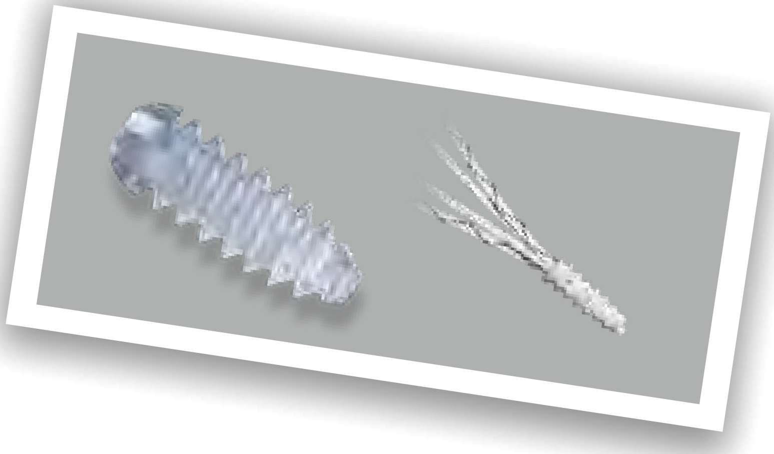
Domain: Health

Oxygen Enrichment Unit

GENRICH MEMBRANES PVT. LTD. is a spin-off based on CSIR-NCL's technology created under the Venture Center's "Lab2Mkt" Program. It uses hollow fibre membrane technology to offer cost-effective solutions for O2-enriched sterile air for medical applications (oxygen therapy). Genrich has developed an Oxygen Enrichment Unit (OEU) based on CSIR-NCL technology. The unit provides ~35% oxygen. In 2017, Genrich has made 16 OEUs under the CSIR-800 scheme and these units were installed at different Primary Health Centers in the rural area of Konkan, Maharashtra. With CSR support from Cipla Foundation, Genrich has donated many 10 litres per minute and 25 litres per minute OEUs to hospitals and COVID centres. During its journey, Genrich has also developed battery-operated OEU for the Indian Army and pilgrims at high altitudes.

ORTHOCRAFTS INNOVATIONS PVT. LTD.

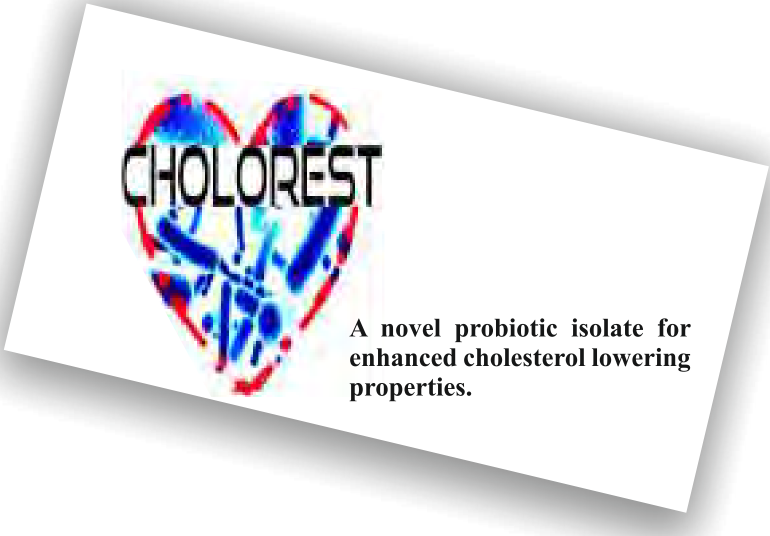
Domain: Health



ORTHOCRAFTS INNOVATIONS PVT. LTD. is a spin-off based on CSIR-NCL's technology created under the Venture Center's “Lab2Mkt” Program. Orthocrafts is committed to design, develop, manufacture and commercialise bioresorbable implants in Indian and global markets. It has sourced the proprietary know-how from CSIR-NCL and developed it further to create differentiated grades of biomedical grade polylactic acid. Start-up has further developed the know-how for the conversion of polymers into end products such as interference screws, suture anchors and surgical fasteners for hernia mesh fixation. Orthocrafts is the only Indian company who manufactures bioresorbable implants using its own polymers.

