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The Innovation Engine of India

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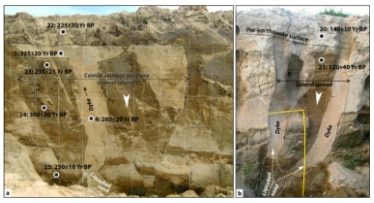

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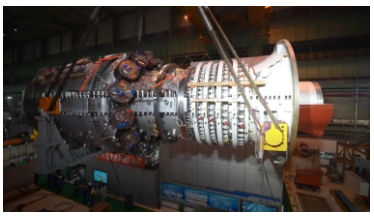

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Editorial

Science Communication and Dissemination Directorate (SCDD) of the Council of Scientific and Industrial Research (CSIR) plays a pivotal role in communicating scientific research and innovation of its constituent labs to a wider audience. In addition to coordinating CSIR's science communication initiatives, the Division also manages and curates CSIR's official social media platforms, ensuring that research outcomes, innovations and institutional milestones reach diverse audiences in a timely and accessible manner.

CSIR's network of 37 national laboratories continuously develops high-impact technologies and scientific solutions with significant relevance to industry, society, and sustainable development. However, the complexity of scientific language often limits the wider dissemination of these achievements beyond the research community. To bridge this gap between laboratories and the public, SCDD, CSIR has initiated this quarterly magazine "CSIR TechConncect".

The quarterly magazine is conceived as a platform to present selected high-impact CSIR technologies and research outcomes in a simplified, engaging and story-driven format. Each issue will highlight innovations that matter, explaining the science behind them in a manner that is easy to understand while retaining their scientific essence. Through these narratives, the magazine aims to showcase how CSIR's research translates into real-world impact.

We hope that this initiative will be well received by readers across backgrounds, including students, researchers, scientists, industry stakeholders and the general public. By making science more accessible and relatable, this magazine aspires to foster greater scientific awareness, curiosity and appreciation for indigenous research and innovation.

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Image Source: www.pexels.com

The Paracetamol Breakthrough: India's Leap Toward Smarter Pharma

Your go-to fever pill just got a high-tech makeover.

A smarter, sustainable process is putting India at the forefront of pharma innovation.

Paracetamol, also known as acetaminophen, is found in nearly every household medicine cabinet. Often taken as a painkiller and fever reducer, it is the most widely used medicine all over the world. Though it is useful for us, its conventional manufacturing has certain adverse impact on the environment. Further, the raw materials used to produce it are classified as 'controlled substances' in India, most of which have to be imported from other countries. As a result, the production cost increases significantly. In a remarkable breakthrough that blends process chemistry with national self-reliance, scientists of National Chemical Laboratory (CSIR-NCL), Pune have discovered a continuous, cheaper, and environmentally friendly process to produce paracetamol.

The problem with the old way

Traditionally, paracetamol is produced in batch mode using two key raw materials: Para-Aminophenol (PAP) and Acetic Anhydride. This is a widespread method that has some limita-tions. Imagine a wedding caterer making a signature dish. They cook a specific quantity, like curry for 50 people, as one "batch," then repeat the process for remaining guests in multiple batches. Akin to this, paracetamol is traditionally manufactured by “batch” methodology. This batch method can result in inconsistent quality, higher raw material consumption, larger manufac-turing footprints, and the generation of wastewater and chemical effluents. Worse still, it often depends on expensive and regulated raw materials like acetic anhydride, which raise both safety and cost concerns.

CSIR-NCL's breakthrough

To tackle such challenges, CSIR-NCL launched a project under the umbrella of "INPROTICS" mission (Innovative Processes and Technologies for Indian Pharmaceuticals and Agrochemical Sector Industries). The aim of this mission was to find smarter, greener, and more scalable solutions for chemical and pharmaceutical industries of India. By 2018-2020, researchers in CSIR-NCL had successfully developed a continuous process (Continuous flow technology) for synthesizing Paracetamol. Imagine replacing the batch manufacturing method with a smooth, uninterrupted manufacturing line, a system where the raw materials flow in and finished medicine flows out, with precision and control at every step. That is what a continuous flow technology offers, a streamlined operation, improved product quality, and greater efficiency. The key to the innovation lies in a multi-functional reactor that enables the continuous reaction of para. amino phenol with readily available, relatively safer and cheaper chemical, Acetic Acid. The lab focused on optimizing every aspect such as temperature, reaction speed, purification methods, and more.

Cleaner, Greener, Smarter Medicine

The continuous production method for Paracetamol is not only a technical breakthrough but also a major step forward in sustainability. Unlike traditional batch processes, this method offers greater control, that ensures each dose consistently meets strict pharmaceutical standards. It uses significantly less solvent, a liquid that helps chemicals mix and react, much like water helps blend spices and ingredients when cooking a curry. Using less of it means fewer chemical leftovers (called effluents), which leads to lower water pollution and less energy needed for clean-up. The process is designed to be compact, minimizing the physical footprint of manufacturing plants and cutting down on infrastructure costs. By relying on affordable and easily sourced raw materials like acetic acid instead of the hazardous and regulated acetic anhydride, it also reduces manu-facturing expenses and regulatory burdens. In short, India now has the ability to produce Paracetamol with the same chemical composition as the traditional batch method, but in a way that is cheaper to make, safer to produce, and significantly better for the environment.

Make in India Product

CSIR-NCL teamed up with Texol Engineering in Pune to build a pilot plant to validate the continuous Paracetamol production process in real-world conditions and generate commercial-grade sample batches. The pilot plant proved a great success that set the stage for industrial-scale deployment of Paracetamol. In February 2020, Hyderabad-based Satya Deeptha Pharmaceuticals Limited (SDPL) stepped in and collaborated with CSIR-NCL to take the innovation forward. This collective effort led to the creation of a state-of-the-art commercial Paracetamol manufacturing facility in Humnabad, Karnataka. This is the first-of-its-kind in India, officially inaugurated in 2024 and boasts an impressive annual production capacity of 2,800 tons. This success is more than a technological triumph. It is a clear validation of national policies like "Make in India", "Innovate in India", and Import Substitution. It also reflects CSIR's larger mission to align cutting-edge science with everyday needs. In the global context, India is one of the largest consumers and exporters of generic medicines. Technologies like this will help the country to reduce depen-dency on imports, strengthen pharmaceutical sovereignty, and open doors for similar innova-tions across other essential drugs.

A Model for the Future

The CSIR-NCL Paracetamol project is now being praised as a first-of-its-kind success story. This is a kind of project where deep science was translated into industrial transformation in a short timeframe. The model could be applied to other generic drugs that India produces. It also sets a precedent for how public research institutions can work hand-in-hand with industry to deliver impact at scale.

Paracetamol may seem like just another everyday medicine, but behind its simplicity lies a quiet revolution assisted by CSIR. It's a story where cutting-edge science combines with sustainable innovation, and where industrial progress fuels national self-reliance. With this breakthrough, India steps forward to reshaping how medicine is produced. So the next time you take a paracetamol, this would be a gentle reminder that it's not only relieving pain, it may also be a product of smarter, greener, and proudly Indian science.

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The 20-Minute Smart Solution to Potholes

Image Source: https://www.omag.org/news/2024/11/potholes-how-they-form-and-how-they-can-be-prevented

At the heart of Delhi's Secretariat Road, road workers poured a mix into a pothole that promised to change how India repairs its streets forever. Within just 20 minutes, the repaired stretch was ready for vehicles again. This wasn't magic, it was ECOFIX, an innovative pothole repair technology developed by the CSIR–Central Road Research Institute (CSIR–CRRI).

