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One laboratory | Different forms

Volume 2 | Issue 2 | April-June 2025

Catalysing Innovation

SEEDING THE FUTURE:

CSIR-NCL'S

Journey in Sustainable and Resilient Agriculture

Cultivating Change: The Inspiring Journey of Dr Ashok P. Giri

Innovative Double-Encapsulated System Targets Parasitic Weeds

What you must learn which they do not teach you in the University

2nd Global Conclave on Plastic Recycling and Sustainability

EDITORIAL

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As we turn the pages of this issue, we delve into a narrative of transformation - one where science meets sustainability and innovation nurtures the future of agriculture. Our cover story, ***Seeding the Future: CSIR-NCL's Journey in Sustainable and Resilient Agriculture,*** chronicles the laboratory's evolution from enhancing fertiliser production in post-independence India to pioneering advanced agro-biologicals. This journey reflects a steadfast commitment to integrating chemistry and biology, traditional practices and modern technologies, ensuring that agriculture continues to serve as the essential foundation supporting national prosperity.

Our "Curious Minds" section features ***Dr. Ashok P. Giri,*** a Chief Scientist at CSIR-NCL, whose work exemplifies the integration of scientific inquiry with societal impact. Rooted in his rural upbringing, Dr. Giri's research focuses on issues pertinent to Indian agriculture. Alongside this, we highlight several path-breaking research and technology-based developments of the quarter, as well as updates on technologies licensed, MoUs signed, training sessions, lectures, outreach activities and student engagements.

In alignment with our theme, *Allotropes of Science*, we underscore the multifaceted contributions of CSIR-NCL to scientific advancement. Much like allotropes are different forms of the same element, NCL embodies various facets: a dynamic knowledge hub shaping upcoming technologies, a capacity-building center, a meeting ground for industrialists, scientists, and policymakers, and a Launchpad for early-career researchers. Through this magazine, we aim to share the latest updates from the laboratory by creating a pathway that will help the readers connect closely with us.

This issue highlights how CSIR-NCL's scientists are pushing the boundaries of science and technology to create sustainable solutions for agriculture. Through these efforts, the laboratory continues to play a vital role in shaping the future of Indian agriculture and contributing to national development.

We hope you find this read both insightful and inspiring.

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 write about their work experience 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

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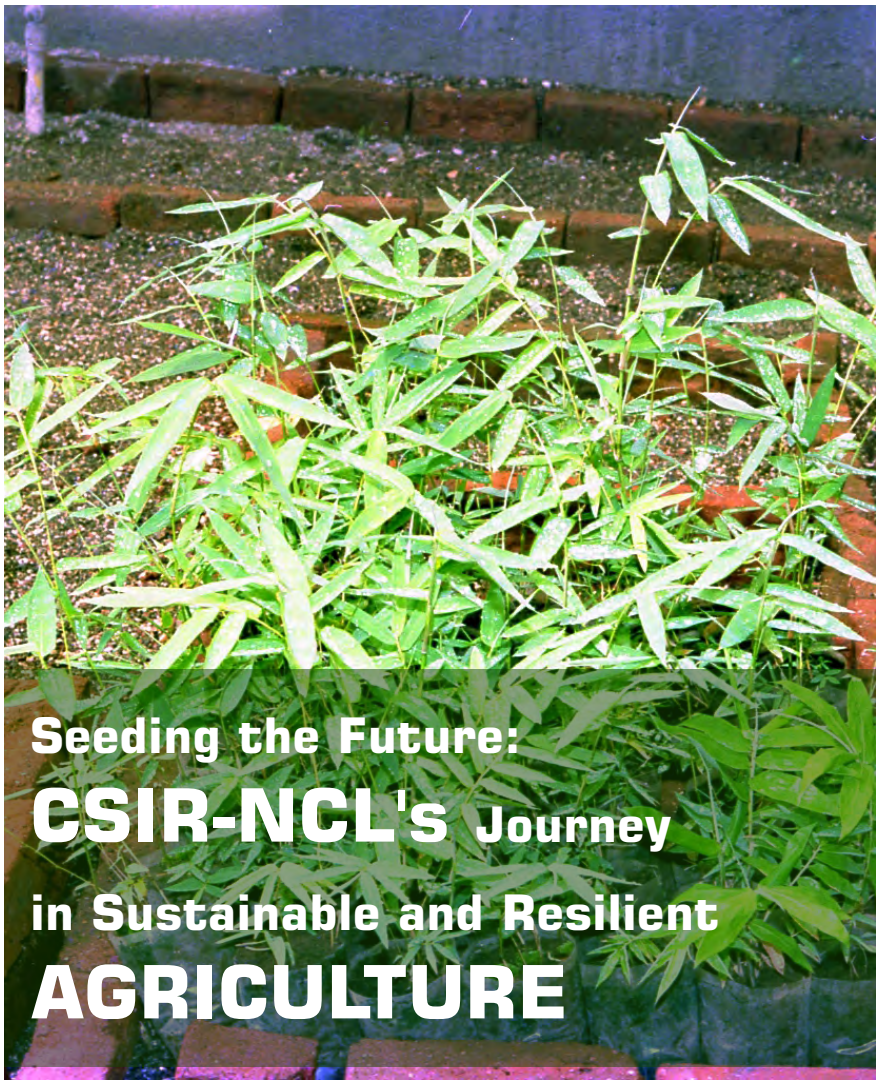
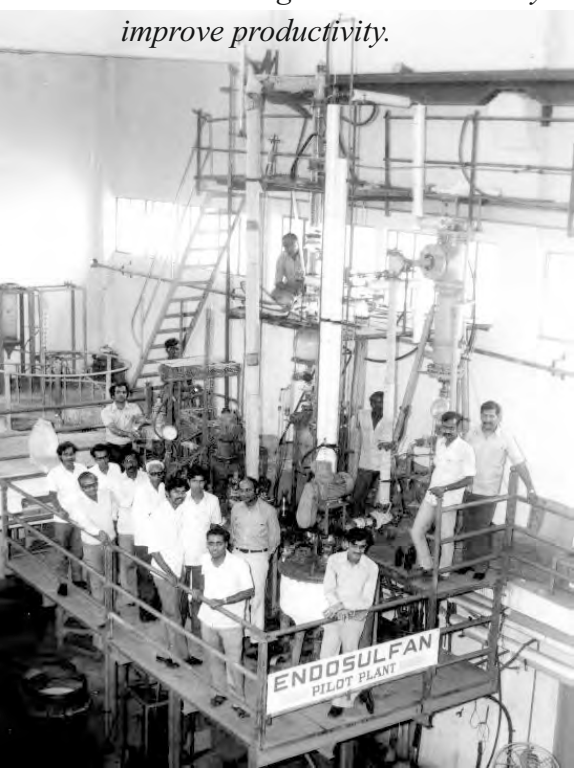


Seeding the Future: CSIR-NCL's Journey in Sustainable and Resilient AGRICULTURE

The CSIR-National Chemical Laboratory (CSIR–NCL), established in 1950, began its journey at a time when Indian agriculture remained largely traditional. Crop yields were low, harvests were dependent on the monsoon, and pest and disease outbreaks frequently caused significant losses. In the years following independence, ensuring national food security was one of India's most primary challenges. Fertilizers and crop protection measures became essential, and NCL responded by developing catalytic processes that enhanced fertilizer production. For instance, during the early 1960s, NCL transferred technologies for the preparation of mixed nitrogen-phosphorus fertilizer to industries. This foundational work has immensely contributed to the Green Revolution, providing farmers with the technological tools necessary to improve productivity.



During the 1970s and 1980s, NCL scientists expanded their contributions to agriculture by developing indigenous agrochemical production technologies and delivery systems for various pesticides and herbicides. Some of the remarkable contributions during this period are the development and technology transfer for the production of Endosulfan, Atrazine, Dalapon, etc. By the late 20th century, as biotechnology began to transform global agriculture, NCL emerged as a leader of plant tissue culture (PTC) in India. Its research in PTC enabled the large-scale production of disease-free, high-quality planting material, ranging from agricultural and horticultural crops to forestry plants. Particularly, the tissue culture and micropropagation technology for Sugarcane, Napier grass, Cashew, Cardamom, Coconut, Pine, Mango, Eucalyptus, Teak, and Bamboo were developed for the first time by NCL and transferred to various industries and research organizations. PTC gave the NCL one of its proudest moments - The discovery of bamboo blooming was splashed across the world, from Japan and Thailand in the East to Europe and the USA in the West. As bamboo was considered not amenable to breeding, there was not much work done on its floral biology and breeding behavior, until NCL developed the technology for early blooming of bamboo. Similarly, NCL made a notable contribution in developing the unique metabolite profile of Devgad Alphoso Mango, which helped farmers to get

Breakthroughs in tissue culture-Premature flowering in bamboo

Bamboo Flowering

a Geographical Indication (GI) tag for their produce. Besides, agri-farming, NCL, in collaboration with Nimbkar Agricultural Research Institute (NARI), Phaltan, has also developed a new prolific sheep breed, "NARI Suwarna", which gives birth to more than one offspring in each lambing, increasing shepherds' incomes, and contributing to livestock farming. These pioneering works and technologies have not only increased agricultural and livestock productivity but also supported biodiversity conservation by safeguarding rare and endangered plant species in controlled laboratory conditions.

NCL's research further advanced enzyme technology and microbial innovations. These included microbes that enhance plant growth and resilience to abiotic stresses and enzymes that can accelerate decomposition of crop residues -technologies that combined biological and chemical approaches to address long-standing agricultural challenges. Long before the concept of "sustainable farming" became widely recognized, NCL had already begun integrating sustainability into its scientific agenda. Over the decades, as India transitioned from a food-deficient nation to one of self-sufficiency, NCL's scientific contributions played a pivotal role in this transformation.
What distinguishes NCL is its multidisciplinary approach. Researchers in organic chemistry, biochemical sciences, and chemical engineering collaborated closely, often with field-based organizations, to ensure that laboratory discoveries translated into practical benefits for farmers. This integrated model yielded innovations such as bio-inputs that reduce dependence on chemical fertilizers, microbial formulations that strengthen crop resilience, and precision tools for monitoring soil and crop health. Alongside these innovations, NCL trained successive generations of scientists and extension workers, ensuring that knowledge dissemination and capacity building reached farmers across India.
Today, NCL's agricultural research is increasingly focused on agrobiologicals-nature-inspired products such as peptides, double-stranded RNAs, plant metabolites, and engineered microbes. Unlike conventional chemical pesticides, these

Mutation-induced sheep breed-NARI SUWARNA

agents offer targeted action against pests, degrade harmlessly in the environment, and leave negligible residues on food. This shift reflects both continuity with NCL's long-standing expertise in molecular science and responsiveness to contemporary challenges, including climate change, pest resistance, and demands for residue-free agricultural products. Scientists at NCL are now integrating molecular tools, digital modeling, and extensive field trials to deliver environmentally responsible solutions.

Synthesis of commercially significant agrochemicals

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Central to NCL's mission is the belief that science must directly benefit farmers. Examples include controlled-release herbicides and pesticides that reduce costs, biofertilizers that restore soil health, and agrobiologicals and pheromone traps that preserve ecosystems. By working with farmer networks, NCL ensures that its technologies are tested across diverse crops and agroclimatic regions.

NCL's work also aligns closely with India's agricultural policy priorities. Its innovations complement national initiatives such as the National Mission on Sustainable Agriculture (NMSA), Paramparagat Krishi Vikas Yojana (PKVY), and the Atmanirbhar Krishi BioE3 policy, all of which emphasize eco-friendly farming and self-reliance in bio-inputs. Internationally, NCL's research strengthens India's competitiveness in agricultural exports, especially as global markets increasingly impose stringent residue regulations. By advancing agrobiological solutions, NCL contributes simultaneously to national food security and global market access.

As climate change intensifies, bringing unpredictable rainfall, shifting pest dynamics, and soil stress, the need for resilient farming practices becomes ever more pressing. NCL's vision is to provide scientifically advanced, eco-safe, and globally competitive agricultural tools. These include next-generation molecular solutions, innovative formulations, digital monitoring platforms, and comprehensive safety evaluations. Importantly, NCL also emphasizes ecosystem-level collaboration among farmers, policymakers, startups, and researchers, and invests in training the next generation of scientists to carry forward its ethos of science serving society.

Over the past seven decades, NCL has evolved from supporting fertilizer production in post-independence India to pioneering the development of advanced agrobiologicals. Its legacy lies in seamlessly integrating chemistry and biology, traditional practices and modern technologies, and laboratory discoveries with field-level applications. More than a record of scientific milestones, NCL's story reflects a broader commitment: agriculture remains the foundation of national prosperity, and science continues to be its most powerful ally.

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.

"CULTIVATING CHANGE: THE INSPIRING JOURNEY OF DR ASHOK P. GIRI"

In the quiet village of Kari in Beed district, young Ashok P. Giri once believed that driving a bus might be the highest dream his circumstances would allow. Today, he is a Senior Principal Scientist at CSIR-National Chemical Laboratory, Pune, with research spanning plant defence mechanisms, molecular insect-plant interactions and specialised metabolites. His work bridges orchards, laboratories, international networks and classrooms in remote districts. Elected fellow of the National Academy of Sciences, India in 2018, his journey is a testament to the persistence, purpose and a belief that science should uplift people, not just publish papers.

ROOTS, RESOLVE AND SPARK OF CURIOSITY

Dr Giri's academic journey began in a modest rural school that offered education only up to the 7th standard. Undeterred by limited resources, he pursued his secondary education at a residential Social Welfare school 25 Km away. The financial strain was significant, but these formative years instilled in him resilience, self-reliance and early leadership skills.

He described himself then as a *"not very top, not very low,"* but people already said, *"this boy will do something different."*
Mathematics attracted him. Biology pulled him forward. Initially inclined toward vocational training, Dr. Giri switched to the science stream in grade 11, a decision he made without informing his parents. The transition was challenging – grappling with complex subjects in English, but his determination saw him through.

He completed his Graduation and post-graduation at Dr. Babasaheb Ambedkar Marathwada University, Aurangabad. During this time, he caught the attention of visiting scientists, leading to informal lab access that laid the foundation for his Ph.D. journey. His doctoral research, completed in 1995, was undertaken without fellowship support.

OUR CURIOUS MINDS

Four years of work in the lab, working often 12-16-18 hours a day, without financial security, balancing married life (arranged early) and raising a family. Those early trials, mentorship gestures, he says, shaped his scientific code: let curiosity lead, lets tools follow; always ask how work serves people, not just papers.

Along with PhD supervisor Prof. Manvendra Kachole, Dr. Ales Svatos from Max Planck Institute of Chemical Ecology Jena and colleagues from BAMU.