ABHIRUCHI PROBIOTICS PVT. LTD.

Domain: Health



ABHIRUCHIPROBIOTICS PVT. LTD. is a spin-off based on CSIR-NCL's technology created under Venture Center's “Lab2Mkt” Program. The company is working towards developing a novel formulation comprising a bacterial isolate AP9, as a probiotic food additive, which helps to lower the serum cholesterol and also reduces cholesterol absorption in the gastrointestinal tract. Pre-clinical trials have been successfully completed. Toxicological studies have demonstrated that probiotic preparations are safe. Also, the cholesterol-lowering efficacy has been demonstrated at therapeutic and prophylactic doses. Revenue generation is in progress with the objective of creating a GMP facility and conducting clinical trials. It's achieved through contract research and the sale of other products such as 45fit and milk boost.

GREEN PYRAMID BIOTECH PVT. LTD.

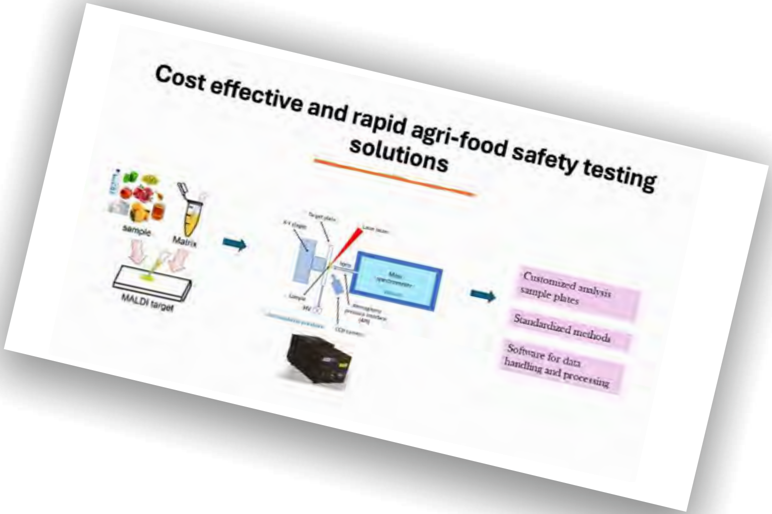
Domain: Agro, food, nutrition

Sophab - Fruits and Vegetable wash

GREEN PYRAMID BIOTECH PVT. LTD. is a spin-off based on CSIR-NCL's technology created under Venture Center's "Lab2Mkt" Program. The company is working towards developing a ready-to-use, biosurfactant-based formulation that can successfully aid all household consumers in decontaminating and sanitizing their fruits and vegetables before consumption. This unique 100% organic formulation removes 99% of pesticides, chemicals, toxins, pathogens, germs and other lethal substances. Washing fruits and vegetables in this formulation has been shown to reduce the shrinkage of produce and double the shelf life of products, even without refrigeration. The organic product, crafted with advanced technology, eliminates nearly all harmful substances from our food, ensuring safer consumption. Beyond benefiting consumers, the entrepreneur's strategic vision, coupled with this technology, not only promotes a healthier lifestyle but also contributes to environmental well-being by reducing chemicals and waste. Moreover, it creates opportunities for others, offering additional income and positively impacting livelihoods.

BAREFEET ANALYTICS PVT. LTD.

Domain: Agro, food, nutrition



BAREFEET ANALYTICS PVT. LTD. is a spin-off based on CSIR-NCL 's technology created under Venture Center's "Lab2Mkt" Program. The company is committed to developing innovative solutions for cheaper, faster and more efficient screening of residual compounds/contaminants in dairy and agro products. BareFeet proposes to screen samples for residual compounds / contaminants using MALDI-MS and to screen multiple analytes per samples at extremely reasonable and affordable costs.