The live demonstration, conducted by the Public Works Department (PWD), showcased the technology's efficiency even in the toughest conditions. Both dry and waterlogged potholes were repaired instantly, no dewatering, no heavy machinery, and no waiting. For Delhi's commuters, it was a glimpse of what smoother, smarter, and more sustainable roads could look like.

Turning Steel Waste into Sustainable Roads

Developed by CSIR–CRRI in collaboration with Ramuka Global Services Pvt. Ltd., a DPIIT-recognized startup, ECOFIX is a ready-to-use cold mix made from processed steel slag, a by-product of the steel industry. Each tonne of steel produced generates nearly 200 kilograms of slag waste, which often ends up in landfills. By converting this waste into a durable repair material, ECOFIX merges science, sustainability, and speed.

"The use of processed industrial waste not only makes the solution cost-effective and long-lasting but also promotes environmental sustainability by reducing dependence on natural aggregates," said Dr. Satish Pandey, Senior Principal Scientist at CSIR–CRRI and the inventor of ECOFIX.

The mix combines processed slag aggregates with a special polymeric binder, giving it excellent cohesion, water resistance, and shelf life. It can be applied directly at ambient temperature, even in waterlogged potholes, without any heating or tack coating making it a true all-weather, low-emission solution.

CSIR delegation led by DG-CSIR, Dr. N. Kalaiselvi meets Hon'ble CM, Andhra Pradesh, N. Chandrababu Naidu.

Delhi Leads the Way

Shri Parvesh Verma, Hon'ble Minister, PWD, Delhi, hailed the technology as a turning point for urban infrastructure. "Providing citizens with better, safer, and pothole-free roads is our top priority. The successful trial of ECOFIX will help us carry out timely and durable repairs ahead of the monsoon season," he told The New Indian Express.

He added, "This isn't just about fixing potholes, it's about reinforcing public trust. Delhi is rapidly moving toward smart and sustainable infrastructure." The success of the Delhi trials inspired other states to adopt the technology for their own road networks.

Andhra Pradesh Embraces ECOFIX

Under the leadership of Hon'ble CM, Shri N. Chandrababu Naidu, the Government of Andhra Pradesh has partnered with CSIR–CRRI to implement ECOFIX across the state's road network.

A live demonstration in Amaravati, attended by Minister for Roads & Buildings Shri Janardhan Reddy, showcased the technology's performance under real field conditions. The demonstration followed a meeting between CSIR's Director General

Live Demonstration by CSIR-CRRI team in presence of Minister Shri Janardhan Reddy

Live demonstration of the technology in front of Dr. Shalini Rajneesh, Chief Secretary, Government of Karnataka

Dr. N. Kalaiselvi and the Chief Minister, where she briefed the state leadership on CSIR's research initiatives, including the ECOFIX technology for sustainable road maintenance.

Andhra Pradesh has also ensured the local availability of steel slag, with Rashtriya Ispat Nigam Limited (RINL) and Arjas Steel Plant collaborating with CSIR–CRRI for processing slag into roadworthy aggregates. With approximately 2 million tonnes of slag generated annually, and an additional legacy stockpile of 2–3 million tonnes, the state has ample raw material to support large-scale deployment.

Karnataka Accelerates Adoption

Following Delhi and Andhra Pradesh, Karnataka has emerged as an early adopter of ECOFIX. In a groundbreaking step toward sustainable infrastructure, Karnataka unveiled a promising solution for eco-friendly road maintenance using the steel slag–based ECOFIX technology. Chief Secretary Dr. Shalini Rajneesh, joined by PWD Chief Engineer H. Suresh and Belagavi Mayor Savita Kamble, witnessed a successful demonstration of this innovative pothole repair method on State Highway-141 (Rakskoppa–Sutagatti). The demonstration showcased the instant repair of a waterlogged pothole without dewatering. Traffic resumed seamlessly after the quick fix, highlighting the efficiency and sustainability of the ECOFIX mix.

CSIR-CRRI Officials during a meeting at the CM office, AP.

In April 2025, the state government signed a tri-party agreement between CSIR–CRRI, the Public Works Department and Urban Development Department, and Ramuka Global Services Pvt. Ltd. to scale up deployment across the state, marking a major step toward greener and more resilient road infrastructure.

A pilot project conducted on State Highway-265 demonstrated exceptional results, paving the way for statewide implementation. ECOFIX will be produced locally in collaboration with JSW, Ballari, ensuring easy availability and efficient logistics. The initiative is set to make pothole repair a faster, more sustainable, and cost-effective technique for the state's road network, simplifying transport and on-site application for maintenance teams.

Assam Joins the Movement

In the northeast, Assam the state government has signed MoUs with CSIR-CRRI to adopt ECOFIX for its own roads. A successful trial in Guwahati was followed by planned deployments in Dibrugarh, Jorhat, Tezpur, and Silchar.

ECOFIX's biggest advantage, its ability to repair even waterlogged potholes without dewatering makes it ideal for Assam's heavy monsoon conditions. PWD officials say the technology could transform maintenance practices, especially during the rainy season when hot-mix plants cannot operate. The cold-application method will save time, cut emissions, and reduce reliance on bitumen heating.

Cleaner Roads, Greener Future

Since ECOFIX requires no heating of aggregates or bitumen, it significantly reduces energy use and greenhouse gas emissions by up to 30% compared to conventional hot-mix repair methods. The innovation also conserves natural resources by replacing quarried aggregates with processed industrial slag.

A retired PWD engineer told The Sentinel, "Potholes usually worsen during rains, and conventional systems require the surface to dry before repairs. ECOFIX's instant patching ability, even in standing water, is a potential game-changer for India's roads."

A National Movement in the Making

What started as a single demonstration in Delhi has evolved into a nationwide movement for resilient and eco-friendly roads. ECOFIX is now being piloted or adopted in Karnataka, Delhi, Gujarat, Jharkhand, Maharashtra, Assam, and Andhra Pradesh, and has even found international use in Chicago, USA.

As India invests in greener infrastructure, CSIR–CRRI's ECOFIX technology exemplifies scientific innovation serving public good, a smart, sustainable, and scalable solution that's reshaping the country's approach to road maintenance, one pothole at a time.

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Decoding Ancient Earthquakes Using Sand and Light

Every earthquake leaves behind more than just cracks on the ground or damaged buildings. A few meters beneath the surface, the Earth keeps silent records of these events — in layers of sand that once moved during the shaking by earthquakes.

Recently, scientists from the CSIR–National Geophysical Research Institute (NGRI), Hyderabad, along with collaborators from IPR, Gandhinagar, PRL Ahmedabad, IUAC, New Delhi, and IIT Gandhinagar, have discovered how to decipher these ancient records (doi.org/10.1016/j.epsl.2025.119578). The study, authored by A.K. Tyagi, D. Kumar, M.K. Murari, R.N. Singh, and A.K. Singhvi, focuses on sand dykes — strange, finger-like formations of sand generated beneath the ground when powerful earthquakes shake water-soaked layers below. By studying these formations and applying a light-based technique known as luminescence dating, the researchers have found a new way to tell when ancient earthquakes struck — helping unlock the seismic secrets buried beneath our feet.

How Earthquakes Create Sand Dykes

When the ground shakes violently, it doesn't just move sideways or up and down. In places where the soil is loose and full of water, something interesting happens. The shaking causes the wet sand to lose its strength and act like a fluid — a process known as liquefaction.

During liquefaction, the water-saturated sand is squeezed and pushed upward through cracks in the layers above it. Once the shaking ceases, the water drains away, leaving behind thin, vertical layers of clean sand within the cracks. Over time, these buried vertical layers consolidate and become sand dykes.

A New Way to Tell Earthquake Time

Traditionally, scientists have used radiocarbon dating to bracket the age of past earthquakes by studying bits of organic material trapped in soil layers. But this approach has limitations because such material isn't always available or is commonly affected by reworking.