TAKING FLIGHT: POST-PHD AND JOINING NCL

After his Ph.D., Dr Giri got a job offer in industry (Advanced Biochemicals, Nashik), but at the same time applied for a position at CSIR-NCL (National Chemical Laboratory), Pune. In the interview, he was upfront: his weakness was lack of proficiency in English; his strength was his data and publications. NCL's Dr. Prabhakar Ranjekar responded by saying: content matters more than grammar or polish. That acceptance was the fork in the road. He joined NCL as a Project Associate after PhD, choosing research over a safer industrial path.

Life at NCL was a fresh world: strong scientific expectation, new techniques, new collaborators, language and writing challenges - but also opportunity. He worked on enzyme systems, plant protein inhibitors, on pest protection. He began publishing in high-impact journals and these early successes opened doors: to the United States, the Netherlands and eventually to higher scientist positions. In 2002, he was selected as Scientist B at CSIR-NCL.

Working at Max Planck Institute of Chemical Ecology Jena, Germany.

BRIDGING BORDERS: INTERNATIONAL COLLABORATIONS

Dr. Giri's research transcended national boundaries through collaborations with esteemed institutions. He secured a Humboldt Fellowship, leading to a two-decade-long partnership with the Max Planck Institute in Germany. His work also extended to the Weizmann Institute in Israel and other global centres. These collaborations enriched his research and provided a platform for his students to engage in international scientific endeavors.

He observes that many overseas labs don't demand immediate applications. You can pursue mechanistic questions, wander across disciplines and let discoveries emerge. In India, he says, scientists are often forced to justify “impact” too early or too concretely, squeezed by funding cycles and the expectation of deliverables.

With international collaborators Dr. Huilian Che (China Agricultural University, Beijing) and Dr. Richard Goodman (University of Nebraska–Lincoln, USA).

SCIENCE AS A SOCIAL MISSION

One thing that shines through in Dr Giri's interaction is his deep commitment to process over metrics. He does not chase h-indices, impact factors or glamour titles. Instead, he asks: A*re you doing good science?* He sees publications, citations, and patents as byproducts, not drivers.

Along with Hon'ble S and T Minister and colleagues inaugurating new concept of Native Forest at Biochemical Sciences Division, NCL.

From the early days, Dr. Giri's motivations were rooted in his origins. He recalls a childhood moment when his family's pigeon pea crop was devastated by insects. As a boy, he didn't know "insect attack," but he sensed loss. Later, he resolved that if he pursued biology, he would work on crops, pests, and solutions for farmers; problems familiar to rural India.

In his decades at CSIR-NCL in Pune, Giri turned that resolve into sustained research. His lab explores plant defence mechanisms, molecular insect-plant interactions, and specialised metabolites. One flagship long-term project centres on Alphonso (Hapus) mango aroma. Why do mango trees grafted from Devgad or Ratnagiri yield a distinct fragrance even when grown elsewhere? What genes, metabolites, and environmental triggers control aroma? His team has published over 20 papers and secured multiple patents on mango metabolite pathways and flavour compounds. They have also contributed data that helped farmers obtain Geographical Indication (GI) status for Hapus grown in certain regions.

What makes these outcomes significant is their dual character: they advance fundamental science and hold tangible social value. He emphasises that the line between basic and applied science is artificial. *"Any research that has a good impact always has application or translation,"* he says.

BRIDGING SCIENCE AND SOCIETY: OUTREACH AND VISION

Though steeped in lab work, Dr. Giri consistently reaches back. He often travels to remote places - taluka and district schools; to speak to students who might be used to hearing that only engineering or medicine are respectable careers. He explains complex technologies (like mass spectrometry, omics) in stories drawn from everyday life: women sorting grains, tailors sewing clothes, even metaphors from the tailoring business of his parents.

Dr. Giri believes future biochemical research in India must engage agriculture, sustainability, nutrition, crop protection and machinery-free or low-chemical farming. He foresees growth in tissue culture, biomanufacturing of metabolites, AI/ML-driven systems biology. But he cautions: new techniques must support creative questions, not replace them.

He also anticipates shifts in biotechnology adoption: non-seed propagated crops, plantlets from tissue culture (e.g. banana, pomegranate) gaining ground; advanced biotech tools entering everyday farming; and sustainable alternatives to chemical pesticides becoming essential rather than optional.

LEADER & MENTOR: WEARING MULTIPLE HATS

In the corridors of CSIR-NCL, Dr. Giri is not just a bench scientist. He's an administrator, a mentor, a public communicator. As department head, he tried to foster dialogues, shared project displays and cross-lab interaction. He pushed a culture where researchers see each other not as competitors but as complements. After all, science grows fastest in fertile collaboration, not isolation.

Despite the divisions of time, he sees administrative work not as a distraction, but as a necessary part of improving the infrastructure and atmosphere that enable good science. Running an institution, setting up labs, overseeing projects, all of it contributes to the possibilities for younger researchers and for better science.

Mentorship matters, both giving and receiving. The qualities that make a young scientist succeed are simple but

Members of the Plant Molecular Biology Research Group.

demanding: ownership, dedication and passion. He warns that research is not everyone's cup of tea, particularly because it often lacks the immediate rewards of other careers - higher salaries, quick feedback. He emphasises that he prefers not to create "followers" but leaders among his students: people who think critically, forge their own paths, and take responsibility.

A LIFE OF QUIET REVOLUTION

In summing up his own achievements, Dr. Giri points first to his mentorship legacy: over 28 PhD students, many now in leadership roles. That, for him, is one of the greatest successes. Others include patents, publications, field trials, GI recognition and institutions improved under his administrative care.

Nearly 30 years into his scientific career, Dr. Giri still describes himself as *"very passionate; I enjoy my profession, I work 26 hours in 24 hours in a day."*

He is candid: he never chased citations or awards. He asks only: "Am I doing good science? Am I mentoring responsibly? Am I building something for others?" If those are true, all else follows.

When asked how he balances life, he says he reads philosophy, enjoys cooking, draws analogies between tailoring (his parent's trade) and molecular ligation, connects science to daily life and uses every opportunity - every lecture in a rural school, every small talk with a student - to carry the message: *science belongs to everyone.*

He still dreams of taking to villages, helping farmers, and demystifying research. He imagines life after retirement in

Parayan of Dnyaneshwari at his Village Kari, Taluka Dharur District Beed.

rural outreach, but he continues today with energy and intention. As he says, if he cannot explain his work to his parents, who never went to school, then something is missing. In his own way, he represents what many scientists believe: that science need not be distant, elitist or disconnected. It can rise out of humble beginnings, self-doubt and scarcity. It can become something that expresses who we are, where we come from and what we care about.

Because for Ashok P. Giri, science is not separated from society; it is society. And his life is proof that a man from a small village, with dedication and faith in possibility, can carry science into orchards, into remote schools, into the minds of young dreamers. That is the quiet revolution he is leading.

OZONE-DRIVEN RECYCLING OF TEXTILE DYE EFFLUENT: REDUCING FRESHWATER, CHEMICALS AND OPERATIONAL COST

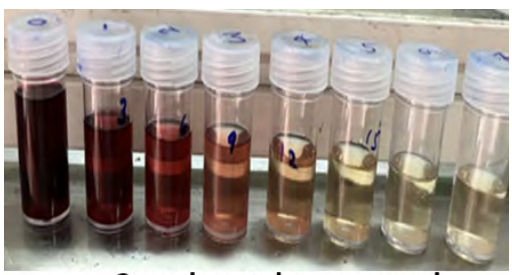
"Ozonation is a chemical water-treatment process that introduces ozone into wastewater, where it breaks down pollutants by oxidizing organic compounds and disinfecting the water."

"This study explores ozonation as a sustainable method to treat textile dyeing effluents, aiming to significantly reduce freshwater and chemical consumption by enabling the reuse of treated wastewater in dyeing processes."

Textile dyeing is a water-intensive process, often consuming 100-200 L per kilogram of fabric, depending on the materials and process. This generates large volumes of wastewater heavily laden with dyes, salts, surfactants and organic pollutants, effluent that is both complex and costly to treat. Conventional treatment systems, whether physical, chemical or biological, frequently fall short, resulting in resource wastage and environmental degradation. Therefore, environmentally sustainable solutions are required to reduce freshwater consumption and help conserve this vital natural resource within our ecosystem.

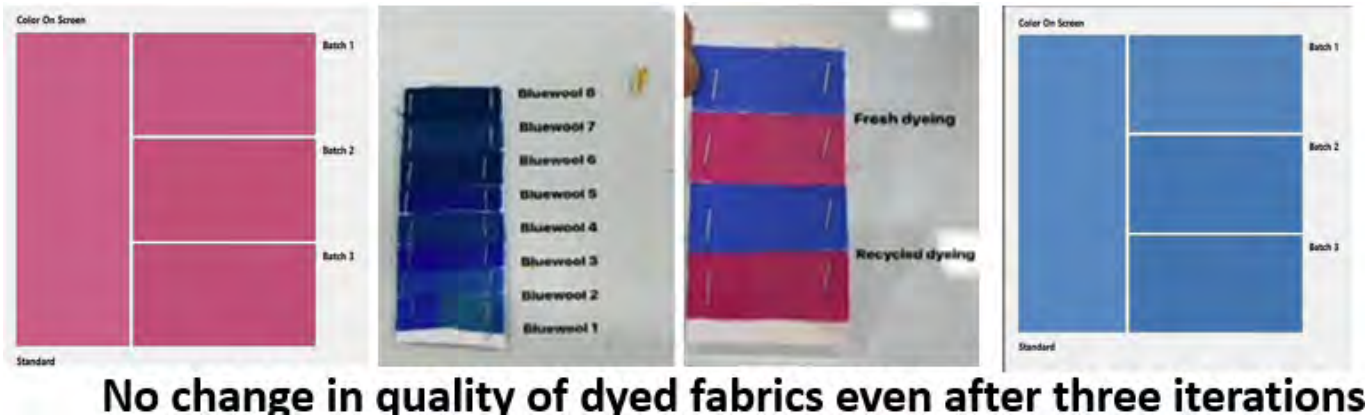
Ozone (O_3) is a potent oxidizer that effectively targets and breaks the chromophore groups responsible for color in dyes. Scientific literature confirms that ozonation can achieve near-complete colour removal across a range of chromophore types, such as monoazo, anthraquinone and phthalocyanine, with efficiencies often exceeding 90% under optimal conditions. However, while colour removal is high, additional treatment may be necessary to address residual chemical oxygen demand (COD).


Ozonation treatment


Complete colour removal

In this study, Dr. Santosh P. Ghuge and colleagues at CSIR-NCL explored recycling through ozonation approach for effluent containing RR198 and RB21 dyes. Just 15 minutes of treatment resulted in virtually complete decolorization, with COD removal efficiency of 32 %, indicating that the visible colour vanished while some refractory organic fragments remained. This aligns with broader advanced oxidation process findings; ozone rapidly destroys colour-causing chromophores, yet mineralization of residual organics often lags, leaving behind partially oxidized compounds.

Importantly, they tested whether the subsequent dyeing with recycled effluent maintained fabric quality. Spectrophotometric analysis and colour-fastness tests after dyeing with the ozonated effluent showed results ranked "excellent" or "good", comparable to fabrics dyed with fresh water. This was consistent across four consecutive dyeing cycles, demonstrating that the recycled effluent remained functionally viable. The practical payoff is substantial: over four cycles, freshwater



consumption fell by 60%, and salt use - critical for reactive dye fixation - dropped by 75%, reducing both operational cost and ionic load.

The work underscores a pivotal insight: ozonation can act as a selective transformer, stripping colour and partially oxidizing effluents quickly enough for practical recycling. Yet, the modest COD reduction signals a need for post-treatment refinements, potentially via biological methods, adsorption, or catalytic enhancements to close the mineralization gap and further reduce operational cost.

This study presents recycling with ozonation treatment as a scientifically sound, industrially relevant strategy to turn textile dyeing effluent from waste into reusable resource. It demonstrates that rapid decolorization, moderate COD reduction, consistent fabric performance and significant savings in water and salt can all be achieved with minimal treatment time. For textile mills seeking sustainability without sacrificing quality, it's a promising approach, combining chemistry, engineering and cost-efficiency.

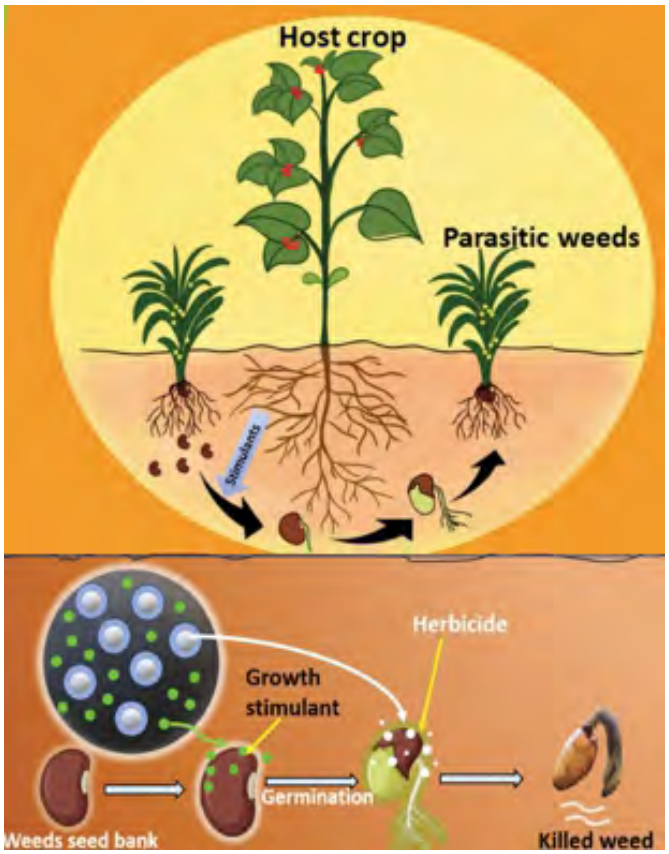
Smita Deogaonkar-Baride, Mitesh Koli, Santosh P. Ghuge*

Recycling textile dyeing effluent through ozonation: An environmentally sustainable approach for reducing freshwater and chemical consumption and lowering operational costs

First published: 05 May 2025

DOI: https://doi.org/10.1016/j.jclepro.2025.145641

INNOVATIVE DOUBLE-ENCAPSULATED SYSTEM TARGETS PARASITIC WEEDS



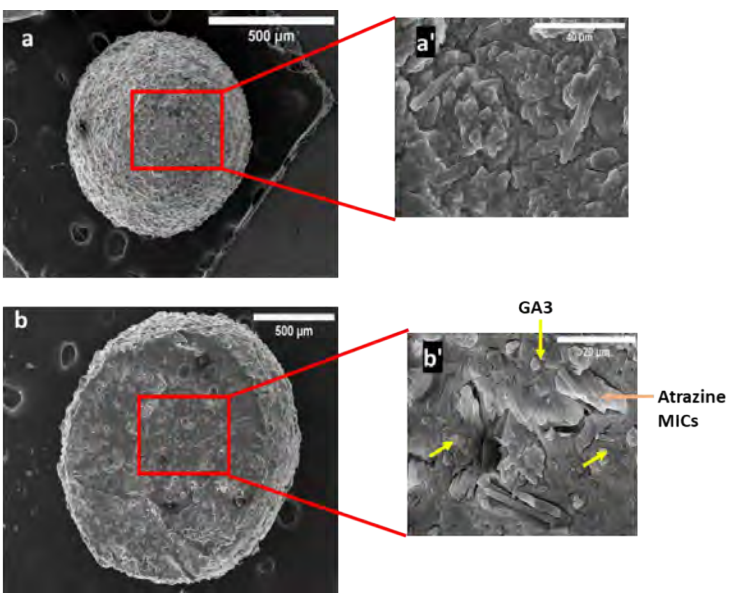
"Suicidal germination is a strategy where parasitic weed seeds are tricked into sprouting prematurely by applying synthetic chemical signals. Without a host plant to attach to, these seeds expend their energy and die off, reducing future infestations."