Dr Vijayakumar Modepalli
Senior Scientist, Technology Management Group
v.modepalli.ncl@csir.res.in

NCL-TEC Industrial Visit to Serum Institute of India

As part of its official activities, the NCL Technology and Entrepreneurship Club (NCL-TEC) organised an industrial visit to the ***Serum Institute of India (SII),*** *on 16-17 June 2026. The visit was organised with support from the Venture Center and was attended by 34 students and 2 scientists from CSIR-NCL.*

The visit provided participants with an opportunity to gain first-hand insights into large-scale biopharmaceutical manufacturing and understand the integration of science, engineering, quality systems, and innovation in vaccine production. The programme commenced with an informative presentation on the journey of Serum Institute of India, its global contributions, and its advanced vaccine manufacturing capabilities.

Founded in 1966 by Dr Cyrus Poonawalla, Serum Institute of India has grown into the world's largest vaccine manufacturer by the number of doses produced, supplying more than 1.5 billion vaccine doses annually to countries across the globe. The organisation has played a significant role in strengthening global immunisation programmes through its commitment to accessible and affordable vaccines.

During the visit, participants toured various facilities, including manufacturing, packaging, quality control, and storage areas. The exposure provided valuable insights into advanced production technologies, stringent quality assurance practices, automation, and the regulatory requirements involved in vaccine manufacturing.

The SII team extended warm hospitality and provided an engaging learning experience for the participants. The visit highlighted the importance of innovation, entrepreneurship, and industry–research collaboration in translating scientific knowledge into impactful solutions for society.

The industrial visit proved to be a highly enriching experience for the students, inspiring them through the remarkable journey of Serum Institute of India and its contribution to global public health. The initiative reflects the vision of NCL-TEC, a student-driven platform at CSIR-NCL, to promote technological awareness, entrepreneurship, and meaningful industry interactions among young researchers.

Ajinkya Krushnatray
(President NCL-TEC)
a.krushnatray.ncl@csir.res.in

Advanced Chromatographic Techniques (6-17 April 2026)

The two-week programme on *Advanced Chromatographic Techniques* was conducted under the mentorship of **Dr Snehal More, Dr Sanjay Borikar and Dr Nilakshi Sadavarte**, with **10 participants** attending the course. The training provided comprehensive knowledge of chromatographic techniques, which are extensively used in industrial and research applications for the separation, identification and purification of components in complex mixtures. Participants were introduced to various chromatographic methods employed for qualitative and quantitative analysis.

As part of its continued commitment to enhancing scientific expertise and technical competencies, the Skill Development Initiative of NCL successfully organised three specialised training programmes during the April-June 2026 quarter. These programmes provided participants with hands-on exposure to advanced analytical techniques, instrumentation and quality assurance practices, thereby supporting their professional development and strengthening laboratory skills. A total of 31 participants benefited from these specialised skill development programmes.

Single Crystal X-ray Diffraction (1-30 June 2026)

A month-long training programme on *Single Crystal X-ray Diffraction (SCXRD)* was conducted by **Dr Rajesh Gonnade** for **5 participants**. The course covered fundamental aspects of X-ray diffraction and crystallography, working principles of SCXRD instrumentation, crystal selection and mounting techniques, data collection and processing, structure solution and refinement, interpretation of crystallographic data, report preparation and troubleshooting. The programme enabled participants to gain a comprehensive understanding of crystal structure determination and analysis.

Quality Control Chemist (8-19 June 2026)

The *Quality Control Chemist* training programme, conducted under the mentorship of **Dr Rajesh Gonnade**, was attended by **16 participants**. The programme highlighted the importance of quality control in ensuring the desired quality of products in manufacturing and research environments. Participants were trained in qualitative and quantitative analytical methods, laboratory testing procedures, documentation practices, preparation of test protocols, maintenance of raw data and implementation of standard operating procedures (SOPs). The course also emphasised the role of quality control chemists in maintaining quality standards from raw material evaluation to final product assessment.