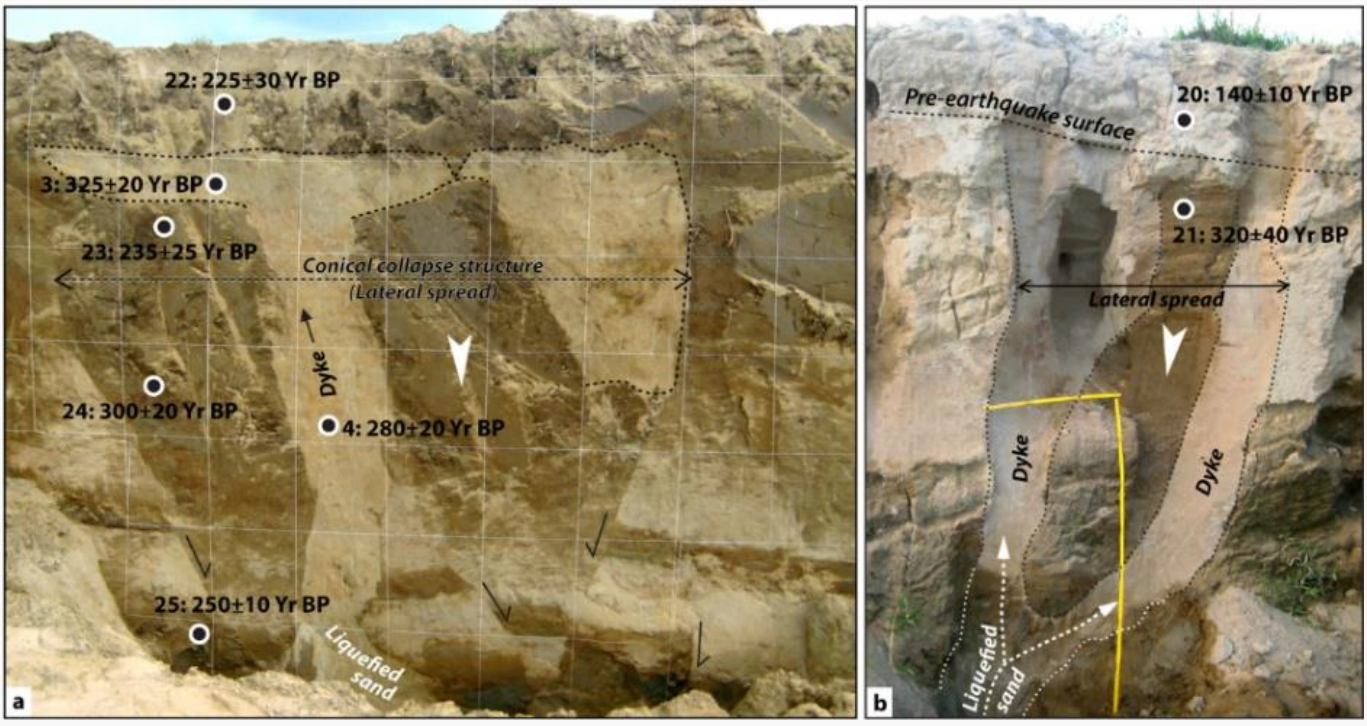
The new study utilizes a technique called Optically Stimulated Luminescence (OSL) dating. This method relies on certain minerals in sand, mainly quartz and feldspar, which can store small amounts of energy from natural radiation present in the surrounding soil and rocks. Over long periods, this energy slowly builds up within the crystal structure of these minerals. The stored energy is termed as luminescence signal.

When the minerals are suddenly exposed to heat or sunlight, the stored energy is released, and the natural "clock" inside them is reset. After this, they start collecting energy again at a steady rate. By measuring the amount of energy now stored inside these mineral grains, scientists can estimate how much time has passed since the last reset — revealing when the causative geological event, such as the formation of a seismogenic sand dyke, occurred.

How Heat Resets the Clock

The researchers proposed that during the formation of a sand dyke, as the sandy fluid rushes through narrow cracks, the sand grains rub against each other intensely. This friction creates heat, similar to how rubbing your hands together warms them up.

Their calculations showed that the temperature inside these moving sediments could rise to 350–450°C — enough to erase any previously stored luminescence signal in the quartz grains. When



View of about 0.5 to 1m thick sand dyke observed at Namgaon village in the Nagaon district of Assam (Credit: https://www.ngri.res.in/research/paleo-seismology.php)

the sand cools, the grains start accumulating energy again, beginning a new timing cycle.

To test this idea, the scientists collected sand samples from dykes in northeastern India, a region known for frequent earthquakes. They carried out laboratory experiments to measure how quartz grains responded to heat. The tests confirmed that the grains became more sensitive after being heated beyond 350°C, showing that the dyke sand had indeed experienced such temperatures during its formation.

Afterward, the team used OSL dating to measure how much energy the quartz grains had built up since they were last heated. This allowed them to determine the approximate ages of the earthquakes that created the dykes. The results pointed to three major seismic events — one about 300 years ago, another around 1,000 years ago, and one over 1,500 years old.

Importance of this finding

This new approach provides a direct way to date earthquakes by analyzing the sand itself, rather than relying on external materials. It gives scientists a more accurate timeline of when large quakes occurred in a region.

Understanding the history of earthquakes is an essential part of paleoseismology, the science of studying past seismic events. It helps researchers estimate how often earthquakes happen and identify regions that may face higher risks in the future. Such knowledge plays a key role in improving earthquake hazard assessments, building design standards, and disaster preparedness. The method also fills an important gap in earthquake research. While radiocarbon dating works well for organic remains, OSL dating directly connects the age measurement to the earthquake event itself — the moment when the sand dyke formed.

Reading Earth's Past Through Sand

Each sand dyke is like a silent record — a reminder of how the Earth once moved. By studying these structures carefully, scientists are learning to interpret the signs of ancient earthquakes that occurred long before humans could record them.

The new luminescence-based method adds an important page to this story. It shows that even the smallest grains of sand can hold valuable information about our planet's dynamic history and help us prepare for its future movements.