"The slow, controlled release of atrazine ensures that the desired amount of herbicide leaches into soil to exert herbicidal effect while reducing potential environmental contamination due to excessive herbicide application."

Parasitic weeds such as *Striga*, *Orobanche* and *Cuscuta* pose significant challenges to agriculture due to their unique germination mechanisms and close association with host plants. Traditional herbicides often fail to effectively control these weeds, necessitating innovative approaches to manage their impact on crop yields.

At CSIR-NCL, Pune, Dr. Kadhiravan Shanmuganathan and his team have developed a novel double-encapsulated controlled release system designed to address this issue. The system comprises two distinct layers: an outer alginate matrix encapsulating gibberellic acid (GA_3), a growth stimulant and an inner polyurea shell containing atrazine, a widely used herbicide. The system operates on a staged release mechanism. Upon application, the outer alginate layer facilitates the rapid release of GA_3, inducing the germination of parasitic weed seeds in the absence of a host plant - a process known as suicidal germination.

Subsequently, the inner polyurea shell releases atrazine over an extended period, effectively eliminating the germinated weeds. *In vitro* release studies conducted in an aqueous medium demonstrated that the time required for 50% release of GA_3 was approximately 3 hours, while atrazine exhibited a slower release profile, with 50% release occurring after 96 hours. It is important to note that this kinetics is under accelerated conditions. In a real environment, the release will be much slower and we can expect this differential release rate of growth stimulants and herbicides to induce germination of weeds first before the herbicide exerts its lethal effect.

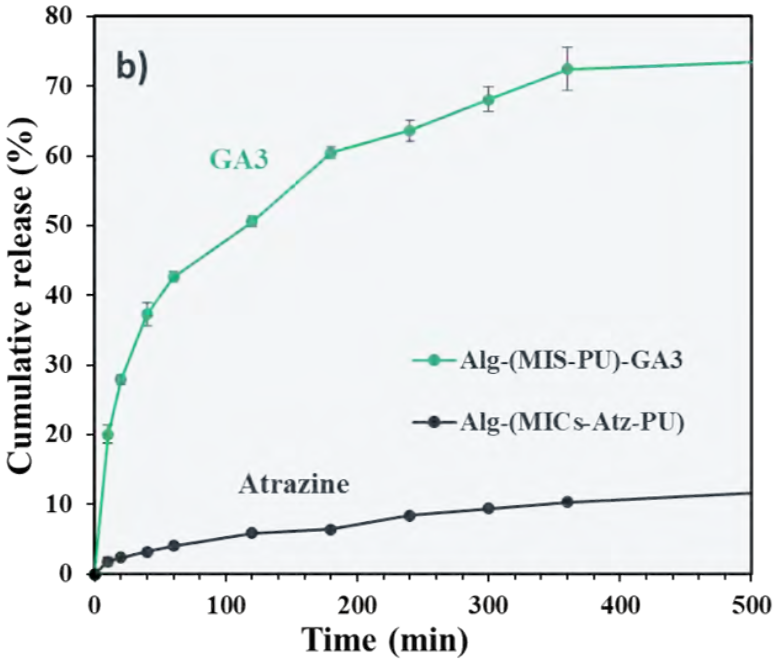


The release profiles of GA_3 and atrazine were analyzed using the Weibull model, a statistical tool that predicts how substances are released over time. This analysis revealed that the release mechanisms primarily follow Fickian diffusion and the active ingredients gradually diffuse out of

the capsule into the surrounding medium. This insight into the release kinetics is crucial for optimizing the system's effectiveness and environmental safety. Soil breakthrough studies further indicated that the double encapsulation of atrazine helps control it's over leaching into the soil, thereby reducing potential environmental contamination and enhancing the sustainability of the herbicide application.

While previous research has explored controlled release systems for herbicides, this study distinguishes itself by integrating a growth stimulant and herbicide within a single delivery system, employing a dual-layer encapsulation approach. For instance, earlier studies have utilized biodegradable and light-responsive polymeric nanoparticles for herbicide delivery, focusing primarily on the herbicide's release profile and environmental safety. However, these systems did not incorporate a staged release mechanism involving both stimulant and herbicide. Moreover, the use of polyurea microcapsules for controlled release has been investigated in other contexts, such as the encapsulation of dimethyl disulfide, but without the dual-agent approach demonstrated in the current study.

The double-encapsulated controlled release system presented offers a promising strategy for the targeted management of parasitic weeds. By combining a growth stimulant and herbicide within a single delivery system, the approach not only enhances the efficacy of weed control but also addresses environmental concerns associated with excessive herbicide application. This innovative system represents a significant advancement in the field of agrochemical delivery and holds potential for broader applications in sustainable agriculture.



Yogeshwar P. Aher, Benu Adhikari, Ravi Shukla, Marimuthu S*, Kadhiravan Shanmuganathan*

Double-Encapsulated Controlled Release System for the Staged Delivery of a Growth Stimulant and Herbicide

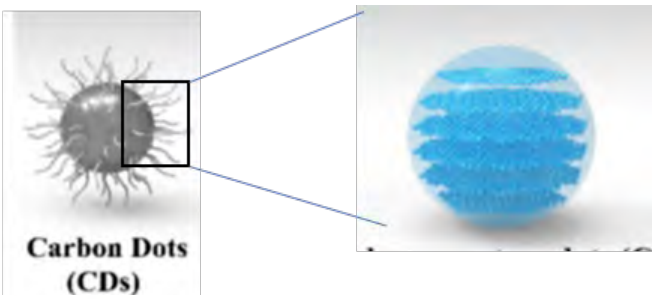
First published: 29 April 2025

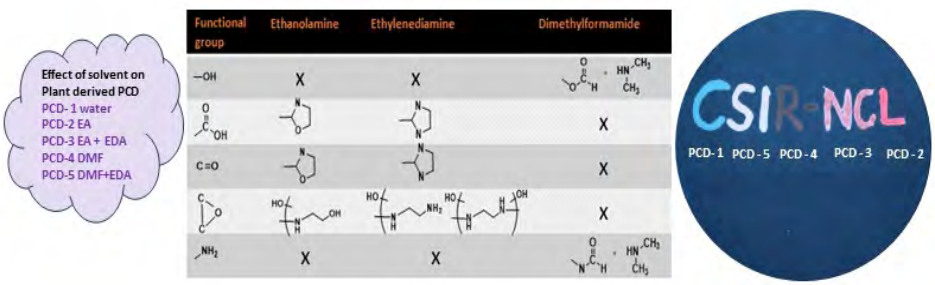
DOI: https://doi.org/10.1021/acsagscitech.4c00784

ENGINEERING LUMINESCENT CARBON DOTS FROM PAPAYA LEAVES

"Carbon dots are minuscule carbon nanoparticles, typically under 10 nanometres in size, that exhibit photo-luminescence - glowing under ultraviolet (UV) light. This unique property makes them valuable in diverse fields such as sensing, imaging and anti-counterfeiting inks."

In a significant advancement for sustainable nanotechnology, researchers have developed a novel method to engineer the emission properties of carbon dots (CDs) derived from papaya leaves. This innovative approach allows for the precise tuning of fluorescence from blue to red by manipulating surface states through solvent selection and heteroatom doping, offering promising applications in fluorescent security inks.





Dr. M. N. Luwang and his team at CSIR-NCL utilized papaya leaves, a readily available and eco-friendly carbon source, to synthesize CDs. This aligns with green chemistry principles by employing water, ethanolamine (EA) and dimethylformamide (DMF) as solvents. The choice of solvents plays a crucial role in determining the optical properties of the resulting CDs.

The study demonstrated that the solvent used during the synthesis of CDs significantly influences their photoluminescent properties. Specifically, CDs synthesized in water exhibited blue emission, while those prepared using EA and DMF emitted red light. This variation in emission colour is attributed to increased oxidation levels in the CDs produced in EA and DMF, leading to a redshift in their fluorescence. The ability to modulate the emission colour of CDs through solvent selection offers a straightforward and effective approach for tuning their optical properties.

To further modulate the emission characteristics, ethylenediamine (EDA) was introduced during synthesis, leading to nitrogen doping of the CDs. This modification resulted in a shift from red to blue emission, suggesting that nitrogen doping can counteract oxidation and restore the blue fluorescence. This finding is crucial for applications requiring stable and tunable luminescence. Various characterization techniques were employed to understand the mechanisms of CD emission tuning. Raman spectroscopy revealed defect-activated D and G bands, indicating structural modifications. X-ray photoelectron spectroscopy (XPS) detected higher levels of C–O bonds in EA and DMF, and increased C–N bonds in EDA-doped CDs. Transmission electron microscopy (TEM) images showed that the synthesized CDs ranged from 1 to 5 nm, with interplanar spacing values consistent with X-ray diffraction(XRD) analysis. These analyses provided a comprehensive understanding of how solvent choice and doping influence the structural and optical properties of CDs.

The ability to engineer the emission properties of CDs through solvent selection and nitrogen doping holds promise for the development of fluorescent security inks. These inks can be used to prevent counterfeiting and ensure the authenticity of documents and products. The tunable fluorescence from blue to red and vice versa, based on the solvents used during the engineering of surface state functional groups, enhances the versatility of these inks. However, scaling up the synthesis of carbon dots from papaya leaves involves addressing challenges such as solvent-related environmental concerns, energy consumption and ensuring cost-effectiveness to facilitate commercial viability.

The study highlights the potential of carbon dots derived from papaya leaves as sustainable and tunable luminescent materials. By understanding and manipulating synthesis conditions such as solvent choice and heteroatom doping, various advanced materials can be developed for a wide range of applications, from security technologies to bioimaging. The integration of green chemistry principles with nanotechnology provides for innovative solutions that are both effective and environmentally friendly.

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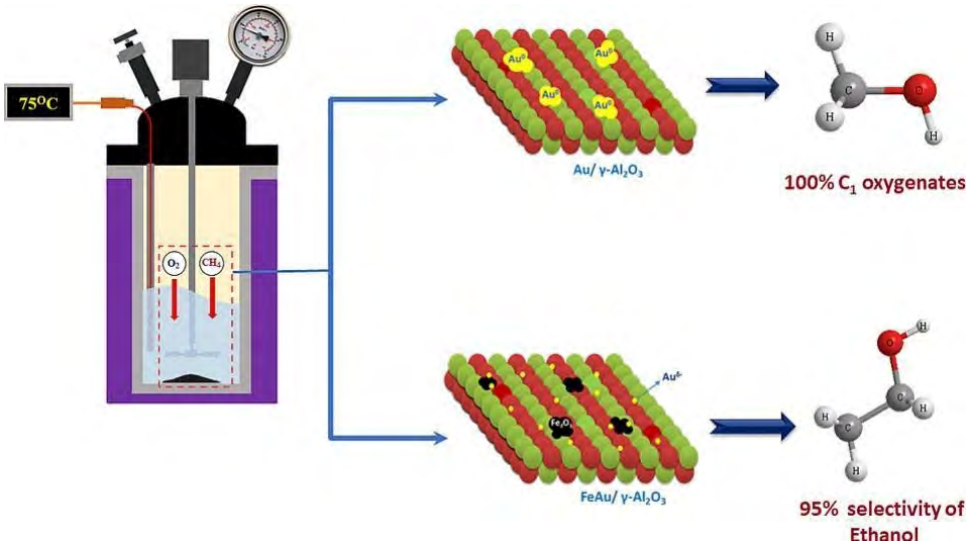
Engineering Luminescent Carbon Dot Emission through Surface State Functional Group via Heteroatom Doping and Unveiling the Effect of Solvents

First published: 28 April 2025

DOI: https://doi.org/10.1021/acs.langmuir.4c05002

SELECTIVE METHANE OXIDATION TO ETHANOL OVER FEAU/γ-AL_2O_3 CATALYSTS

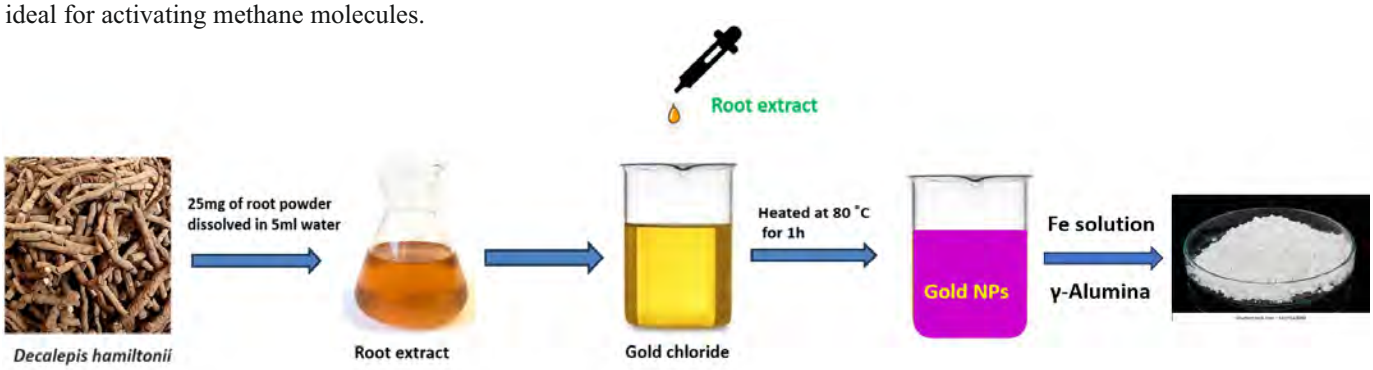
"FeAu/γ-Al_2O_3 catalyst harnesses a unique gold-iron interface to activate methane under mild conditions, a rare combination of precision and performance."