Students and Teachers Visit CSIR-NCL

CSIR-National Chemical Laboratory (CSIR-NCL), organised a half-day science outreach programme on 2 April 2026 under the CSIR-Jigyasa Student-Scientist Connect Programme. The programme was coordinated by the Science Outreach Resource Centre, CSIR-NCL and was attended by 131 students and 16 teachers from two schools.

The programme featured two engaging scientific talks and a visit to the Dimethyl Ether (DME) facility at CSIR-NCL. Dr Wafia Masih, Chief Scientist, CSIR-NCL, delivered a presentation titled *"Where Curiosity Meets Science: Jigyasa in Action"*, introducing students to the objectives and achievements of the CSIR-Jigyasa initiative. She highlighted the outreach activities conducted by CSIR-NCL over the past five years, including facility visits, science demonstrations, hands-on workshops and mentoring sessions aimed at nurturing scientific curiosity among students and teachers.

A lecture on *"Plant Biotechnology for Healthy Food"* was delivered by Dr Narendra Kadoo, Chief Scientist, CSIR-NCL. The session introduced students to the fundamentals of DNA, crop improvement, transgenic crops and the role of biotechnology in addressing challenges related to food security and nutrition. Through examples such as *Bt cotton* and Golden Rice, Dr Kadoo explained the benefits, safety considerations, and societal aspects of modern agricultural biotechnology.

Mr Akash Bhatkar, PhD student at CSIR-NCL, presented an informative talk on alternative fuels and sustainable energy, focusing on Dimethyl Ether (DME) technology developed at CSIR-NCL. The session familiarised students with the challenges of climate change and fossil fuel dependency, while showcasing DME as a clean and sustainable fuel alternative. Students learnt about catalyst development, technology scale-up and the journey from laboratory research to the nation's first DME semi-pilot plant.

The participants also visited the DME facility, where they observed the technology demonstration and interacted with researchers involved in the project. The demonstrations on DME production, catalyst testing and its applications in domestic burners provided students with a first-hand understanding of how scientific research is translated into real-world solutions. By connecting students with researchers and advanced laboratory facilities, the event reflected the core vision of the CSIR-Jigyasa programme: bridging the gap between laboratory research and classroom learning.

Faculty Development Programme

CSIR-National Chemical Laboratory (CSIR-NCL), in collaboration with the Maharashtra State Faculty Development Sanstha (MSFDA), organised a half-day Professional Development Programme (PDP) for college and university faculty members on 7 April 2026 under the Science Outreach Resource Center (SORC). The programme brought together 40 faculty members from 22 higher education institutions across Maharashtra, offering them an opportunity to engage with CSIR-NCL's research ecosystem and science outreach initiatives.

The programme commenced with a presentation by Dr Wafia Masih, Chief Scientist and Head, Science Outreach Resource Center, on the CSIR-Jigyasa Student-Scientist Connect Programme. She highlighted CSIR-NCL's outreach achievements over the past five years, including 70 Jigyasa programmes benefiting 4,892 students and 901 teachers from 349 schools through laboratory visits, One Day as a Scientist (ODAS), science demonstrations, workshops and teacher training.

This was followed by a lecture by Dr Ashok P. Giri, Chief Scientist, Biochemical Sciences Division, on *plant specialised metabolism*. He discussed the role of specialised metabolites in plant growth, defence and environmental interactions, and presented his group's research using integrated OMICS approaches to understand biosynthetic pathways in potato, tomato and mango, with applications in agriculture and synthetic biology.

Participants also visited the Molecular Biology and Plant Tissue Culture laboratories and greenhouse facilities of the Biochemical Sciences Division, guided by Ms Rutuja Kale and Ms Preshita Bhatt, Senior Research Fellows, gaining first-hand exposure to contemporary research facilities and experimental techniques.

The programme concluded with a visit to the CSIR-NCL Archives and Science Museum, led by Mr Jithin Jacob, Senior Project Associate. The visit provided participants with valuable insights into CSIR-NCL's scientific legacy while strengthening interactions between the laboratory and the higher education community.