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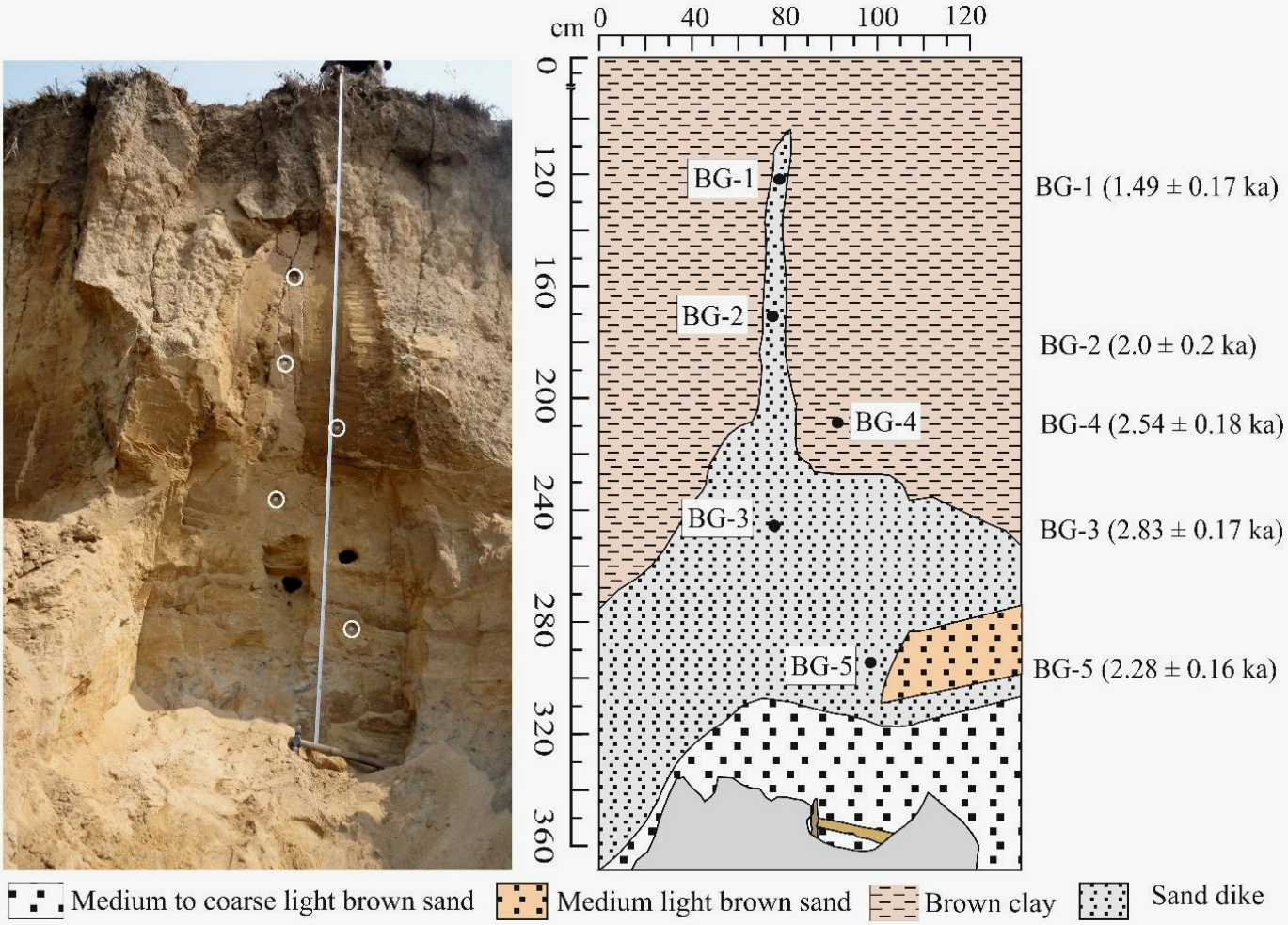
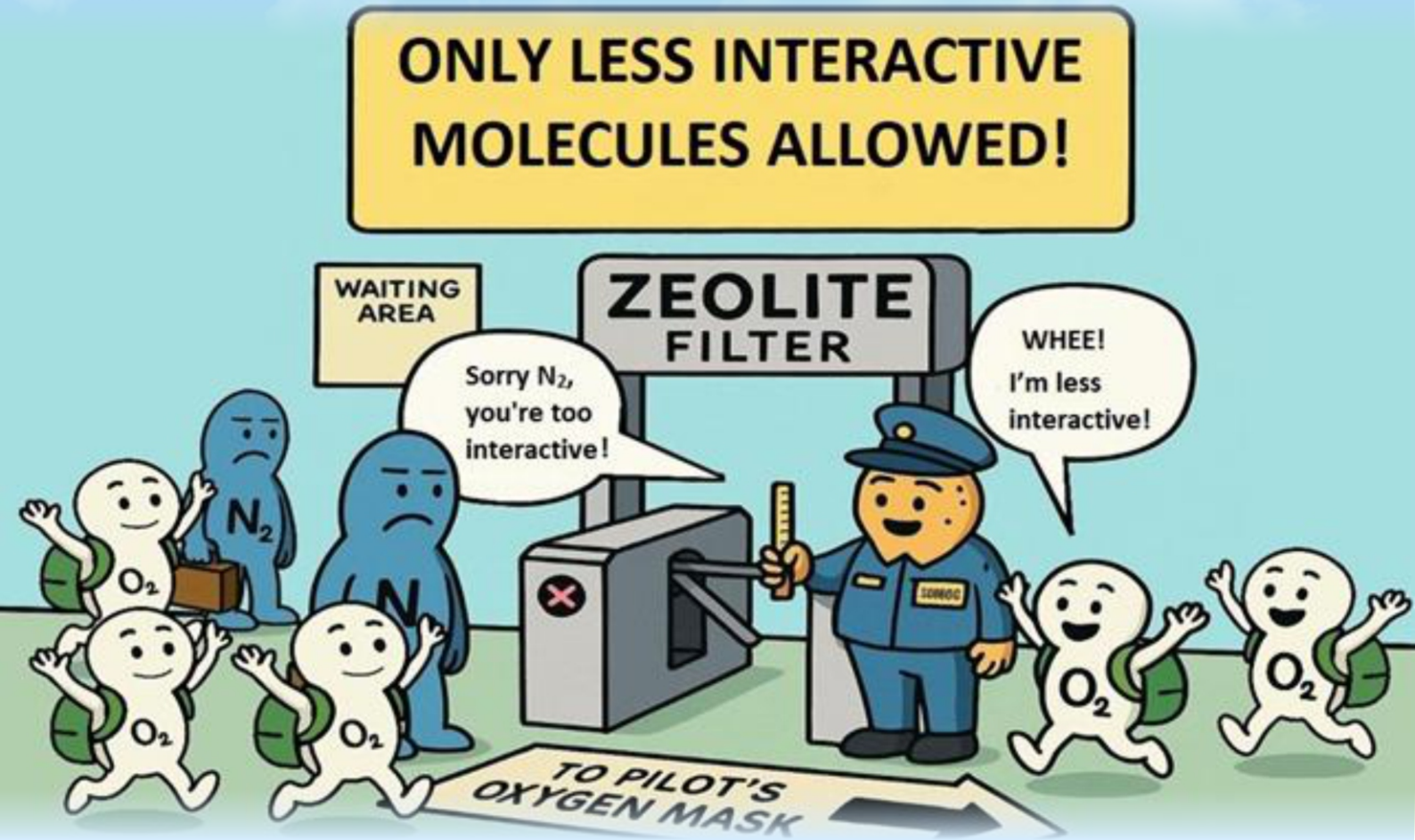


Field photograph and corresponding stratigraphic profile of the Beltaghat sampling site -1, samples from different sedimentary units are labelled with age (Ref: doi.org/10.1016/j.epsl.2025.119578)

Oxygen Boost for the Skies: Reviving Zeolites in MiG-29 Jets



Inside a MiG-29, survival depends on molecules and materials. Now, rejuvenated zeolites are rewriting aviation safety.

At 35,000 feet high above the Earth's surface, the air is much thinner than at the ground to support human life. Luckily, passengers inside commercial aircrafts do not suffocate at that height because air is pumped into the cabin and the air pressure is maintained.

However, fighter jets like Mig-29 fly as high as 50,000 feet. At that altitude, the level of breathable oxygen is low, and air pressure is also extremely low. Pilots of fighter jets depend on a critical life-support system called the On-Board Oxygen Generation System (OBOGS). This system generates breathable oxygen in real time, ensuring that pilots remain alert and safe during high-altitude flight and extreme maneuvers.
At the heart of the OBOGS lies a fascinating material that makes this possible—Zeolites.

Zeolites: The Microscopic Gatekeepers

Zeolites are crystalline materials filled with micro and nanoscale pores—so they can separate gases based on molecular interaction. They act like filters, selectively adsorbing nitrogen while allowing less adsorptive oxygen molecules to pass through.

When air passes through the OBOGS system in the aircraft, the zeolites trap nitrogen molecules due to higher molecular interaction and allow the less interactive oxygen molecules to flow freely. This excellent filtering allows the system to deliver oxygen rich air to the pilot. This selective behavior makes zeolites incredibly valuable in air purification and gas separation.