Methane (CH_4) is one of the most potent greenhouse gases, but it's also an untapped reservoir of clean energy. Unfortunately, transforming it into liquid fuels like ethanol typically requires very high temperatures beyond 300°C and aggressive chemical additives, making the conversion process both energy-intensive and environmentally taxing.

Researchers at CSIR-NCL, led by Dr. T. Raja, have achieved a significant breakthrough by converting methane into ethanol under remarkably mild conditions, just 75°C without using any co-reactants. The team's innovation lies in a new multifunctional catalyst: FeAu/γ-Al_2O_3. This catalyst combines gold nanoparticles with iron oxide (FeOx), supported on gamma-alumina (γ-Al_2O_3). What makes it remarkable isn't just the high 95% selectivity for ethanol or its efficiency at low temperatures, but how it works at the atomic level.

Gold nanoparticles in the catalyst are synthesized using an eco-benign, root extraction method. This method produces small, electronically enriched nanoparticles that specifically carry a partial negative charge (Auδ−). These charged gold particles strongly interact with the surrounding iron oxide, forming a highly dispersed and electronically active interface that proves ideal for activating methane molecules.



Advanced techniques such as in situ DRIFTS spectroscopy and Density Functional Theory (DFT) simulations reveal that the ethanol formation occurs through the coupling of two key intermediates: CH_2OH and CH_3. These reactive species are generated and guided by the unique Auδ⁻–FeOx surface, allowing the coupling to proceed efficiently without high temperatures or added chemicals.

Interestingly, when gold or iron catalysts are used independently, such as Au/γ-Al_2O_3 or Fe/γ-Al_2O_3, they primarily produce methanol (CH_3OH) or formaldehyde (HCHO), not ethanol. It's the synergy between gold and iron oxide in FeAu/γ-Al_2O_3 that enables this selective, low-temperature ethanol pathway.

Ethanol is a widely used fuel and chemical feedstock. The

ability to produce it from methane, cleanly and efficiently, opens new doors in green chemistry and methane valorization. It also offers a potential route for capturing and transforming methane emissions from agriculture, landfills or fossil fuel operations.

However, challenges remain. The catalyst's ability to maintain stability over time, the scalability of the synthesis process, considering gold's cost even in nanoparticle form and performance of this method in real-world and continuous flow systems. That said, the developed approach proves to be both efficient and stable, with results that are consistently reproducible across multiple trials.

While questions linger, this breakthrough is a strong step toward methane-based ethanol production that's efficient, environmental friendly and aligned with global sustainability goals. By turning a climate threat into a clean fuel source, the FeAu/γ-Al_2O_3 catalyst highlights how smart science can shift the balance, from pollution to solution.

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Deciphering the intricate mechanisms behind the selective oxidation of methane to C1 and C2 oxygenates over FeAu/γ-Al2O3 catalysts

First published: 17 April 2025

DOI: https://doi.org/10.1016/j.cej.2025.162510

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- Moneesha Fernandes; G-rich Iso-rna Oligomers As Aptamers. United States 12305172. 2025 May 20
- Rajnish Kumar; Sudip Roy; A Process For Dissociation Of Hydrates In Presence Of Hydrate Dissociation Promoters. KR 102816346. 2025 May 29

Dr. B. D. Kulkarni Endowment Lecture

BUILDING WORLD-CLASS INDUSTRIAL R&D IN INDIA - PERSONAL REFLECTION

On 3 April 2025, the CSIR-National Chemical Laboratory (NCL), Pune, hosted the ***Dr. B. D. Kulkarni Endowment Lecture.*** The event commenced with a warm introduction from Dr. Ashish Lele, Director of CSIR-NCL, who reflected on Kulkarni's mesmerizing lectures, forward-looking expertise in data-driven modeling and his gentle yet incisive approach to solving complex challenges.

Dr. B. D. Kulkarni Endowment Lecture is instituted to honor the late Dr. B. D. Kulkarni, a visionary in chemical engineering whose career progressed from Ph.D. student to senior scientist at NCL. Dr. Kulkarni was renowned for his groundbreaking work in mathematical modeling of stochastic reactions, nonlinear dynamics, biochemical 1 process design, scale-up, and data-driven modeling. He earned admiration for his sharp intellect, mentorship, and impactful research legacy.

The keynote talk, titled *"Building World-Class Industrial R&D in India - Personal Reflection,"* was delivered by Dr. Ajit Sapre, former Group President, R&D, Reliance Industries Ltd. Drawing from his 18-year tenure in industrial R&D, Dr. Sapre emphasized the importance of multidisciplinary collaboration, bringing together physicists, biologists and mathematicians, to drive both innovation and commercial value. He celebrated several commercial triumphs, including breakthroughs in gasoline benzene separation, thermic fluid cleaning, homogeneous catalysis innovations that surpassed existing patents and a multi-layer zeolite technology that offered a superior alternative to traditional clay treaters in aromatics processing. One of the most striking highlights of the talk was the demonstration of a new ultra-high molecular weight polyethylene - stronger than Kevlar and steel, used to create bullet-stopping plastic sheets, underscoring its vast potential for industrial and protective applications.

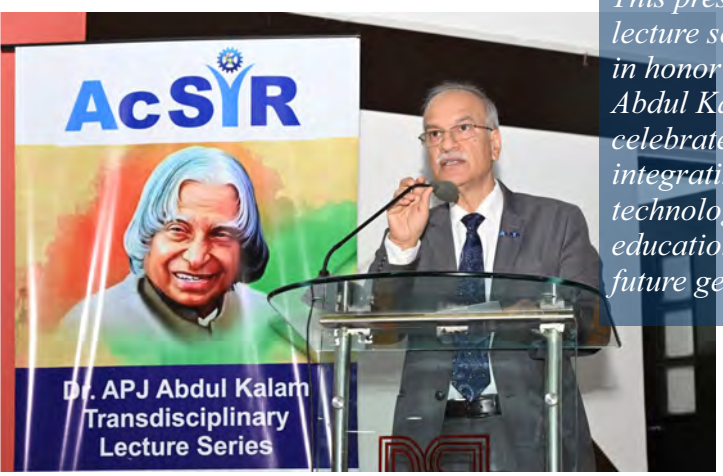
A recurring theme of Dr. Sapre's address was belief in Indian ingenuity and the need to drive research from the lab to full-scale commercial implementation, thus asserting India's presence on the global R&D stage. He also spotlighted the importance of sustainable and climate-conscious innovation, advocating approaches like process intensification to reduce carbon emissions and energy-efficient catalytic processes to minimize industrial waste and energy consumption. He stressed the value of nurturing an R&D culture grounded in low-carbon technologies and circular economy principles.

This Endowment Lecture not only paid tribute to Dr. Kulkarni's remarkable scientific contributions but also charted a compelling vision for India's future in chemical engineering and industrial innovation. Dr. Sapre's narrative wove together lessons on cross-disciplinary teamwork, the commercial value of indigenous innovation and the urgency of sustainability in R&D. His message resonated as both a tribute and a challenge: to carry forward Dr. Kulkarni's legacy by advancing research that is intellectually rigorous, commercially impactful and environmentally responsible.

Dr. APJ Abdul Kalam Transdisciplinary Lecture Series

WHAT YOU MUST LEARN WHICH THEY DO NOT TEACH YOU IN THE UNIVERSITY

The Academy of Scientific and Innovative Research (AcSIR) organized the Second Lecture of the *Dr. APJ Abdul Kalam Transdisciplinary Lecture Series* on April 4, 2025, at the CSIR-National Chemical Laboratory (NCL), Pune. The event commenced with a warm welcome to dignitaries, faculty and students followed by the traditional lamp-lighting ceremony in the main foyer. Prof. Manoj Dhar, Director, AcSIR, delivered the welcome address and provided an overview of the lecture series, emphasizing its role in bridging the gap between academic learning and the practical skills required to excel in research and innovation.



This prestigious lecture series, named in honor of Dr. A.P.J. Abdul Kalam, celebrates his vision of integrating science, technology and education to inspire future generations.

The distinguished speaker for the session was Dr. Swaminathan Sivaram, Padma Shri awardee and Honorary Professor at the Indian Institute of Science Education and Research (IISER), Pune and Kolkata. He was introduced by Prof. Ashish Lele, Director, CSIR-NCL.

Dr. Sivaram delivered an insightful lecture on the theme, *"What you must learn which they do not teach you in the University."* Drawing from decades of academic and industrial experience, he highlighted the critical importance of skills such as problem-solving, creativity, adaptability, teamwork and ethical responsibility, qualities that go beyond formal education yet are indispensable for success in science and innovation. *"It is not enough to master equations and attend lectures; you must cultivate an inventor's mindset and a collaborator's spirit,"* he urged the audience. He emphasized that *"it is more important to ask questions than to provide an answer,"* highlighting the critical role of defining the right problem and persisting despite uncertainty. He also encouraged students to embrace collaboration across fields and develop comfort with ambiguity.

His talk resonated strongly with students and researchers, offering them guidance on navigating real-world challenges that extend beyond textbooks and classrooms.

The lecture was followed by an engaging Q&A session, where students and faculty interacted with Dr. Sivaram, seeking his advice on research directions, career growth and multidisciplinary collaborations. The program concluded with a vote of thanks by Prof. Ajay Dhar, Associate Director, AcSIR, acknowledging the contributions of the speaker and the efforts of organizers in making the event a success. As part of the day's proceedings, dignitaries also visited the CSIR-NCL Archives and Science Museum, which chronicles the rich legacy and achievements of the institute in advancing chemical sciences.

The lecture not only honored the memory of Dr. Kalam but also reaffirmed his belief that education must empower students to think beyond conventional boundaries and innovate for societal progress. With its focus on transdisciplinary learning, the series continues to serve as a platform for inspiring the next generation of scientists and innovators.

Prof. B.D. Tilak Memorial Lecture

ADVANCEMENTS IN CHEMICAL ENGINEERING: BRIDGING ACADEMIA AND INDUSTRY

On April 8, 2025, the CSIR-National Chemical Laboratory (CSIR-NCL), Pune hosted the esteemed *Prof. B.D. Tilak Memorial Lecture*, honouring the legacy of a visionary in chemical sciences. The lecture was delivered by Prof. Mark Everard, consultant and author associated with Bournemouth University and University of the West of England.

Prof. Bal Dattatreya Tilak served as the Director of CSIR-NCL from 1966 to 1978 and made significant contributions to self-reliant chemical technologies in organic chemistry. Under his leadership, NCL's industrial research led to the establishment of several Indian industries producing organic intermediates, dyes, pesticides and textile auxiliaries. To honour his indelible contribution, the NCL Research Foundation instituted the Prof. B.D. Tilak Memorial Lecture Series in Chemical Sciences in 2003.

Prof. Everard's lecture, titled *"Advancements in Chemical Engineering: Bridging Academia and Industry,"* focussed on the evolving landscape of chemical engineering. He emphasized the importance of interdisciplinary collaboration and the integration of academic research with industrial applications. Drawing from his extensive experience, Prof. Everard highlighted several case studies where academic innovations were successfully translated into industrial processes, leading to enhanced efficiency and sustainability.

A key focus of the lecture was the role of emerging technologies in shaping the future of chemical engineering. Prof. Everard discussed advancements in areas such as catalysis, process intensification and sustainable manufacturing. He highlighted the need for continuous innovation and the adoption of green technologies to address global challenges such as climate change and resource depletion.

Crucially, he drew on the ethos of sustainable development, citing the now-classic definition: *"development that meets the needs of the present without compromising the ability of future generations to meet their own needs."* He reinforced this by telling his audience: *"We innovate to meet needs, not to cause harm."* This dual emphasis - on meeting present challenges responsibly, while safeguarding the future - framed much of his presentation. He invited the audience to view research not merely as knowledge creation, but as a stepping-stone to real-world industrial impact that respects societal and environmental boundaries.

The lecture was attended by a diverse audience comprising scientists, researchers, academiciansand industry professionals. The attendees engaged in a lively Q&A session following the lecture, discussing topics ranging from the commercialization of research to the ethical considerations in chemical engineering. The interactive session provided valuable insights and meaningful dialogues among the participants.

NATIONAL TECHNOLOGY DAY LECTURE

CSIR-National Chemical Laboratory (CSIR-NCL), Pune, commemorated National Technology Day 2025 with a special lecture by Mr. Karthick R., Chief Manager (Innovation) at ONGC-MRPL (Oil and Natural Gas Corporation – Mangalore Refinery and Petrochemicals Limited), Mangalore. The event, held on 16 May 2025, was themed YANTRA - Yugantar for Advancing New Technology, Research, and Acceleration, emphasizing India's commitment to technological innovation.

Dr. Ashish Lele, Director of CSIR-NCL, inaugurated the session by highlighting the significance of National Technology Day and the importance of integrating emerging technologies like Artificial Intelligence (AI) and Machine Learning (ML) into industrial sectors. He introduced Mr. Karthick R., who delivered the lecture titled *"Deployment of Artificial Intelligence and Machine Learning Applications to Improve Productivity in Petroleum Refining and Petrochemicals Industry."*

Mr. Karthick R. began by addressing the challenge of managing vast amounts of industrial data, quoting John Naisbitt: *"We are drowning in information but starved for knowledge"*. He shared insights from MRPL, stating, *"If knowledge is power, data is knowledge"*.

He discussed how big data computing at scale is enabling the development of dynamic, data-driven industrial applications. He elaborated on different types of algorithms and explained the AI/ML Algorithm Tree, offering a foundational understanding of how these tools are structured and used in real-time scenarios.

A major focus of his presentation was MRPL's real-world application of AI and ML in addressing an industrial issue.

MRPL had been experiencing odour problems in the final propylene product. To tackle this challenge, the MRPL Innovation Center turned to artificial intelligence and machine learning techniques. By adopting a data-driven approach, they were able to identify and resolve the underlying causes of the issue. The combination of Explainable AI and association mining revealed critical operational parameters. The novelty of this initiative lies in its patented models and hybrid algorithms. Mr. Karthick compared mechanistic models, such as kinetic first-principle models, with AI/ML-based models, offering a clear distinction in their design and functionality. He also discussed Real-Time Optimization systems and informed about the Real-Time Condition Monitoring App developed at MRPL. He described its features and model performance, emphasizing its role in optimizing industrial productivity and decision-making.