The visit provided faculty members with valuable exposure to contemporary research, innovation and science communication, while strengthening interactions between CSIR-NCL and the higher education community.

NCL study: Jamun honey rich in antioxidants, low in glucose

Ardhra.Nair@timesofindia.com

Pune: Scientists at the CSIR-National Chemical Laboratory (NCL) have provided scientific evidence confirming that authentic jamun honey is a healthier natural sweetener, characterised by low glucose levels and a rich antioxidant profile.

The study analysed 82 authentic samples collected from Mahabaleshwar region using advanced techniques, including nuclear magnetic resonance (NMR) and mass spectrometry (MS). The findings suggest that India's indigenous honey varieties may be significantly undervalued on the global stage. "Antioxidant-rich jamun honey, which retails in India for approximately Rs1,000 to Rs1,200 per kg, has health-promoting properties comparable to Manuka honey imported from New Zealand," said Dr Ashish Lele, director, NCL. "Manuka honey often sells for eight to ten times the price. This vast price gap is primarily due to a lack of branding, consumer awareness, and scientific characterisation of our local honey."

Currently, India lacks a national repository for honey profiles and frequently sends samples abroad for scientific authentication. To address this, NCL is developing a national database of indigenous honey varieties. NCL scientist Udaya Marelli, who led the Jamun honey study, emphasised the importance of NMR spectroscopy in this process. "NMR is a technique used to identify every chemical compound in a product. While it is mandatory for medicines and many food products, honey is rarely tested via NMR in India. Most of that data currently resides in European databases," Marelli said.

By establishing a master database in India, the NCL hopes to prevent loss of national biological data and curb sale of fraudulent products. The study also examined Karvi honey, produced from the Strobilanthes callosa flower, which blooms only once every seven to eight years in the Western Ghats. Researchers found that Karvi honey also boasts high antioxidant activity.

"Karvi honey has a distinct fluorescent marker. Under UV light, it fluoresces," said Marelli. "This unique metabolite profile serves as a natural 'signature' that makes authenticating Karvi honey much easier."

Ravindra Sathe, chairman, Maharashtra State Khadi and Village Industries Board, announced that a proposal has been sent to the state government to launch a registration portal for all honey producers.

"Currently, there is no centralised tracking of producers. This portal will help regularise the industry, maintain high quality, and facilitate training," Sathe said.

KEY COMPARATIVE INSIGHTS

> **Antioxidant power** | Jamun honey shows a mean antioxidant activity of 85%, which is substantially higher than the reported range for Manuka honey (38.6–50.3%)

> **Bioactive flavonoids** | Jamun honey is particularly rich in myricetin (150.5 mg/kg) and kaempferol (81.7 mg/kg)

> **Sugar profile** | Jamun honey has a lower glucose and fructose content than Manuka honey but contains a higher mean sucrose level (4.2 g/100g vs. <1.2 g/100g)

स्वदेशी मधांचा 'राष्ट्रीय विदासाठा'

राष्ट्रीय रासायनिक प्रयोगशाळेचा पुढाकार

कसत्ता प्रतिनिधी

ी : देशात उत्पादित होणाऱ्या ाची अस्सलता आणि भौगोलिक ठ शोधण्यासाठी राष्ट्रीय ायनिक प्रयोगशाळेने नसीएल) पुढाकार घेतला आहे. विध प्रांतांमध्ये असलेल्या वध्यपूर्ण फुलोऱ्यापासून तयार णाऱ्या अनोख्या स्वदेशी मधांचा ट्रीय विदासाठा (नॅशनल ाबेस) तयार करण्याचे काम नसीएल'ने सुरू केले असून, चे प्रारूपही विकसित करण्यात ले आहे.