Image Source: https://theprint.in/defence/flying-mig-21-is-a-tradition-for-the-varthamans-dad-flew-it-son-abhinandan-flies-it/199933/

The Problem: Degradation in Efficiency of Zeolite

While zeolites are highly effective, they don't function forever. With prolonged use, wear and tear and moisture accumulate on the surface. As a result, zeolites become less effective, leading to a noticeable drop in efficiency. The pores get clogged, their performance drops, and they no longer adsorb nitrogen efficiently. As a result, oxygen output from the OBOGS declines—posing a serious risk during missions.

Zeolite Rejuvenation Technology

The Council of Scientific and Industrial Research-National Chemical Laboratory (CSIR-NCL) has stepped in with a game-changing zeolite rejuvenation solution.

Scientists at CSIR-NCL have developed a new class of zeolites called Li-LSX (Lithium-exchanged Low Silica X). These specialized materials have enhanced adsorption capacity and can be regenerated to restore performance. In trials, the Li-LSX zeolite delivered oxygen with up to 94% purity.

When performance drops, the zeolites are treated with rejuvenation process to release the trapped gases/moisture etc. Once cleared, the zeolites are as good as new—ready to filter again. Think of it like washing and reusing a high-performance sponge or a coffee filter.

CSIR-NCL has successfully rejuvenated over 5 kg of used zeolites from a MiG-29 OBOGS unit. Post-rejuvenation, oxygen output jumped from 30% to 85%, enabling safe high-altitude operations once again. This effort has now scaled up to rejuvenate over 100 kg of zeolites, ensuring the readiness of multiple aircraft.

Broader Impact: Beyond the Cockpit

This innovation doesn't just benefit fighter pilots. The rejuvenation technology has far-reaching applications, including spacecrafts, submarines, remote medical facilities, especially in rural or disaster-hit areas, industrial oxygen generators and so on.

Moreover, by eliminating the need to carry oxygen cylinders, this system reduces aircraft weight, improving fuel efficiency and lowering carbon emissions.

Science Serving the Skies and Beyond

The zeolite rejuvenation technology developed by CSIR-NCL is a powerful example of how materials science can enhance operational safety, sustainability, and strategic capabilities. By extending the life of vital components and ensuring uninterrupted oxygen supply at high altitudes, this breakthrough strengthens India's self-reliance in aerospace technology.

With applications that stretch from fighter jets to remote hospitals, this innovation highlights translation of cutting-edge research into real-world impact.

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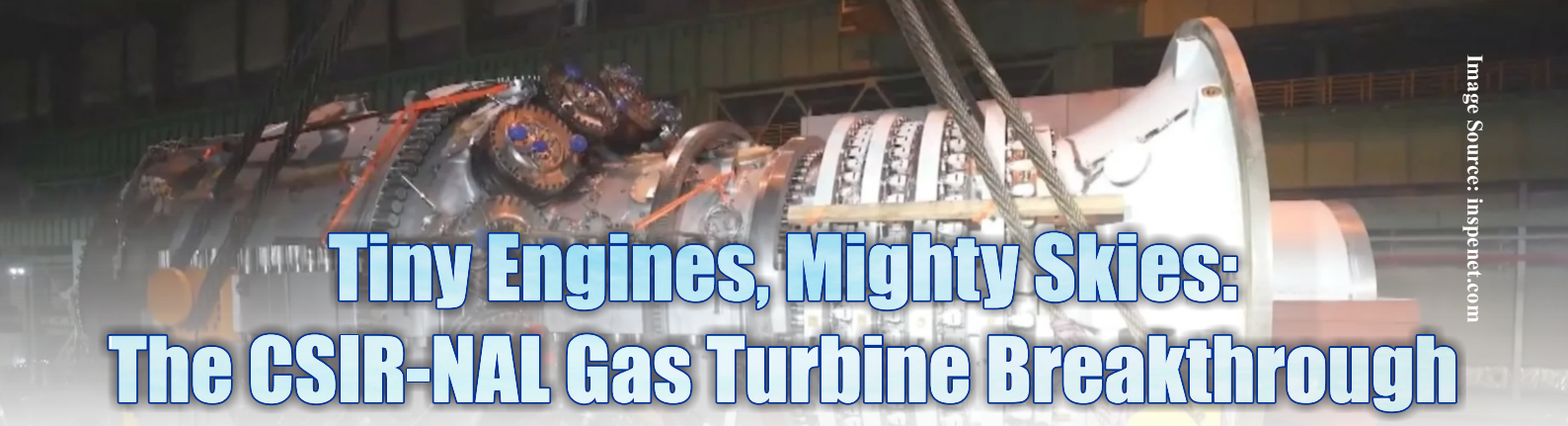


Image Source: inspenet.com

Tiny Engines, Mighty Skies: The CSIR-NAL Gas Turbine Breakthrough

India's aerospace ambitions are taking flight with a quiet revolution in miniature propulsion. CSIR-NAL's indigenously developed small gas turbine engines are compact, powerful, and marking a bold step toward true self-reliance in advanced aerospace technology.

India's aerospace ambitions are taking flight with a quiet revolution in miniature propulsion. CSIR-NAL's indigenously developed small gas turbine engines are compact, powerful, and marking a bold step toward true self-reliance in advanced aerospace technology.

Imagine a tiny engine, small enough to hold in your hands, spinning 250 times faster than the blades of a ceiling fan, and so powerful that they can lift small drones and even guide precision missiles. This is the world of small gas turbines, a high-tech marvel that until recently, India relied on other countries to provide. But now, scientists at CSIR-National Aerospace Laboratories (CSIR-NAL) have changed the game, developing these miniature powerhouses right here in India.

A small gas turbine is a mini version of a jet engine that works just like the ones on airplanes, it compresses air, mixes it with fuel, burns it, and pushes the hot gases out to create thrust. These engines are much smaller and lighter, producing anywhere from a few dozen to up to a thousand newtons (N) of thrust. They run on aviation-grade kerosene like Jet-A1 fuel, known for its high energy and reliability. Even though they can fit in your hands, they spin at around 1,00,000 rotations per minute (RPM), making them complex to design and a real test of precision engineering.

Development of the Micro/Small Gas Turbine Engine

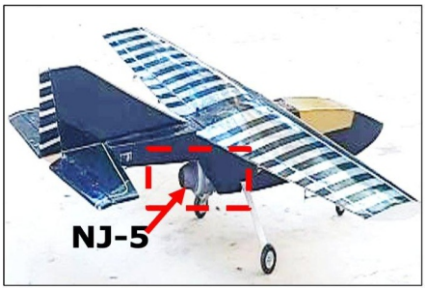
One of the early milestones in India was the development of the engine called NJ-5. This micro gas turbine engine was developed by CSIR-NAL as a technology demonstrator. This achievement, though small in thrust, is significant in demonstrating core competencies: high-speed turbomachinery, micro-scale compressor and turbine design, combustor miniaturisation, bearings/lubrication in extreme RPM regimes, and system integration within compact volumes.

Building on the NJ-5 foundation, CSIR-NAL has developed the next-generation engine, the NJ-100, which pushes thrust to

NJ-5 small gas turbine engines

approximately 1000 N, which is enough force to lift an object weighing around 100 kilograms, like a motorbike, straight off the ground. Its design focuses on having a high thrust-to-weight ratio, compact design, and fuel efficiency, making it suitable for both agile and long-endurance missions.

The NJ-100 is CSIR-NAL's next-generation small gas turbine engine in the mid-range class between micro unmanned aerial vehicle (UAV) engines and larger turbojets. It is aimed at tactical UAVs, loitering munitions, and compact cruise missiles, offering an indigenous alternative to imported engines. Its development demonstrates India's growing capability in high-RPM turbomachinery, miniaturized combustion systems, and integrated propulsion solutions, paving the way for domestic production, system integration, and potential export opportunities in the aerospace and defence sectors.