The lecture concluded with an engaging Q&A session and a vote of thanks, bringing the event to a successful close. This event highlighted the significance of AI and ML in enhancing productivity and addressing challenges in the petroleum refining and petrochemicals industry, aligning with the national vision of technological advancement.

EVENTS

SWACHTA PAKHWADA

CSIR-National Chemical Laboratory (CSIR-NCL), Pune, actively observed Swachhata Pakhwada 2025 from 1st to 15th May 2025 with a series of activities aimed at promoting cleanliness, hygiene and environmental sustainability. The campaign reflected NCL's commitment to the national mission of Swachh Bharat Abhiyan and to creating a greener, cleaner and more responsible workplace.

The initiative began with comprehensive cleanliness drives across different sections of the campus. Various divisions took part in restoring and improving key spaces such as the main building entrance canopy, biochemical engineering terrace, engineering services unit and PAM building terraces, transforming them through dedicated cleaning and upkeep activities. The before and after impact was visibly striking, showcasing the collective efforts of staff and volunteers.

As part of Swachhata Pakhwada, tree plantation activities were also carried out on the campus, reinforcing NCL's commitment to environmental conservation and sustainability. The success of Swachhata Pakhwada lay in the active participation of all divisions, staff members and supporting units. The initiative went beyond routine cleaning and became a movement that highlighted the values of teamwork, ownership and civic responsibility.

Swachhata Pakhwada 2025 at CSIR-NCL successfully combined cleanliness, structured waste management and green initiatives. The programme not only reinforced the objectives of *Swachh Bharat Abhiyan* but also strengthened the institute's culture of responsibility and collective participation. Through such initiatives, CSIR-NCL continues to uphold its role as a leading scientific institution that is equally committed to societal and environmental responsibilities.

WORLD ENVIRONMENT DAY

On 5 June 2025, CSIR-National Chemical Laboratory (NCL), Pune marked a vibrant celebration of World Environment Day, intertwined with the spirit of Janjatiya Varsha. The day brought together scientists, staff and environment enthusiasts in meaningful activities aimed at enriching both the ecosystem and community bonds.

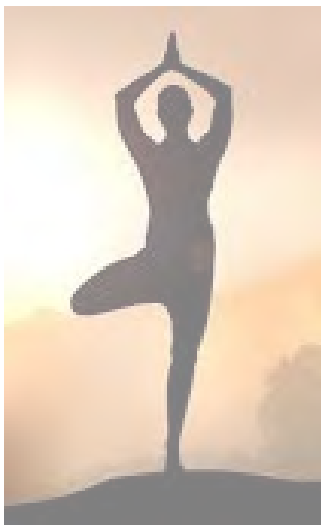
The festivities began with Dr. Ajit Joshi, Chief Scientist and Head of the Engineering Services Unit (ESU) inaugurating proceedings by planting native tree saplings near the Open-Air Theatre. Over the next 45 minutes, participants each planted a sapling, contributing to the planting of 50 carefully selected native species, with the dual aim of preserving regional biodiversity and honoring traditional ecological wisdom.

1,800 ornamental saplings, indoor and outdoor varieties like *Aralia, Calocasia, Dracaena, Zamia, Schefflera* and Rose were distributed to staff and researchers. This effort was intended to encourage individuals to contribute to a greener environment by planting and nurturing these saplings in their homes and surroundings.

Aligned with *Janjatiya Varsha* - a celebration of indigenous heritage, the choice of native species for planting underscored the importance of preserving regional biodiversity and honoring traditional ecological wisdom. The twin celebrations of World Environment Day and Janjatiya Varsha went beyond ceremonial duties. This initiative reflects our continued commitment to the betterment of the campus environment. It also serves to sensitize the campus community about the importance of environmental and the role each individual in preserving nature for future generations.

INTERNATIONAL YOGA DAY 2025

CSIR-National Chemical Laboratory (CSIR-NCL), Pune, observed International Yoga Day 2025 with great enthusiasm and active participation from staff, students and research scholars. The event highlighted the significance of yoga as a holistic practice for achieving balance of body, mind and soul, which is in line with this year's global theme *"Yoga for Body, Mind and Soul."*



The session was organized in collaboration with Shree Yog, led by Shri Subhash S. Jindam and Mr. Mahendra S. Jindam, both experienced yoga practitioners and teachers. The structured programme combined traditional yoga practices with modern relaxation and mindfulness techniques.

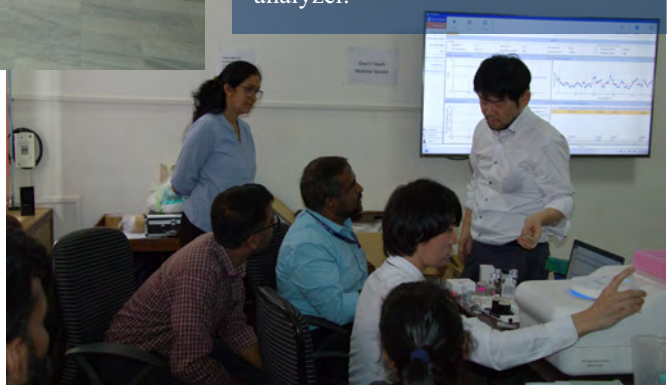
The session began with a prayer, Om chanting and mantra recitation, creating an atmosphere of peace and focus. This was followed by joint movements, stretching exercises, side twisting and Surya Namaskar energizing participants and preparing them for the asanas. Participants then engaged in a series of asanas, including forward and side extensions, backward bends, twisting postures and supported poses with props. Each posture was demonstrated with careful guidance to ensure correct practice and accessibility for all levels. Breathing techniques formed an essential part of the event. Various pranayama practices such as Ujjayi, Vilom, Pratilom and Kumbak were introduced to enhance respiratory control, concentration and vitality. The session also emphasized relaxation and mental well-being. Yoga Nidra and Shavasana provided participants with a deep sense of rest and rejuvenation, while guided meditation techniques like breath-awareness meditation and progressive muscle relaxation helped promote mindfulness and inner calm.

The programme witnessed active involvement from across the NCL community, with participants appreciating the balance of physical postures, breathing practices, and meditative techniques. Many shared that the session not only refreshed them physically but also instilled a sense of mental clarity and relaxation, making it a meaningful way to mark International Yoga Day.

SYMPOSIUM, CONFERENCE, WORKSHOP

One-day Workshop - Particle Size Analysis, Zeta Potential and Molecular Weight Measurement by Otsuka ELSZNeo

On June 23, 2025, the Physical & Materials Chemistry Division at CSIR–National Chemical Laboratory (NCL), Pune, hosted an insightful workshop titled "Particle Size Analysis, Zeta Potential, and Molecular Weight Measurement". This event, organized in collaboration with LabIndia Instruments and Otsuka Electronics, aimed to provide attendees with a comprehensive understanding of advanced particle characterization techniques using the ELSZneo analyzer.



The ELSZneo, developed by Otsuka Electronics, is a high-end analyzer that integrates multiple measurement techniques, including particle size, zeta potential and molecular weight analysis. It offers features such as multi-angle measurement for enhanced particle size distribution resolution, the ability to measure in high-salt environments and ultra-micro-volume sample analysis, making it a versatile tool for researchers in various fields.

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The workshop commenced at 10:00 AM with participant registration and a welcome address. The morning session featured a detailed technical presentation on the principles and applications of Dynamic Light Scattering (DLS)-based particle size analysis, zeta potential measurements and molecular weight determination. This was followed by a Q&A session, allowing participants to engage with the speakers and clarify their queries.

After a lunch break, the afternoon sessions focused on hands-on demonstrations of the ELSZneo instrument. Participants had the opportunity to analyze their own samples in three rotating batches, experiencing firsthand the capabilities of the instrument in real-time analysis. The day concluded with a wrap-up session and a vote of thanks, acknowledging the contributions of all involved.

This workshop not only provided valuable technical knowledge but also fostered networking opportunities among researchers, academicians and industry professionals, contributing to the advancement of particle characterization methodologies in India.

Half-Day Workshop on Importance of **IP** protection & commercialization for MSME

On June 27, 2025, CSIR-National Chemical Laboratory (NCL), Pune, hosted a focused half-day workshop titled *"Importance of IP Protection & Commercialization for MSMEs."* Jointly organized by the Intellectual Property Group, CSIR-NCL, and the Ministry of Micro, Small & Medium Enterprises (MSME), Government of India, the session ran from 10:00 AM to 1:15 PM in an online mode. It aimed to strengthen understanding of how intellectual property (IP) can serve as a cornerstone for innovation, protection and growth among micro, small and medium enterprises.

The workshop aimed to demystify key IP concepts relevant to MSMEs. It explored the differences between copyrights, patents, trademarks and design rights, emphasizing the strategic value these protections offer. Participants were guided through practical considerations in identifying their own IP assets and learning how to protect, manage, and translate them into viable commercial opportunities.

A significant focus was placed on commercialization strategies - how small enterprises can augment value through licensing, partnerships and technology transfers. The session also highlighted institutional frameworks available to MSMEs, guiding attendees toward IP facilitation centres and existing support mechanisms that help with filing, valuation and market linkage.

By equipping MSMEs with actionable insights, the workshop empowered participants to see IP not just as a legal requirement, but as a strategic asset, one that can protect innovation, enhance collaboration with industry and open new revenue avenues. The workshop demonstrated how knowledge transfer and capacity building can embolden MSMEs to embrace innovation and sustainable competitiveness. Through informed use of IP tools, small enterprises are better positioned to protect their creations, carve business differentiation and flourish in increasingly competitive markets.

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FEATURED TECHNOLOGY OF THE QUARTER

ORGANIC PROBIOTIC SOLUTION FOR ANTIBIOTIC-FREE POULTRY FEED

Synopsis: *In response to the surging global demand for high-quality protein and concerns over antibiotic use in poultry farming, CSIR-NCL has developed a unique organic probiotic solution. This innovation aims to enhance food safety, improve poultry health, and eliminate the need for antibiotics as growth promoters. With a rapidly expanding probiotics market, this solution offers a safe and efficient alternative for the poultry industry. The technology is now poised for production and patent approval, signaling a healthier and more sustainable future for poultry farming.*

Problem:

The world's population is expected to reach 9 billion by 2050, leading to a 60% increase in the demand for cost-effective, premium-quality protein. The poultry industry, a key contributor to the protein supply, is investing 70% of its total production costs in feed for broiler chicken. However, the susceptibility of poultry feed to microbial contamination poses significant risks to both poultry and human well-being. To combat these contaminants, antibiotics and growth promoters are commonly used as prevalent additives in poultry feed. However, excessive antibiotic use has resulted in antimicrobial resistance in animals, which is now recognized as a grave global concern. With rising feed prices, the industry is now exploring alternative materials demanding antibiotic-free and organic food and nutrition for poultry, thereby ensuring safe, cost-effective, and quality protein sources for human consumption.

Solution:

CSIR-NCL has developed a specialized and unique probiotic strain formulation, which can be used either independently or in combination with prebiotics as a dietary supplement for poultry birds. This solution is designed to transform organic broiler chicken farming, with a primary focus on enhancing food safety standards. It is intended to enhance growth, improve meat quality, increase egg-laying capacity, foster healthy gut microbiota, and reduce the bioavailability of toxins in chicken. A promising outcome of this solution is a healthier and sustainable future for poultry farming, effectively eliminating the necessity for antibiotics as growth promoters.

Technology Management Group
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Tech Offering:

CSIR-NCL has brought a comprehensive technological package to the table, including:

- **Probiotic bacteria isolation and characterization:** The isolation of pure bacterial culture and in-depth analysis of bacterial properties, ensuring the use of a safe and efficacious strain.
- **Evaluation of pathogenic and hemolytic activities:** A thorough examination of potential harm-causing activities in the probiotic strain.
- **Mycotoxin inhibition:** A significant achievement in the inhibition of various naturally occurring toxins in poultry feed, enhancing safety.
- **Single-strain probiotic and prebiotic formulation:** A formulation that not only bolsters poultry growth rates without the need for antibiotics but also reduces mortality rate.
- **Validated dosage:** A precisely determined dosage of the probiotic ensures optimal efficiency.
- **Optimized, validated, and scaled-up process:** The entire process has been refined, validated, and is now scaled up to 10 liters, ready for larger production.

The Expanding Probiotic Market:

The feed probiotics market is on the upswing, with expectations to grow from $2.9 billion to $5.56 billion between 2023 and 2030, with a compound annual growth rate (CAGR) of 7.5%. This clearly underscores the burgeoning demand for alternatives to conventional additives in the poultry industry.

Value Proposition

The formulation developed by CSIR-NCL offers a multitude of benefits:

- **Antibacterial, antifungal, and mycotoxin detoxifying properties**: This product's inclusion is highly beneficial due to its ability to combat bacteria, fungi, and detoxify naturally occurring toxins in poultry.
- **GRAS classified for poultry supplements**: The developed probiotic is classified under the generally recognized as safe (GRAS) for poultry supplements, underscoring its commitment to safety and reliability.
- **Efficient substitute for synthetic additives:** This solution effectively addresses issues related to antimicrobial resistance without the need for synthetic additives.
- **Enhanced poultry well-being**: This product contributes to improved poultry health, advanced food safety, and accelerated growth.
- **Cost-effective and eco-conscious solution**: It offers an efficient product that aligns seamlessly with the contemporary demands of poultry farming.

Current Status:

The entire process, from inception to implementation, has been carefully optimized, validated, and scaled up to a substantial 10-liter production capacity. This ensures readiness to meet the demands of the poultry industry.

Future perspective:

CSIR-NCL has applied to protect this innovation with national and international patents. As this technology progresses toward regulatory approval and eventual market entry, it offers vast potential in the poultry industry as an antibiotic-free growth promoter for chicken. This initiative highlights the transformative impact of scientific innovation in shaping a healthier and safer food future.

In conclusion, the probiotic strain formulation developed by CSIR-NCL stands as a unique approach for organic poultry farming. It promises a safer, more sustainable, and cost-effective method of raising poultry. Through detailed optimization and validation, CSIR-NCL has paved the way for economical food production considering operational safety in the process. With this innovation, the days of heavy antibiotic use in poultry farming are numbered, and both poultry and consumers can look forward to a healthier, more promising future.

MOUs/ MOAs SIGNED (April to June 2025)

Sr. No.	Client Name	Title of MoU/ MoA	Project Leader
1	Department of Biotechnology (DBT)	National Network Project for National Institute of Immunology	Dr. Chetan Gadgil
2	GMM Pfaudler Limited	To Develop Innovative Solutions for Decarbonizing Indian Pharma and Fine and Specialty Chemicals Sector	Dr. Amol Kulkarni
3	D. Y. Patil College of Engineering & Technology	Research Collaboration	Dr. Ashish Lele
4	Farmlab Yeranda Agrosolutions Producer Company Limited	Educating and Training Farmers to Develop Natural Fertilizers in their Own Farms	Dr. Syed Dastager
5	Tamil Nadu Agricultural University	Moisture Triggered Starch/Nanocellulose based Controlled Release System for the Delivery of Herbicides in Rainfed Ecosystems	Dr. Kadhiravan S.