'एनसीएल'चे संचालक डॉ. शिष लेले, शास्त्रज्ञ डॉ. उदय रण मारेल्ली यांनी या बाबतची हिती दिली. 'देशात विविध यांमध्ये मधाचे उत्पादन मोठ्या णात घेतले जाते. मात्र, मधाची सलता तपासण्याची सुविधा ाप उपलब्ध नाही. विविध ारच्या मधाच्या चाचण्या करून च्यातील गुणधर्मांचा अभ्यास करून मधाच्या अस्सलतेचे निकष तयार करण्यात येत आहेत. त्याच्या पहिल्या टप्प्यात 'एनसीएल'ने जांभूळ मध, कारवी मध, मोहरी मध अशा काही मधांचा अभ्यास केला आहे. त्याच्या पुढील टप्प्यात मधाचा राष्ट्रीय विदासाठा तयार केला जाणार आहे. त्यासाठी 'एनसीएल'ने आठ प्रकारच्या मधांचे सुमारे ६००हून अधिक नमुने संकलित केले आहेत. येत्या काळात आणखी नमुने संकलित करून त्यांचाही अभ्यास करण्यात येणार आहे.'

डॉ. लेले म्हणाले, 'भारतीय मधाचे नेमके मूल्य काय, मध अस्सल आहे की नाही, हे तपासण्यासाठी मधाचा राष्ट्रीय विदासाठा असणे आवश्यक आहे. आतापर्यंत युरोपीय निकषांनुसार मधाची चाचणी करावी लागते. मात्र, भारतीय मधासाठी युरोपीय निकष लावणे योग्य नाही. भारताची भौगोलिकता वैशिष्ट्यपूर्ण आहे. त्यामुळे फुलोराही वेगळा आहे. उदाहरणार्थ, आठ वर्षांतून एकदा फुलणाऱ्या कारवीच्या फुलांपासूनही मध तयार होतो. ही प्रदेशनिष्ठ वनस्पती आहे. त्यामुळे या वनस्पतीच्या फुलांपासून तयार होणाऱ्या मधासाठी युरोपीय निकष लावणे योग्य नाही. त्यासाठी स्वतंत्रपणे अभ्यास करून विदासाठा तयार करण्याची गरज आहे.'

'स्वदेशी मधांचा राष्ट्रीय विदासाठा मधांचे वेगळेपण सिद्ध करण्याशिवाय मधातील भेसळ रोखण्यासाठीही महत्त्वाचा ठरणार आहे. युरोपात अशा प्रकारचा विदासाठा आहे. त्यामुळे त्यांना मधाच्या अस्सलतेबाबत चाचण्या करणे शक्य होते. आपल्याकडे विकल्या जाणाऱ्या मधाची 'एनएमआर' (न्यूक्लिअर मॅग्नेटिक रेझोनन्स) चाचणी करणे गरजेचे आहे,' असे डॉ. उदय यांनी नमूद केले.

विशेष प्रयोगशाळेची उभारणी

'एनसीएल'ने आता विशेष 'एनएमआर' (न्यूक्लिअर मॅग्नेटिक रेझोनन्स) सुविधा असलेली प्रयोगशाळा उभारण्याचा निर्णय घेतला आहे. ही प्रयोगशाळा 'नॅशनल ॲक्रिडिटेशन बोर्ड फॉर टेस्टिंग अँड कॅलिब्रेशन लॅबोरेटरीज'कडून (एनएबीएल) प्रमाणित असेल. त्यामुळे मधासह विविध अन्नपदार्थ, औषधांच्या चाचण्या करून त्याचे प्रमाणपत्र देणे शक्य होईल. येत्या वर्षभरात ही प्रयोगशाळा उभारण्याचा मानस असल्याची माहिती डॉ. आशिष लेले यांनी दिली.

'भौगोलिक मानांकन मिळवणे शक्य'

'आपल्या स्वदेशी मधांचा अभ्यास करून त्यांचे वेगळेपण तपासता येईल. त्याद्वारे मधांचे भौगोलिक मानांकनही मिळवता येईल. त्या आधारे स्वदेशी मधांचे ब्रँडिंग करता येऊ शकेल,' असेही डॉ. आशिष लेले यांनी नमूद केले.