NJ-5 small gas turbine engine integrated UAV platform

Economic/Industrial Impact

Developing small gas turbine engines helps boost India's aerospace supply chain by advancing precision manufacturing, control systems, testing, and engineering capabilities. It also is set to reduce import dependency. It opens opportunities for exporting defence and aerospace hardware, contributing to defence diplomacy and technology leadership in the region. Beyond defence, these engines can be used in small power generators, remote energy units, and educational training systems.

Propelling into the Future

The NJ-100 marks more than just a leap in propulsion, it signals India's steady rise as a designer and manufacturer of advanced aerospace systems. By mastering technologies once considered out of reach, CSIR-NAL has given India the power to build engines that can drive its own defence ambitions. Compact, efficient, and home-grown, the NJ-100 has built a strong foundation for building more advanced propulsion systems in the future. It is a quiet revolution, one that turns self-reliance from a slogan into a spinning, roaring reality.

NJ-100 small gas turbine engine

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Energy from the Lampshade: Light that Works Overtime

What if the lamp on your table could power your gadgets too? Indoor light is quietly becoming the next clean energy source.

Walk into your living room, turn on the light, and you're not just illuminating your room, you might be contributing to store energy for the future. We are used to thinking of solar energy as something that happens only outside where sunlight hits rooftop solar panels, and it converts the sunlight into usable electricity. But what if we told you that the light already illuminating your room could also power your gadgets? Step into the world of indoor light harvesting, a promising, eco-friendly technology that's set to energize everything from smart thermostats to health trackers, all by soaking energy from the lights already around us.

Indoor Light Harvesting

Unlike traditional solar panels that works in sunlight, indoor light harvesters are built to function under artificial lighting like LEDs, fluorescents, and even old-school bulbs. The key is specialized photovoltaic materials that are tuned for converting low-intensity, diffuse light into electricity. These devices don't need direct sunshine to function but a gentle glow is enough. Dye-sensitized solar cells (DSCs) are among the most promising cost effective and sustainable technology that could be engineered to work efficiently for indoor light harvesting. Some of these materials can even be printed onto thin, flexible surfaces or blended seamlessly into everyday objects like furniture and walls.

Tiny Devices, Big Potential

The beauty of indoor light harvesting lies in its simplicity and scale. Many modern electronic devices require only tiny amounts of energy, especially those in the Internet of Things (IoT). We're talking about motion sensors, wireless tags, smart watches, digital thermometers, and even some hearing aids.

Imagine a TV remote that charges itself while sitting on the coffee table, or a sensor in a factory that never needs a battery change. These scenarios aren't science fiction, they're already in development or on the market.

By eliminating the need for frequent battery replacements, indoor light harvesting also reduces electronic waste, a growing global concern. It's a small change with a big environmental impact.

Image credit: https://www.niist.res.in/centre-sustainable-energy-technologies-focus-areas

How does it work?

Indoor light harvesters use special materials that are similar in concept to the ones found in outdoor solar panels to absorb light and convert it into energy. At its core, the process is simple, light hits a solar cell, which converts it into electricity that's either stored or used to power a device. To handle the low-light environment indoors, researchers pair these solar cells with smart power management circuits that store every bit of energy in micro-batteries or supercapacitors. It's like saving coins in a piggy bank and using them only when needed.

Is it popular?

You might wonder if indoor light harvesting is so clever/efficient, why isn't it everywhere already? Until recently, the timing wasn't right. Now, three key trends have changed, the rapid rise of IoT devices, the widespread use of LED lighting, and major advances in solar technology. Together, they've made it practical to power everyday gadgets using the light already around us. Indoor light harvesting is no longer just a good idea but it's becoming a real solution.

Challenges to Overcome

Of course, it's not perfect, yet! One big challenge is making sure these tiny solar cells can keep working for years. Indoor conditions are gentler than the outdoors (no rain, dust, or extreme heat), but the cells can still wear out over time. Some materials don't handle humidity well. Others lose their performance slowly after long hours of light exposure.

Researchers are working on this by designing better, more stable materials and improving how the cells are protected or packaged. The good news is that the small size of indoor devices makes this easier than, say, building a solar farm in the desert.

Another hurdle is cost. Some of the best-performing materials are still expensive to make. But with more demand, prices are expected to drop, just like they did for regular solar panels over the past two decades.

Looking Ahead

The future of indoor light harvesting is bright, with smarter materials and real-world applications becoming a reality. Companies are testing ultra-thin solar strips embedded in smart packaging and even transparent solar films for windows. Researchers all over the world are already pushing boundaries.

In India, Council of Scientific and Industrial Research (CSIR) labs are leading this progress. Scientists at CSIR-National Institute for Interdisciplinary Science and Technology (NIIST) recently set an indoor light efficiency record of 40% using DSCs employing indigenously developed organic dyes combined with nature-friendly and earth-abundant copper-based redox electrolytes, offering a sustainable alternative to single-use batteries. In a significant step towards commercialization, NIIST has also developed the necessary scale-up fabrication equipments in-house. The team has successfully demonstrated self-powered temperature/humidity sensor prototypes operating entirely on ambient indoor light, with ongoing field trials currently underway at the Thiruvananthapuram International Airport.

Globally, researchers are developing indoor solar cells that could be built into furniture, packaging, or walls. As devices require less power, indoor light becomes a practical and sustainable energy source that powers our everyday tech without wires or waste.

Final Thought

Light is everywhere, glowing from your lamps, screens, and overhead bulbs. What used to be wasted energy is now a resource. Indoor light harvesting may not power your fridge or your car. But for the countless small devices that surround us, it offers a future where energy is always available, battery changes can become a thing of the past, and sustainability can be built into the very walls of our homes. Indoor light harvesting is a small change. But like many small changes, it could make a big difference.

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Reinforcing India's Infrastructure: Threaded Rebar Anchors

From skyscrapers to seismic zones, stronger connections matter. CSIR-SERC's threaded rebar anchor is rewriting the rules of construction.

Image Credit: www.sntp.in

Reinforced concrete, a strong building material made by combining concrete and steel, is the backbone of modern construction, used in buildings, bridges, metro systems, foundations, industrial plants, and dams. Its strength comes from combining concrete, which resists compression, with bars reinforced with sreel called rebars, which handle tension. Despite years of engineering improvements, one problem has remained: crowding of rebars, especially at joints which are crucial for transferring loads and absorbing earth-quake forces. This is called reinforcement congestion. Traditionally, workers bend the ends of rebars into hooks or loops to anchor them in concrete. While this works, it takes up space, makes placement harder, slows construction, and increases labour. In high-rise buildings or heavily loaded structures, these challenges become even bigger.

CSIR-SERC's threaded end anchor (Head-T)

To address this issue, the CSIR-Structural Engineering Research Centre (CSIR-SERC) in Chennai has developed an indigenous Threaded End Anchor system for rebars that meet IS 1786:2008 standards. Called Head-T, this system removes the need to bend bar ends. Instead, rebars are threaded at the ends during fabrication and can be screwed directly into specially designed anchor heads. This reduces manual work and eliminates the need for extra anchorage length, which was previously achieved by bending. The biggest advantage is a significant reduction in reinforcement congestion, making it easier to place, align, and tie rebars in dense sections. In earthquake-prone areas, where beam-column joints are vital, this innovation improves safety and simplifies construction.