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)

FACULTY RECOGNITIONS

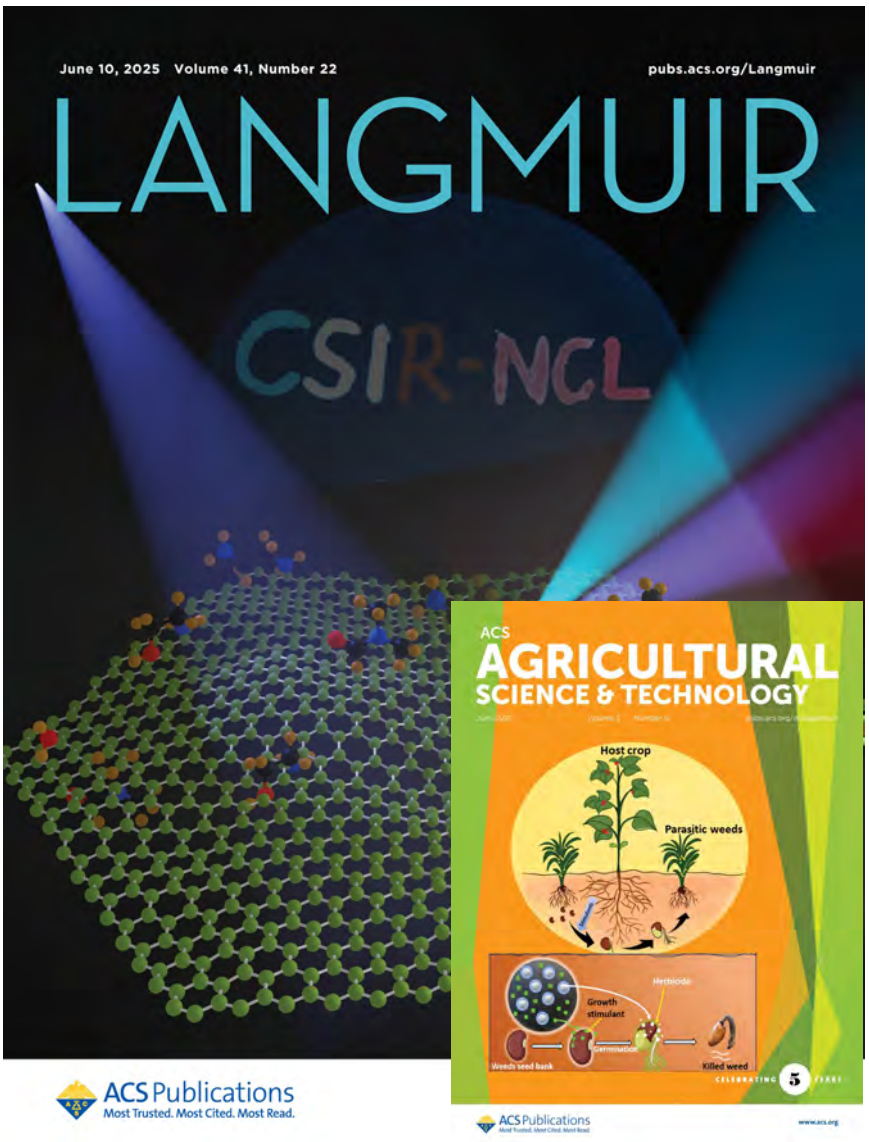
Name of Faculty

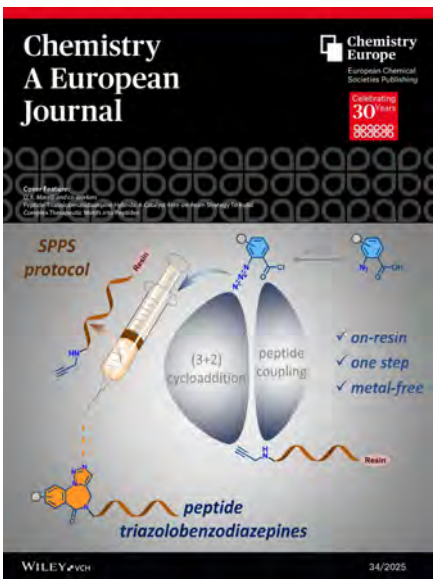
Dr. Kadhiravan Shanmuganathan and his team's research work featured on the cover page of ACS Agricultural Science & Technology (Volume 5, Issue 6, June 2025), a prestigious journal published by the American Chemical Society (ACS).

Dr. Meitram Niraj Luwang and his team's research work featured on the cover page of Langmuir (Volume 41, Issue 22), a prestigious journal published by the American Chemical Society (ACS).

Dr. Udaya Kiran Marelli and his team's research work featured on the cover page of Chemistry-A European Journal (Volume 31, Issue 34), a prestigious journal published by the Chemistry Europe.

Dr. Udaya Kiran Marelli and his team's research work featured on the cover page of Organic Letters (Volume 27, Issue 24), a prestigious journal published by the American Chemical Society (ACS).





INDUSTRY MEETS ACADEMIA: NCL-TEC EXPLORES SUSTAINABLE INNOVATION AT THERMAX LIMITED

On 22 April 2025, students from the Technology & Entrepreneurship Club (NCL-TEC) at CSIR-NCL visited Thermax Limited for a deep dive into industrial applications of clean tech. The visit focused on three pilot-scale facilities showcasing gas purification systems for emission control, green hydrogen production via advanced electrolyser technologies and coal gasification pathways towards clean fuels such as methanol.

Participants toured units where process design meets scale-up challenges: how emission control works in practice, what material, thermal and energy efficiencies matter in hydrogen systems and the potential trade-offs of converting coal into syngas and downstream fuels under low-carbon constraints. Thermodynamic integration, waste heat and strategies to reduce lifecycle emissions formed recurring themes.

The visit provided insights into process design, scale-up challenges and decarbonization strategies. It highlighted the relevance of green hydrogen and low-carbon technologies in industrial sustainability.

Supported by Venture Center and CSIR–NCL, the interaction emphasized the value of industry-academia collaboration in advancing clean technology and equipping students with real-world engineering perspectives.

Ajinkya Krushnatray
(President NCL-TEC)
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Recognizing the need for a skilled and high-quality workforce relevant to current and emergent industries, CSIR-NCL has implemented a Skill Development Program under CSIR's Integrated Skill Development Initiative programs. These specifically designed and expert-led courses have been offered to upskill unemployed graduate and postgraduate students, industry staff and workers, scientists, inventors, etc.

During this quarter, 6 courses were conducted which were attended by 50 participants.

Mass Spectrometry based proteomics (1st April - 30th May, 2025)

This Skill Development Programme workshop provides an introduction to various technologies in proteomics, including peptide mapping, protein identification, characterization of post-translational modifications and quantitative proteomics approaches such as iTRAQ, SILAC, SWATH, MRM and PRM.

Chromatographic Techniques (21st April – 2nd May, 2025)

This course offers comprehensive training on various chromatographic techniques, including High-Performance Liquid Chromatography (HPLC), Gas Chromatography (GC), and Thin-Layer Chromatography (TLC). Participants will gain both theoretical knowledge and hands-on experience in these methods, which are extensively employed in industry and research for the separation, identification, and purification of components in a mixture. By the end of this course, participants will be proficient in deploying these techniques for both qualitative and quantitative analysis of chemical compounds.

Industrial Catalysis (22nd April – 09th May, 2025)

This course provides an in-depth exploration of catalysis, focusing on both homogeneous and heterogeneous catalysts. Participants will gain hands-on experience in catalyst synthesis methods such as impregnation, precipitation, sol-gel, and ion exchange. The course covers catalyst characterization techniques including surface area analysis, X-ray diffraction (XRD), scanning electron microscopy (SEM), and thermal stability assessments. Practical sessions will involve catalytic reactions in both batch and continuous reactors, with product analysis using techniques like Gas Chromatography (GC), High-Performance Liquid Chromatography (HPLC), and GC-Mass Spectrometry (GC-MS). Additionally, the course delves into catalyst deactivation mechanisms and regeneration strategies. By the end of the course, participants will be proficient in catalyst preparation, characterization, and application in industrial catalytic processes.

CAPACITY BUILDING

Synthetic Organic Chemistry (15th May – 30th Aug, 2025)

This comprehensive course immerses students in hands-on training within established research groups, focusing on various organic transformations and the execution of multistep syntheses. The training encompasses meticulous planning, adherence to safety protocols, reaction setup under direct guidance, monitoring of reactions, product isolation and purification, and thorough analysis of the synthesized products. All experimental procedures and analyses are meticulously documented for future reference and reproducibility.

In the initial two weeks, students underwent intensive training in laboratory safety, safe handling practices with laboratory chemicals, literature data mining, analytical data processing, and proper recordkeeping.

Controlled Release of Active Molecules: Hands on Preparation, Characterization and Release Studies of Active Molecules (28th May – 03rd June, 2025)

This intensive workshop focuses on the preparation, characterization, and controlled release of active molecules using advanced techniques. Participants will engage in hands-on training with instruments such as High-Performance Liquid Chromatography (HPLC), Mass Spectrometry (MS), UV-Visible Spectrophotometry, Fourier Transform Infrared (FTIR) Spectroscopy, electrospinning units, and optical microscopes. The course is designed for industry-sponsored candidates, entrepreneurs, and students with backgrounds in science and biotechnology. Upon completion, participants will be equipped with the skills to develop and analyze controlled release systems for applications in consumer goods, agriculture, pharmaceuticals, academia, R&D labs and entrepreneurship.

Surface Characterization Techniques (16th June – 27th June, 2025)

This course offers comprehensive training in advanced surface analytical techniques essential for characterizing materials at the atomic and molecular levels. Participants will gain hands-on experience with instruments such as X-ray Photoelectron Spectroscopy (XPS), Auger Electron Spectroscopy (AES), Scanning Electron Microscopy (SEM), Atomic Force Microscopy (AFM), and Secondary Ion Mass Spectrometry (SIMS). The course covers methods for analyzing surface composition, chemical states, morphology, and topography, providing valuable insights into surface chemistry and functionality. By the end of the course, participants will be proficient in applying these techniques to study and interpret surface properties of various materials.

CSIR START-UP CONCLAVE MUMBAI 2025

The CSIR Start-up Conclave 2025 was held on 20-21 May 2025 at the NESCO Centre, Goregaon (East), Mumbai, jointly organized by three premier CSIR laboratories - CSIR-NCL, CSIR-NIO and CSIR-NEERI, with Venture Center, by CSIR-NCL, serving as the official incubation partner. The event, aligned with the Government of India's ***"Startup India"*** *mission, attracted over 800 participants, including more than 70 CSIR-incubated deep-tech start-ups, investors, industry experts, researchers and policymakers.*

Dr Ashish Lele, Director of CSIR-NCL, underscored NCL's pivotal role by highlighting about the Venture Center - launched in 2006 as India's first deep-tech incubator, dedicated to nurturing start-ups in health tech, clean energy and sustainable industries. The incubator has supported over 1,500 start-ups to date, cementing NCL's leadership in science-based entrepreneurship. Throughout the Conclave, Venture Center's efforts reinforced NCL's commitment to translating lab-scale innovations into scalable, market-ready enterprises.

The Conclave opened with a pre-inaugural registration and welcome session, featuring remarks from Prof. Sunil Kumar Singh (Director, CSIR-NIO), Dr. Ashish Lele (CSIR-NCL) and Dr. S. Venkata Mohan (CSIR-NEERI), culminating in the inauguration by Dr Jitendra Singh (MoS, Science & Technology) and Shri Devendra Fadnavis (Chief Minister of Maharashtra). On Day 2, participant engagement continued with an interactive session led by Hon'ble Deputy Chief Minister Shri Eknath Shinde, followed by a valedictory address from Deputy CM Ajit Pawar.

One of the most dynamic segments was the Pitch Darbar, modeled after *"Shark Tank"*. Here, 14 selected deep-tech start-ups presented their innovations to an investor-panel, gaining critical feedback and visibility. This high-energy pitching session exemplified Venture Centre's role in bridging deep-tech founders with funding networks and accelerating their entrepreneurial trajectories.

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The technical sessions at the CSIR Start-up Conclave 2025 formed the backbone of the event, spotlighting India's strategic innovation domains. Sessions on Marine Robotics and Bio-manufacturing showcased emerging technologies such as autonomous underwater systems and marine biotechnological processes, critical building blocks for advancing India's "Blue Economy". These discussions emphasized how deep-tech innovation in maritime sectors can unlock new economic opportunities and strengthen self-reliance.

In parallel, sessions on Environmental Technologies highlighted CSIR-NEERI's cutting-edge innovations in sustainable engineering and eco-entrepreneurship. Presentations focused on scalable solutions for environmental challenges, including water purification and waste management technologies, emphasizing the increasing importance of entrepreneurship in environmental stewardship.

The Conclave hosted an extensive exhibition featuring over 50 start-ups nurtured by CSIR laboratories and the Venture Center (CSIR-NCL's deep-tech incubation partner). These emerging ventures showcased a wide spectrum of innovations spanning healthcare, diagnostics, sustainability, environmental technologies and advanced materials. The exhibition was made accessible to the public, including students and aspiring entrepreneurs, providing a rare opportunity to engage first-hand with cutting-edge technologies and the minds behind them. This outreach effort served to broaden engagement with the science and innovation ecosystem, bringing visibility not only to CSIR-NCL's incubation achievements but also to its commitment to promoting public awareness.

CSIR PARTICIPATES IN THE 2ND GLOBAL CONCLAVE ON PLASTIC RECYCLING AND SUSTAINABILITY (GCPRS)

The 2nd Global Conclave on Plastic Recycling and Sustainability (GCPRS-2025) was held at Bharat Mandapam, New Delhi, 17-20 June 2025, bringing together more than 250 companies, research organizations and stakeholders from across the globe to showcase innovations in plastic recycling and sustainable technologies. At this international exhibition, the Council of Scientific and Industrial Research (CSIR) presented its mission-mode project on Waste Plastic Depolymerization and Upcycling (DEPOLUP), highlighting cutting-edge solutions to address the pressing challenge of plastic waste management.