मधुमेहींसाठी गोड बातमी ! जांभूळ मध साखर नियंत्रित ठेवण्यास उपयुक्त

रासायनिक प्रयोगशाळेचा शोध; अँटीऑक्सिडंट्सचा खजिना व कमी ग्लुकोज; जांभूळ मधावर 'एनसीएल'चे शिक्कामोर्तब

पुणे : पुढारी वृत्तसेवा

जांभूळ मधामध्ये रक्तातील साखरेवर तुलनेने कमी परिणाम करणारे गुणधर्म असल्याचे आणि त्याचबरोबर शरीराला संरक्षण देणाऱ्या अँटीऑक्सिडंट्सचे प्रमाण मोठ्या प्रमाणात असल्याचे पुण्यातील राष्ट्रीय रासायनिक प्रयोगशाळेतील शास्त्रज्ञांच्या संशोधनातून स्पष्ट झाले आहे. अत्याधुनिक वैज्ञानिक तंत्रज्ञानाच्या आधारे करण्यात आलेल्या या अभ्यासामुळे जांभूळ मधाला नवी ओळख मिळण्याची शक्यता निर्माण झाली आहे.

[illegible]

भेसळयुक्त मधाला बसणार चाप

[illegible]

> [illegible]
> — डॉ. आशिष लेले, संचालक, एनसीएल

> [illegible]
> — रविंद्र साठे, अध्यक्ष, महाराष्ट्र राज्य खादी आणि ग्रामोद्योग मंडळ

भेसळयुक्त मधाला बसणार चाप

[illegible]

रक्तातील साखर कमी करण्यासाठी प्रभावकारी

[illegible]

स्वदेशी मधांच्या जातींना मिळणार नवी ओळख

[illegible]

विविध जातींच्या मधाच्या माहितीचे होणार संकलन

[illegible]

जांभूळ मधाची वैशिष्ट्ये

[illegible]

सीएसआईआर-एनसीएल में अनुवाद प्रशिक्षण कार्यक्रम संपन्न

ण, 4 मई (आ.प्र.)

भारत सरकार, राजभाषा विभाग, गृह लय, केन्द्रीय अनुवाद ब्यूरो, नवी ई के तत्वावधान में नराकास के सदस्य र्यालयों एवं नेशनल केमिकल लेबोरेटरी नसीएल) के स्टाफ सदस्यों हेतु 20 24 अप्रैल तक 5 दिवसीय संक्षिप्त नुवाद प्रशिक्षण कार्यक्रम का आयोजन एसआईआर-एनसीएल में संपन्न हुआ.

यह 5 दिवसीय प्रशिक्षण कार्यक्रम तिदिन दो सत्रों में आयोजित किया गया. सके प्रथम सत्र में डॉ. सुस्मिता भट्टाचार्य वं द्वितीय सत्र में कुसुम शर्मा झा द्वारा भिन्न विषयों पर प्रशिक्षण प्रदान किया या. उपस्थित सभी कर्मचारियों तथा धिकारियों को राजभाषा हिन्दी संबंधी गई और इसी के साथ अनुवाद कार्य में आने वाली समस्याओं पर चर्चा कर उनका समाधान भी किया गया. जिसमें कार्यक्रम के अध्यक्ष के रूप में सीएसआईआर-एनसीएल के मुख्य वैज्ञानिक डॉ. नरेन्द्र कडू एवं सीएसआईआर-एनसीएल की वरिष्ठ हिन्दी अधिकारी डॉ. स्वाति चड्ढा मंच पर उपस्थित थे.इस दौरान प्रतिभागियों द्वारा मंच पर अपना अनुभव साझा किया गया.