Construction benefits and seismic performance

The Head-T system does more than just make installation easier. By removing bent bar ends, it frees up space at joints, allowing for better concrete placement and compaction. This is important for structural strength, especially in areas that experience high stress and repeated loads during earthquakes. Threaded rebars also make assembly more precise and consistent, reducing dependence on the skill level of on-site workers. Time-consuming bending work is eliminated, which speeds up construction and lowers labour costs. These benefits make Head-T particularly useful for large-scale projects, where delays and variations in quality can be costly and risky.

Validation: Laboratory investigations and full-scales joint tests

The team, led by Dr. V. Srinivas and Dr. Saptarshi Sasmal, Chief Scientists of CSIR-SERC have comprehensively conducted investigations on threaded rebars to ensure the anchors do not weaken the steel or affect its flexibility. They also tested full-scale beam-column joints of a multi-storey building under reverse cyclic loading, which simulates earthquake forces. The results showed that Head-T anchors can offer very promising performance in terms of strain capacity, energy dissipation, and perform as well as or better than traditional anchorage methods.

Deployment flexibility: Sizes and head geometries for Indian practice

The system is also very adaptable. It has been designed for different rebar diameters commonly used in India. Two types of anchor heads, square and circular, have been developed to suit different needs, strength requirements, and construction practices. This flexibility means Head-T can be used in various structures, from buildings and bridges to dams, foundations, retaining walls, and even nuclear facilities.

National relevance: Make in India and self-reliance

Head-T also aligns with national priorities. By creating an indigenous alternative to imported anchorage systems, CSIR-SERC supports the Make in India initiative and the country's goal of self-reliance in construction technology. Using locally made solutions reduces costs, speeds up project execution, and ensures critical components are available without relying on foreign supply chains. According to Dr. N. Anandavalli, Director of CSIR-SERC, the technology is ready for industry adoption.

Global context: International precedents and India-specific design

Threaded anchorage concepts have been explored in other countries, especially in high-seismic and high-rise construction markets like the US, Japan, Germany, and China. What sets Head-T apart is that it is the first system designed specifically for Indian reinforcement standards, construction conditions, and seismic requirements. Instead of adapting costly imported systems meant for foreign codes (needs performance tests before use to validate for the Indian Standard requirements for adaptability), CSIR-SERC created a fully indigenous solution that fits Indian rebar specifications (IS 1786:2008), local fabrication practices, and project needs. In that sense, the global idea has been transformed into a made-in-India innovation with its own research base, testing data, and deployment readiness, marking a significant technological milestone rather than an imitation.

Bridging research and practice

What makes Head-T truly significant is how it connects research and practical use. It addresses a long-standing problem in concrete construction without changing standard practices, offering a solution that is both better and easier to use. For construction professionals and infrastructure developers, solutions like Head-T can be game-changers. It represents a new chapter in rebar anchorage that is timely, practical, and made in India. By tackling reinforcement congestion and improving seismic performance, Head-T has the potential to shape the way India builds its future: stronger, smarter, and more self-reliant.

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India's Exotic Flower Revolution

From tulips in the Himalayas to Eustoma blooms in Odisha, CSIR scientists are bringing exotic flowers home to Indian soil. What once thrived only in distant lands now blossoms across India — turning science into beauty, and beauty into opportunity for farmers.

India is a land of endless variety — from snow-covered mountains to golden deserts, from lush valleys to the sea-lined coasts. With such diverse landscapes and climates, our country is home to countless kinds of flowers that colour every season. Yet, some blooms have always remained out of reach — exotic flowers that flourish only in faraway lands with cooler air or gentler sunshine.

These rare flowers, much loved for their beauty and value, are often imported to meet growing demand. But that story is changing. Across India, scientists of the Council of Scientific and Industrial Research (CSIR) have been quietly working to make these delicate blossoms feel at home in Indian soil. Through years of research and patient trials, they have turned what once seemed impossible into a living, blooming reality. From the tulip fields of Himachal Pradesh to the Eustoma blooms of Odisha, their efforts are helping India grow its own share of the world's most exquisite flowers, and giving farmers a new reason to smile.

Tulip Garden at CSIR-IHBT Palampur, Himachal Pradesh

Tulips in the Himalayas: A Garden of Dreams

Nestled in the serene hills of Palampur, Himachal Pradesh, the CSIR-Institute of Himalayan Bioresource Technology (CSIR-IHBT) has turned a scientific experiment into a breathtaking spectacle. Under the CSIR-Floriculture Mission, the institute has been cultivating tulips — one of the world's most popular cut flowers — right on its campus.

On February 2, 2024, the institute opened its colourful Tulip Garden to the public. Inaugurated by Dr. Sudesh Kumar Yadav, Director of CSIR-IHBT, the garden dazzled visitors with 50,000 tulip bulbs of six vibrant varieties. From deep red to sunshine yellow, the garden was a painter's palette come alive in the lap of the Dhauladhar mountains. The response was overwhelming. In 2024, more than 70,000 visitors came to witness this floral wonder; the numbers are expected to rise even higher in the coming years.

But behind the beauty lies a serious scientific mission. Tulips, native to cooler climates, are a major export commodity. Globally, they rank third in the cut-flower trade; yet, India has long relied on imported bulbs. To change that, CSIR-IHBT started experimental trials in the Lahaul valley, a region whose climate closely matches tulip-growing regions abroad.

Soon, local farmers joined in. Societies like Yaani Mahadev Floriculture Society (Madagran), Pattan Valley Floriculture Society (Shansha), and Tinan White Mountain Floriculture Society (Jangla) were trained to cultivate tulips for both bulbs and flowers. Today, these farmers are earning profits while proudly displaying their vibrant fields.

Dr. Yadav and his team envision a self-reliant future where India no longer needs to import tulip bulbs. The institute plans to produce enough tulip bulbs to meet India's domestic demand over the next 7–8 years, moving the country toward self-reliance. With such success, the IHBT tulip garden has also become a centre for scientific tourism, blending beauty with biotechnology and making the hills bloom with opportunity

Eustoma in Odisha: A New Bloom of Hope

Far away from the snow-kissed peaks, in the warm plains of Sambalpur, Odisha, another CSIR lab has created floral history. For the first time, the exotic North American flower Eustoma — known for its rose-like elegance and long shelf life — has bloomed in Odisha's soil.

The achievement belongs to CSIR-National Botanical Research Institute (CSIR-NBRI), Lucknow, which supplied 2,000 seedlings to the Green Sanatanpali

Farmer Producer Organisation (FPO). Among its members was 25-year-old Itish Pradhan, a young farmer who left his job at a steel plant to chase a dream in floriculture.

The FPO was provided a polyhouse along with planting materials of Eustoma through the CSIR Floriculture Mission. Shri Dharmendra Pradhan, Honourable Union Minister of Education, Government of India, inaugurated the polyhouse and planted the first Eustoma. Further on, Itish experimented the Eustoma cultivation under the guidance of scientists from CSIR-NBRI, Lucknow. Speaking to ETV Bharat, he said, "I was not very sure if such an exotic flower could survive here. But I got so much help and guidance, which included information on the importance of controlled temperature and hard work, that I succeeded." In just four months, his hard work paid off — he harvested the first 35 beautiful Eustoma flowers in shades of pink, purple, and white.

The flowers fetched an impressive price of up to `1,500 per bunch in export markets. With minimal investment and scientific support, Itish's experiment became a success story that inspired other farmers.

Eustoma's appeal goes far beyond its beauty. It thrives in temperatures between 16°C and 28°C, ideal for controlled cultivation. According to CSIR-NBRI, it can be harvested twice a year, yielding profits of up to `2 lakh per acre. Dr. Ajit Kumar Shasany, Director of CSIR-NBRI, told The Hindu, "This initiative not only creates new opportunities for farmers but also introduces high-value exotic flowers to Indian markets."