DEPOLUP: A Mission Project by CSIR

India generates nearly 20 million tons of plastic waste annually, of which only 15–20% is recycled. The rest ends up in landfills or water bodies, leading to severe environmental impacts. To counter this unsustainable linear model of plastic use, CSIR has launched the DEPOLUP mission, which focuses on four key interventions:

- Segregation and sorting of plastics
- Mechanical recycling into useful products
- Conversion of waste plastics into diesel and downstream processing
- Upcycling into high-value chemicals and materials

Significant progress has been achieved across these domains. At CSIR–NCL, discarded PPE kits (non-woven polypropylene) were decontaminated and successfully transformed into automobile components and agricultural pots, scaled up to 100 kg level and licensed to a start-up. At CSIR–CEERI, an advanced AI–NIR based sorting technology capable of segregating rigid and flexible plastics at 150–200 kg/hour throughput has been developed and integrated with the 1 TPD pyrolysis pilot plant at CSIR–IIP, Dehradun. Notably, the catalyst used in this process has achieved a lifetime enhancement from ~24 hours to ~100 hours, enabling continuous operation and advancing the plant's readiness to TRL-7.

In the downstream processing stream, pyrolysis oils from "plastic-to-oil" units are being refined through hydrotreating, hydrogenation, and hydrodesulfurization (HDS). Promising results have also been obtained in converting plastic-derived naphtha into BTX (benzene, toluene, xylene). In parallel, laboratory studies have demonstrated the upcycling of polyolefins such as polyethylene into long-chain alkenes, waxes, and detergent precursors. Several patents have been filed to secure these innovations.

CSIR Booth at GCPRS-2025

The CSIR booth (Hall 6, Booth B-23) was set up by a multidisciplinary team comprising researchers from CSIR–NCL, CSIR–CEERI (Chennai & Pilani) and CSIR–IIP, Dehradun. Six major exhibits were presented:

- A working model of the AI–NIR plastic sorter by CEERI
- 3D models of the 1 TPD pyrolysis plant
- 3D model of the microwave-assisted pyrolysis system
- Upcycled PP products (automobile parts, pots) from NCL
- Pyrolysis oil samples from NCL's 2 kg reactor
- An electrochemical flow-cell for PVC valorization

These exhibits, supported by detailed posters, attracted significant interest from industry leaders, academia, policymakers, and associations such as AIPMA and ICPE. Dignitaries and representatives from companies including Reliance Industries, ExxonMobil, Godrej and Prag Industries engaged with the CSIR team to explore collaboration and scale-up opportunities.

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Over four days, the CSIR booth facilitated meaningful interactions, networking, and visibility. Industry delegates appreciated the technical depth and commercialization potential of the showcased technologies, particularly the AI-NIR sorter, continuous waste-to-diesel process, and polyolefin upcycling strategies. Several organizations expressed interest in technology transfer and pilot-scale evaluations. Importantly, this marked the first dedicated CSIR booth at an international exhibition on plastic recycling in India, setting a precedent for translating publicly funded research to a global platform. The DEPOLUP mission's participation not only enhanced CSIR's visibility but also underscored its leadership in developing sustainable, science-based solutions for plastic waste management.

THE CHEMICAL CONCLAVE 2.0

On June 24, 2025, Mumbai hosted the Chemical Conclave 2.0, organized by ASSOCHAM Maharashtra State Development Council, under the theme ***"Catalyzing Maharashtra's GDP to a US$1 Trillion Economy."*** *The event brought together industry leaders, policymakers, investors, and academics to discuss the transformative potential of Maharashtra's chemical industry.*

Maharashtra's chemical sector continues to anchor the state's economy, underlining its strategic importance across downstream industries such as automotive, textiles and pharmaceuticals. The state's robust infrastructure and the presence of research powerhouses like CSIR-NCL reinforce its industrial readiness and leadership.

A recurring theme at the conclave was the paradigm shift from regulatory constraints to reform-oriented governance. Dr. P. Anbalagan, Secretary of Industry, highlighted over 500 regulatory reforms, deep decriminalization of civil procedures, and the launch of the Maitri 2.0 single-window clearance system, all designed to streamline compliance and enhance ease of doing business. Praveen Pardeshi, CEO of Maharashtra Institution for Transformation and Chief Economic Advisor to the CM, advocated adopting land recycling models to optimize industrial land use. Meanwhile, Prof. M. Mohan Sharma, Emeritus Professor of Eminence at ICT Mumbai, called for accelerated environmental clearances appropriate for fast-evolving technological demands.

The conclave also saw the unveiling of the ASSOCHAM-EY knowledge report, spotlighting strategic enablers to drive the chemical sector's contribution to the state's trillion-dollar GDP ambition. Sessions addressed vital themes including investment facilitation, quality, safety, and sustainability, industry-academia partnerships and *"Idea-to-Market"* pitch platforms, each mirroring CSIR-NCL's core agenda of deep-tech innovation and translational research. For CSIR-NCL, Chemical Conclave 2.0 reaffirmed its strategic significance within Maharashtra's chemical ecosystem. The laboratory's leadership in specialty chemicals, green chemistry and circular economy research aligns closely with the event's focus on innovation-led industrial transformation.

CHEMEXPO

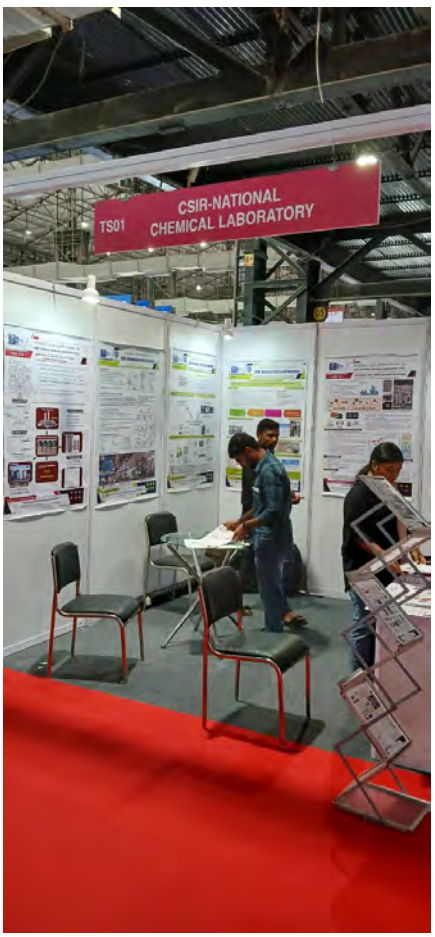
At ChemExpo India 2025, held from 29-30 April at the Bombay Exhibition Centre in Mumbai, CSIR-National Chemical Laboratory (CSIR-NCL), Pune showcased a compelling range of technologies and research initiatives, reflecting its commitment to innovation, sustainability, and industrial collaboration. ChemExpo India serves as a premier platform uniting industry leaders, researchers and technology innovators focused on smart and eco-conscious chemical solutions.

CSIR-NCL spotlighted several breakthrough technologies and processes. A prominent feature was the Continuous Flow Synthesis (CFS) system, ready for licensing, highlighted through dedicated posters. Equally compelling was the Bisphenol-A production process, supported by a physical exhibit and visual display. The Dimethyl Ether (DME) production technology drew attention with its working model, showcasing catalyst and burner components. The NaLi-LSX Zeolite Granule - designed for gas separation, was also featured with practical catalyst samples to demonstrate real-world applications.

Beyond laboratory innovations, CSIR-NCL presented its collaborative initiatives. Posters introduced the Common Research and Technology Development Hub (CRTDH) and its distillation-related R&D projects. The growing field of bio-agrochemicals was also highlighted as a testament to the lab's sustainable agriculture efforts. Visitors could explore both a broad overview of CSIR-NCL's institutional capabilities and a deep dive into its technology portfolio.

CSIR-NCL's engagement at ChemExpo India 2025 was a resounding success, capturing industry interest, reinforcing its scientific leadership and sparking meaningful dialogue on commercialization and collaboration.

CHEMEXPO



AIR FORCE SCHOOL STUDENTS VISIT

On 16 April 2025, thirty-nine Class XII students, accompanied by two teachers, visited the Central Analytical Facility (CAF) at CSIR-National Chemical Laboratory (NCL), Pune, from 10:00 AM to 1:00 PM, with the goal of acquainting them with cutting-edge analytical tools and igniting research curiosity.

Welcomed by Mr. Siddharth Bhosale and the Science Outreach Resource Center, the students were divided into three groups for immersive exposure to a range of advanced instruments: SEM, TEM, XPS, LC-HRMS (Orbitrap), HPLC, GC and GC-MS.

At the microscopy stations, Mr. Rithik Balde showcased SEM, explaining its high resolution and depth-of-field advantages, while Ms. Shreya Patil demonstrated TEM, emphasizing its nanometer-scale imaging capabilities and sample prep challenges. Mr. R. S. Gholap coordinated these sessions. Mr. Nitin B. Dabke introduced the group to XPS for surface chemical analysis, and Ms. Mrudula Apte demonstrated LC-HRMS, using real examples like identifying plant pigments. Ms. Shital Nirgunda detailed the principles and applications of HPLC and Ms. Nikita Tekade brought GC and GC-MS to life, explaining their role in separating volatile compounds and detecting impurities in pharmaceuticals.

The session concluded with Dr. Wafia Masih offering tips to avoid rote learning, presenting CSIR-Jigyasa initiatives and encouraging scientific exploration beyond textbooks. The students left inspired, with a deeper appreciation for how lab-based science powers innovation.

VIKRAM SARABHAI SCIENCE FOUNDATION (VSSF) STUDENTS VISIT

On 12 June 2025, 71 meritorious students (Grades VIII–XII) and 8 teachers from Vikram Sarabhai Science Foundation, Kochi, toured CSIR-National Chemical Laboratory (NCL) as part of their *"National Science Mentoring Programme"*. The visit began with a warm welcome by Dr. Siddharth Bhosale, after which students split into three groups for hands-on lab exposure.

At the National Collection of Industrial Microorganisms (NCIM) facility, led by Sayali Jamdade, Snehal Sangale and Vaishnavi Mahajan, they explored microbial techniques, from isolation and cultivation to PCR, Sanger sequencing, lyophilization and chromatography. Mr. Kiran Nanaware demonstrated RT-PCR, while Ms. Priyanka Bankar covered fermentors and HPLC/GC methods.

In the Molecular Biology lab, Dr. Ashwin NMR introduced strategies to boost crop yield and resist pests, delving into pathways like colchicine biosynthesis in *Gloriosa superba* and sweet potato root development. The Tissue Culture facility, guided by Dr. Kritikumar Kondare, highlighted sterile techniques using potato tissue culture.

At the outreach center, Dr. Wafia Masih showcased CSIR-Jigyasa's opportunities, internships, student projects and lab visits. The visit concluded with an enlightening talk by Dr. K. Krishnamoorthy on energy storage and conversion - especially lithium-ion batteries, sparking lively student interaction. The trip left participants motivated, informed and inspired toward scientific careers.

DR. G. R. VENKITAKRISHNAN
A VISIONARY IN CHEMICAL ENGINEERING

The scientific community mourns the loss of Dr. G. R. Venkitakrishnan, fondly known as GRV, who passed away on June 22, 2025. As the former Head of the Process Development Unit at CSIR-National Chemical Laboratory (NCL), Pune, GRV's contributions to chemical engineering and catalysis have left an indelible mark on India's industrial landscape.

Joining NCL in the early 1980s, GRV recognized the critical need for close collaboration between chemists and chemical engineers in catalyst technology development. In March 1982, he embarked on a pivotal project to explore catalyst development for xylene isomerization, partnering with industry leaders to advance this initiative. The endeavour marked the beginning of a two-decade-long collaboration that led to the successful development and commercialization of several indigenous catalyst technologies. These innovations spanned various processes, including xylene isomerization, toluene disproportionation, ethylbenzene and styrene production, formaldehyde synthesis from methanol and ethylene production from both methanol and ethanol.

Throughout these projects, GRV and his team meticulously handled all engineering aspects, ensuring the seamless translation of laboratory-scale processes to industrial-scale applications. His technical expertise and unwavering commitment were instrumental in NCL's success in these ventures. Beyond his technical acumen, GRV was known for his humility, integrity and collaborative spirit. He created an environment of mutual respect and camaraderie, working harmoniously with colleagues and industry partners alike. His approach to teamwork was characterized by open communication and a shared dedication to excellence.

GRV's legacy extends beyond his professional achievements. He was a mentor and a friend to many, always willing to share his knowledge and experience. His contributions have not only advanced the field of chemical engineering but have also inspired countless individuals to pursue careers in science and technology. As we remember Dr. G. R. Venkitakrishnan, we honor not only his scientific achievements but also the kindness, integrity and humility that defined his life. His legacy lives on through the many technologies that continue to power industries and through the friendships and mentorships he so generously cultivated.

NCL finds Covid traces in city's sewage, levels akin to past build-ups

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Pune: Covid-19 viral presence has been detected across all 30 sewage treatment plants in the city since early May, with wastewater surveillance by CSIR-National Chemical Laboratory (NCL) revealing patterns that resemble the early build-up phases observed before previous surges.

Dr Mahesh S Dharne, scientist and microbiologist at NCL, told **TOI** that while the current rise "appears gradual", the positivity levels in wastewater samples are tracking similarly to patterns seen in the weeks preceding earlier surges, providing valuable early insights into Covid transmission trends. "The first sample turned positive on April 22 from one of the STPs. From May 6 onwards, all STPs are showing positive results for SARS-CoV-2 via RT-PCR," he said.

Wastewater surveillance has emerged as a critical early warning system for tracking community spread of Covid-19, often detecting viral presence days or weeks before clinical cases are reported. The method involves monitoring sewage samples from treatment plants to identify genetic material of the SARS-CoV-2 shed by infected individuals, regardless of if they show symptoms or get tested.

This surveillance technique provides public health officials with real-time insights into infection trends across entire communities, making it particularly valuable for tracking asymptomatic cases and emerging variants. Unlike clinical testing, which depends on individual behaviour and healthcare access, wastewater monitoring captures the collective viral load of entire populations served by specific sewage systems.

MAHA CASUALTY COUNT UP TO 17

- **2 Covid-linked deaths registered in Mumbai Metropolitan Region on Wednesday**
- With this, Maharashtra's tally of Covid-linked casualties went up to 17 since mid-May

4,302 PEOPLE HAVE SO FAR TESTED POSITIVE FOR COVID-19 IN THE CURRENT SURGE ACROSS THE **COUNTRY**

44 PEOPLE HAVE DIED SO FAR

All deaths so far have involved patients with comorbidities and pre-existing medical conditions

- **The current spike in India is suspected to be fueled by emergence of new sub-variants - NB.1.8.1 and 4 cases of LF.7 - of SARS-COV2, the virus that causes Covid-19**
- As of May 2025, WHO classifies LF.7 and NB.1.8 sub-variants as Variants Under Monitoring, not as Variants of Concern or Variants of Interest, govt sources said
- **Govt sources said even in the Covid-19 cases in Singapore and Hong Kong in the past few weeks, the cases are mostly mild, not associated with unusual severity or mortality**

NCL remains the sole institute conducting systematic wastewater surveillance in Pune monitoring all 10 STPs across the city. The laboratory has been successfully tracking previous surges caused by Omicron and its sub-lineages.