इस कार्यक्रम में नराकास के सदस्य कार्यालयों द्वारा निर्मित संक्षिप्त संयुक्त शब्दावली का भी विमोचन किया गया. तत्पश्चात् नराकास सदस्य कार्यालयों के प्रतिभागियों द्वारा नाटिका प्रस्तुत की गई. इसके बाद सभी प्रतिभागियों को केन्द्रीय अनुवाद ब्यूरो, राजभाषा विभाग, गृह

सीएसआईआर-एनसीएल ने स्वच्छता पखवाड़ा मनाया

पाषाण, 26 मई (आज का आनंद न्यूज नेटवर्क)

सीएसआईआर-नेशनल केमिकल लेबोरेटरी ने 1 से 15 मई तक स्वच्छता पखवाड़ा मनाया, जो सीएसआईआर लैबोरेटरी में शुरू किए गए देशव्यापी सफाई अभियान के मुताबिक है.

दो हफ़्ते तक चलने वाली इस पहल की शुरुआत स्वच्छता शपथ दिलाने के साथ हुई, जिसके बाद ऑफिस परिसर और आस-पास के इलाकों की सफ़ाई के लिए श्रमदान किया गया. एक पेड़ मां के नाम थीम पर एक पौधारोपण अभियान भी चलाया गया, जिससे पर्यावरण की स्थिरता के प्रति संस्थान की प्रतिबद्धता को मज़बूत किया गया. पूरे पखवाड़े के दौरान, स्टाफ़ सदस्यों और उनके परिवारों के लिए सफ़ाई और नागरिक ज़िम्मेदारी के संदेश को बढ़ावा देने के लिए कई तरह के जागरूकता फैलाने वाले कॉम्पिटिशन आयोजित किए गए. पूरे कैंपस में खास कोशिशें की गईं, जिसमें ऑफिस की जगहों, लैबोरेटरी, पानी की टंकियों और

सैनिटेशन सुविधाओं की गहरी सफ़ाई शामिल है.

इसके अलावा, कर्मचारियों के बीच स्वच्छता जागरूकता वेस्ट-टू-वेल्थ कॉन्सेप्ट और सिंगल-यूज़ प्लास्टिक को कम कर पर ट्रेनिंग सेशन और वर्कशॉप आयोजित किए गए. पखवाड़ा 15 म को एक क्लोज़िंग सेरेमनी के साथ ख़त्म हुआ.

प्रभात

प्लॅस्टिक प्रदूषण विळख्यात जैवप्लॅस्टिककडे दुर्लक्ष

राष्ट्रीय रासायनिक प्रयोगशाळेने केलेले संशोधन ठरणार आशेचा किरण

प्रभात वृत्तसेवा

पुणे, दि. ४ - जगासमोरील प्लॅस्टिक प्रदूषण हे सर्वांत गंभीर पर्यावरणीय संकटांपैकी एक बनले असताना प्लॅस्टिकला जगात एकीकडे प्लॅस्टिकचा वापर कमी करण्याचे आवाहन केले जात असताना त्यावरील अवलंबित्व वाढत आहे. त्यामुळे पर्याय म्हणून जैवप्लॅस्टिकचा विचार होत असला, तरी त्याचा भारतातील वापर आल्यास उत्पादनासाठी लागणाऱ्या कच्च्या मालावरील खर्च कमी होण्यास मदत होऊ शकते. त्यामुळेच एनसीएलचे संशोधन महत्त्वाचे ठरते.

एनसीएलने विकसित केलेले तंत्रज्ञान

> जैवप्लॅस्टिकचा सर्वांत मोठा गैरसमज म्हणजे ते पूर्णपणे जैवविघटनशील असते. प्रत्यक्षात अनेक जैवप्लॅस्टिक प्रकारांचे विघटन विशिष्ट तापमान, आर्द्रता आणि जैविक परिस्थितींमध्येच होते. त्यामुळे त्यांचे स्वतंत्र संकलन, वर्गीकरण आणि

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Sausage Tree (Kigelia Africana)

CSIR-National Chemical Laboratory

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Email: allotrope.ncl@csir.res.in

CSIR-National Chemical Laboratory
Dr. Homi Bhabha Road, Pune 411 008 (INDIA)
Email: director.ncl@csir.res.in Website: www.ncl.res.in
Facebook:@csir.ncl Twitter: @csir_ncl

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