Dr Dharne said the current findings emerged from a retrospective analysis triggered by reports of Covid-19 resurgence in Singapore and other countries. "We were collecting samples and storing them. But when we saw news from Singapore, we decided to analyse what the scenario was in Pune," he said.

Weekly testing of samples from the 10 sewage treatment plants shows approximately 40 of the 80 samples returning positive results. The first positive sample was detected on April 22 from a single STP, with all treatment plants showing positive results from May 6.

"The positive samples from April 22 onwards confirmed the virus's presence, though heavy rainfall last month may have diluted the viral load, making it challenging to assess the true extent of the rise. The rain likely affected our samples. But with clearer weather now, this week's data, expected by Friday or Saturday, will provide a clearer picture," he said.

Unlike clinical testing, identifying specific variants in wastewater is complex. Dr Dharne said: "RT-PCR helps us detect viral presence and estimate load, but pinpointing the exact variant is difficult."

The current findings show a pattern worth noting. "What we are observing now is that the viral load patterns are similar to those threshold levels we have seen before surges picked up momentum. This gives us a better opportunity to track trends as they develop," Dr Dharne said, emphasising the value of early detection through wastewater monitoring.

NCL has been informing the sewage surveillance trends to health and IDSP officials, Maharashtra state Covid task force, and National Centre for Disease Control, New Dehli, on a weekly basis for required preparedness.

The sewage surveillance work has been supported by Rockefeller Foundation, USA, under the Four City Surveillance Programme initiated in Aug 2021 in Pune, Hyderabad, Bengaluru and Sonepat. The partners include CSIR-Centre for Cellular and Molecular Biology (CCMB), Tata Institute for Genetics and Society's National Centre for Biological Sciences (TIGS-NCBS), Bengaluru, Ashoka University, Sonipat, and CSIR-NCL, Pune. The programme is mentored by Dr Rakesh Mishra, director, TIGS; Dr LS Shashidhara, NCBS; Dr Vinay Nandicoori CCMB. In Pune, the partner organisation is Pune Knowledge Cluster.

News

सरकारी कार्यालये सौरऊर्जेवर

मुख्यमंत्री देवेंद्र फडणवीस यांची घोषणा; 'सूर्यघर योजना' प्रभावीपणे राबविणार

म. टा. प्रतिनिधी, पुणे

'राज्यातील सर्व प्रमुख सरकारी कार्यालयांमध्ये २०२५ अखेरपर्यंत सौरऊर्जेचा वापर सुरू करण्यात येणार आहे. याद्वारे ऊर्जेची बचत आणि निर्मिती शक्य होणार आहे,' असे मुख्यमंत्री देवेंद्र फडणवीस यांनी रविवारी जाहीर केले. 'पंतप्रधान सूर्यघर योजना राज्यात प्रभावीपणे राबविण्यात येईल,' असे त्यांनी सांगितले.

'महाऊर्जा'च्या (मेडा) नवीन प्रशासकीय इमारतीच्या उद्घाटनप्रसंगी ते बोलत होते. विधान परिषदेच्या उपसभापती डॉ. नीलम गोऱ्हे, विधानसभेचे उपाध्यक्ष अण्णा बनसोडे, अपारंपरिक ऊर्जामंत्री अतुल सावे, खासदार मेधा कुलकर्णी, श्रीरंग बारणे, आमदार उमा खापरे व भीमराव तापकीर, महापालिकेचे आयुक्त नवलकिशोर राम, प्रभारी विभागीय आयुक्त कविता द्विवेदी, जिल्हाधिकारी जितेंद्र डुडी, 'महाऊर्जा'च्या महासंचालक डॉ. कादंबरी बलकवडे, राज्य वीज कंपनीचे संचालक विश्वास पाठक, ऊर्जा दक्षता ब्यूरोचे सचिव मिलिंद देवरे, अतिरिक्त महासंचालक डॉ. त्रिगुण कुलकर्णी उपस्थित होते.

'सूर्यघर योजनेशी संलग्न असलेली राज्याची योजना सुरू करून पहिल्या टप्प्यात १०० युनिटपर्यंतच्या आणि दुसऱ्या टप्प्यात ३०० युनिटपर्यंतच्या सर्व ग्राहकांना सौरऊर्जा पुरवायची आहे. ३०० युनिटपर्यंत विजेचा वापर करणाऱ्या ग्राहकांचे वीज देयक शून्यावर यावे, असा प्रयत्न आहे. ही दोन्ही उद्दिष्टे पूर्ण करण्यासाठी महाऊर्जा चांगले काम करील,' असा विश्वास फडणवीस यांनी व्यक्त केला.

'हरित इमारतीसाठी असलेली सर्व मानके पूर्ण करणारी, ऊर्जेची बचत करणारी आणि आवश्यक ऊर्जा निर्माण करणारी 'महाऊर्जा'ची ही नवी इमारत हरित इमारतीचा उत्तम नमुना आहे. अपारंपरिक ऊर्जेच्या क्षेत्रात महाराष्ट्राने चांगली कामगिरी केली आहे. मागील दोन वर्षांत देशभरात चार लाख कृषिपंप बसाविण्यात आले असताना राज्याने अपारंपरिक ऊर्जेच्या वापराला प्रोत्साहन देऊन पाच लाख सौर कृषिपंप बसविले आहेत. १६ हजार मेगावॉट क्षमतेचे फीडर २०२६पर्यंत सौरऊर्जेवर करण्यात येणार आहेत,' असे फडणवीस यांनी सांगितले.

'महाऊर्जा'च्या (मेडा) नवीन प्रशासकीय इमारतीचे उद्घाटन मुख्यमंत्री देवेंद्र फडणवीस यांच्या हस्ते रविवारी झाले. या वेळी 'मेडा'च्या प्रकल्पांची पाहणी फडणवीस यांनी केली. या वेळी डॉ. नीलम गोऱ्हे, अतुल सावे आणि खासदार मेधा कुलकर्णी उपस्थित होते.

'सौरऊर्जेच्या वापरामुळे विजेचे दर होणार कमी'

'सन २०२६च्या डिसेंबरपर्यंत कृषीची संपूर्ण विजेची मागणी सौरऊर्जेवर परिवर्तित करण्यात येणार आहे. सन २०२५ ते २०३०मध्ये दर वर्षी विजेचे दर आपण कमी करणार आहोत. नुकतेच रशियाच्या सरकारी कंपनीसोबत थोरियमपासून ऊर्जा निर्मितीसाठी करार करण्यात आला असून, यामुळे देशाचे ऊर्जा क्षेत्राचे चित्र बदलेल. या कामांमुळे पर्यावरणाचा विनाश थांबविता येईल आणि सन २०३०पर्यंत ५० टक्के वीज अपारंपरिक ऊर्जा क्षेत्रातून निर्माण करण्याचे ध्येय पूर्ण होईल. सन २०३०पर्यंत राज्यात ५२ टक्के वीज अपारंपरिक स्रोतातून निर्माण होईल,' अशी माहिती देवेंद्र फडणवीस यांनी दिली.

IN News

सर्व शासकीय कार्यालये सौरऊर्जेवर

मुख्यमंत्र्यांची घोषणा; 'महाऊर्जा'च्या नवीन प्रशासकीय इमारतीचे उद्घाटन

पुणे, ता. ८: "राज्यातील सर्व शासकीय कार्यालये यंदा डिसेंबरअखेर सौरऊर्जेवर आणण्यासाठी गती देऊ. प्रधानमंत्री सूर्यघर योजना यशस्वी झाल्याने या योजनेशी पूरक योजना राबविण्याचा राज्य सरकारचा निर्धार आहे. याअंतर्गत पहिल्या टप्प्यात १०० आणि दुसऱ्या टप्प्यात ३०० युनिटपर्यंत वीज वापरणाऱ्या ग्राहकांना सौरऊर्जेवर आणले जाईल," अशी घोषणा मुख्यमंत्री देवेंद्र फडणवीस यांनी केली.

महाराष्ट्र ऊर्जा विकास अभिकरणाच्या (महाऊर्जा) नवीन प्रशासकीय इमारतीचे उद्घाटन करताना ते बोलत होते. यावेळी विधान परिषदेच्या उपसभापती डॉ. नीलम गोऱ्हे, अपारंपरिक ऊर्जामंत्री अतुल सावे, महाऊर्जाच्या महासंचालक डॉ. कादंबरी बलकवडे आणि इतर नेते व अधिकारी उपस्थित होते.

फडणवीस म्हणाले, "हरित इमारतीसाठी असलेली सर्व मानके पूर्ण करणारी, निसर्गाचा पूर्णपणे उपयोग करणारी, ऊर्जेची बचत करणारी आणि आवश्यक असणारी ऊर्जा १०० टक्के निर्माण करणारी महाऊर्जाची ही नवी इमारत हरित इमारतीचा उत्तम नमुना आहे. ऊर्जा बचतीच्या क्षेत्रात आणि अपारंपरिक ऊर्जेच्या क्षेत्रात, महाराष्ट्राने चांगली कामगिरी केली आहे. गेल्या दोन वर्षांत देशभरात चार लाख कृषिपंप बसविण्यात आले. हेच राज्याने अपारंपरिक ऊर्जेच्या वापराला प्रोत्साहन देत पाच लाख सौर कृषिपंप बसविले. मुख्यमंत्री सौर कृषी वाहिनीच्या माध्यमातून १६ हजार मेगावॉट क्षमतेचे फीडर २०२६ पर्यंत सौरऊर्जेवर परिवर्तित करण्यात येणार आहेत."

शासकीय इमारतींमध्ये सौरऊर्जेचा वापर करण्यावर भर असल्याचे सांगताना मुख्यमंत्री फडणवीस यांनी या वर्षी डिसेंबरपर्यंत सर्व शासकीय कार्यालयांना सौर ऊर्जेतून वीजपुरवठा होण्यासाठी कामाला गती आणणार असल्याचे सांगितले. तसेच, तीनशे युनिटपर्यंत वीजवापर असलेल्या ग्राहकांचा वीजबिलाचा खर्च शून्यावर आणण्याचा सरकारचा प्रयत्न असून त्यासाठी आणी लेभ युनिट आणि नंतरच्या टप्प्यात तीनशे युनिटपर्यंत वीजवापर असलेल्या ग्राहकांना सौर ऊर्जेवर आणले जाईल,' असे फडणवीस यांनी सांगितले.

सौरऊर्जेमुळे विजेचे दर कमी करणार

■ "सौरऊर्जा निर्मितीत आपण अग्रेसर आहोत. कुसुम योजनेच्या अंमलबजावणीतही महाराष्ट्र पुढे आहे. २०२६ च्या डिसेंबरपर्यंत कृषी क्षेत्राची विजेची मागणी सौरऊर्जेवर परिवर्तित करता येईल. गेल्या २० वर्षांत दरवर्षी विजेचे दर नऊ टक्क्यांनी वाढत आहेत; पण २०२५ ते २०३० मध्ये दर कमी करणार आहोत," असेही फडणवीस म्हणाले.

पुणे : मुख्यमंत्री देवेंद्र फडणवीस यांनी रविवारी पुण्यात महाराष्ट्र ऊर्जा विकास अभिकरणाच्या (महाऊर्जा) नवीन प्रशासकीय इमारतीतील प्रदर्शन हॉलची पाहणी केली.

मुख्यमंत्री म्हणाले

- प्रधानमंत्री सूर्यघर योजना राज्यात आणखी प्रभावीपणे राबविणार
- राज्यातील ५२ टक्के वीज २०३० पर्यंत अपारंपरिक स्रोतांतून निर्माण करणार
- सौरऊर्जा निर्मितीतील अडचणी दूर करण्यास प्राधान्य
- थोरियमपासून ऊर्जानिर्मितीसाठी रशियन शासकीय कंपनीसोबत महत्त्वाचा करार, ऊर्जा क्षेत्रात क्रांतिकारक बदल घडविणार
- ऊर्जा निर्मितीतील बदल पर्यावरण संरक्षणालाही चालना देणारा ठरणार

CSIR- National Chemical Laboratory

Eco-efficient & Autocatalytic Process for the Manufacturing of Tributyl Citrate (TBC)

- CSIR-NCL has developed an auto-catalytic and patented process for manufacturing Tributyl Citrate (TBC) (CAS No. 77-94-1) — a biodegradable and non-phthalate plasticizer
- TBC is a safe and versatile alternative to conventional phthalates, widely used in toys, medical devices, printing inks, coatings, and cosmetics.
- Developed through an innovative reactive distillation process using citric acid and butanol as raw materials. This technology ensures high purity, efficiency, and sustainability.
- The process has been validated at laboratory scale and is available for licensing or co-development with industry partners.

Technology Available For Licensing/ Co-development

BACKGROUND

- Organic esters are key intermediates in chemical and pharmaceutical industries. TBC stands out for its versatility, safety, and performance, finding wide use in cosmetics, personal care, coatings, and plastic formulations.
- Traditionally made by esterifying citric acid with alcohol, TBC production faces issues like acidic catalysts, corrosion, and by-products.
- Our patented auto-catalytic process overcomes these challenges, delivering high purity, minimal waste, and lower operational costs in an eco-efficient way.

TECHNOLOGY OFFERING

- Auto-catalytic process
- Based on Reactive distillation
- No separation step required
- Raw material: Citric acid
- Purity: >95 % & Yield: >85 %
- Product: Colorless
- Optimized process

CURRENT STATUS

- Lab scale (5 L Demonstration/TRL 4).
- This technology is available for licensing and co-development.

TBC MARKET

TBC Market Revenue was valued at USD 1.2 billion in 2024 and is estimated to reach USD 1.8 billion by 2033, growing at a CAGR of 5.0% from 2026 to 2033.

(https://www.verifiedmarketreports.com/product/tributyl-citrate-market/)

VALUE PROPOSITION

- Patent protected process
- Reactive distillation-based process
- Auto-catalytic & cost-effective process
- No catalyst required
- Eco-friendly
- Water is the only discharge
- No separation step needed

APPLICATIONS

- A non-toxic plasticizer in toys, medical products, printing ink, coatings, pharmaceuticals, cosmetics, flavours and fragrances
- Used for granulation of non-toxic PVC
- TBC is a biocompatible substitutes for phthalic acid esters

IP: IN337784, WO2017085745, US 10604472

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Compiled and Published by
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CSIR-NCL
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