When the first blooms appeared, Shri Dharmendra Pradhan, Honourable Union Minister of Education, shared the images on social media, calling it "A first-ever bloom of the exotic and high value Eustoma in the state, these flowers have a huge demand in the floriculture industry globally." With moral support and encouragement from district officials, including the District Magistrate of Sambalpur, Siddheshwar Baliram Bondar, plans were soon announced for seven more polyhouses dedicated to Eustoma cultivation in the nearby Jujumura block — a step towards turning Sanatanpali into a hub of flower farming.

Eustoma's success proves that India's varied climate can support even the most delicate exotic species. CSIR-NBRI scientists now plan to extend this initiative to other districts like Koraput, training more farmers in temperature control, disease management, and marketing.

Alongside Eustoma, CSIR-NBRI is also promoting flowers such as marigold, jasmine, gerbera, tuberose, gladiolus, and lotus across its network of 400 farmer clusters nationwide.

Blooming Beyond Beauty

By connecting Himalayan farmers with tulip trade networks and empowering young entrepreneurs in Odisha with exotic floriculture, CSIR is paving the way for a new green economy. These flowers symbolize innovation, sustainability, and hope — blooming proof that when science meets soil, miracles happen.

As visitors walk through the tulip beds of Palampur or see the pastel petals of Eustoma in Sambalpur, they are not just admiring flowers — they are witnessing the flowering of India's scientific spirit.

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Light Metal, Heavy Impact: The Al-Mg-Sc Alloy Revolution by CSIR-NIIST

Your go-to fever pill just got a high-tech makeover.
A smarter, sustainable process is putting India at the forefront of pharma innovation.

Imagine a metal so light that it can shave kilograms off a rocket, yet keeping it strong enough to survive the violent vibrations and searing heat of a space launch. This is not science fiction but the reality being shaped by scientists at the CSIR-National Institute for Interdisciplinary Science and Technology (CSIR-NIIST). Their work on aluminium-magnesium-scandium (Al-Mg-Sc) alloys is opening new doors for India's space and aerospace missions, helping the country move closer to complete materials self-reliance.

What Makes the Alloy Special

At its core, the Al-Mg-Sc alloy is a smart mix of three elements: aluminium, magnesium, and scandium. Aluminium provides a light but sturdy base, magnesium helps reduce weight even further, and scandium, the rarest and most expensive of the three, transforms the alloy into a super-metal. Even a small pinch of scandium refines the metal's internal grain structure, dramatically improving its strength, flexibility, and resistance to cracking or fatigue. It also makes the alloy easier to weld, a crucial property when building the complex structures of satellites, launch vehicles, or aircraft.

What Spacecrafts are Usually Made of

Most rockets and spacecraft today are built primarily from aluminium and titanium alloys, chosen for their light weight, strength, and resistance to heat. For example, launch vehicle bodies, fuel tanks, and satellite frames often use high-strength aluminium-lithium or aluminium-copper alloys, while titanium is used in sections that face extreme heat or stress. These metals have served well for decades, but engineers everywhere are constantly searching for lighter, stronger alternatives that can improve payload efficiency and cut launch costs.

A Global Alloy, Now Made in India

The Al-Mg-Sc alloy represents one of these advanced materials, not entirely new to the world, but new to India's manufacturing ecosystem. It has been developed and used abroad in select aircraft and space systems, mainly in Russia and Europe, where scandium additions gave aluminium alloys superior strength and weldability. What's new is that CSIR-NIIST has begun developing this alloy indigenously, adapting it for India's own aerospace needs. This step means that high-performance materials once imported at high cost can now be produced at home, giving India a lighter, stronger, and truly homegrown alloy for its next generation of space missions and aircrafts.

Engineering Self-Reliance in the Skies

CSIR-NIIST's work fits into India's broader effort to design and manufacture critical aerospace materials domestically. The institute has a long history of developing advanced alloys for the automotive and defence sectors, and now it is applying that expertise to the skies and beyond. This alloy provides 4-5% weight savings without demanding design changes in the component geometry. These developments mark an important shift, from simply assembling imported components to mastering the science behind them.

Building Strength Beyond Space

The impact of this breakthrough goes far beyond rockets and satellites. Developing indigenous alloys strengthens India's manufacturing base by advancing metallurgical research, precision casting, and high-temperature processing. It means engineers, foundries, and designers across the country can work with materials that were once considered too complex or costly to produce locally. It also opens export opportunities, allowing India to offer not just spacecraft and engines but the very materials that power them.

The Promise for Future Missions

For the space sector, the benefits are immediate and tangible. A launch vehicle built with Al-Mg-Sc alloy components can carry more payload for the same amount of fuel or achieve the same payload with less fuel, making missions cheaper and more efficient. Structures made of this alloy can endure multiple thermal cycles and stresses without failure, critical for reusable or long-duration missions. It's a material that quite literally gives wings, or rather thrust, to India's ambitions in space.

A Step Toward True Self-Reliance

In the bigger picture, this effort is about more than metallurgy. It's about transforming India into a country that not only dreams of space but builds every nut and bolt needed to get there. The Al-Mg-Sc alloy from CSIR-NIIST is a quiet but powerful step in that direction, a shining example of how scientific precision and national vision can come together to create technology that is light in weight but heavy in impact.

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A Hot Invention: Leather that keeps you Cool

What if leather could beat the heat instead of trapping it? A new "cool leather" invention is turning that irony into innovation.

Leather has always carried an aura of strength and luxury. Be it rugged jackets or stylish boots, leather items are prized for its durability and timeless appeal. Yet there has always been a catch that leather functions best in the cold. In warm and tropical climates, where heat and humidity rule most months of the year, leather clothing becomes uncomfortable, even impractical. It is a paradox that has shaped global trade for centuries: countries in tropical and desert regions have traditionally produced leather, while colder regions consumed it.

A team of scientists from India and Egypt has now set out to rewrite that script. In a collaborative project spanning CSIR–Central Leather Research Institute (CSIR-CLRI) in Chennai and the Desert Research Centre in Cairo, researchers have developed a "cool leather" that defies leather's conventional thermoregulation behaviour. Their innovation uses smart materials and an unexpected ingredient like industrial leather waste.

Smart Materials that Keep their Cool

The breakthrough revolves around phase change materials (PCMs), substances capable of absorbing, storing, and releasing heat during transitions like melting or solidifying. PCMs are widely used in advanced building materials, smart textiles, telecommunications, and micro-processors, but applying them to leather is a first.

The team used n-Eicosane, a paraffin-based PCM with a melting point close to human body temperature (36–38°C). This allows the material to absorb excess heat from the body, buffering the wearer against rising temperatures.

Turning Leather Waste into a Cooling Solution

However, incorporating PCMs directly into leather is not straightforward. PCMs tend to leak or lose shape when they melt. To solve this problem, the scientists created a carrier material: micro- and mesoporous (materials with tiny holes on the surface) activated carbon, produced by converting leather trimmings from tanneries. This waste that is usually discarded, was carbonised, chemically activated, purified, and turned into a highly porous black powder with a large surface area. The n-Eicosane was infused into this porous carbon structure, creating a stable composite that holds its shape and retains the PCM during use.

Testing the Cool Factor

The composite was spray-coated onto leather using a binder, creating a thin and uniform layer of PCM-infused carbon. When tested, the treated leather showed remarkable thermoregulation properties, maintaining temperatures up to 3–9°C lower than conventional leather surfaces. On a hot day, this difference can transform leather from a heat trap into a comfortable wearable.

The research also reveals a strongly symbolic connection. India and Egypt, two ancient civilizations with deep histories in leather and craftsmanship, have come together to tackle a modern challenge: climate resilience.

Beyond Fashion: Many Ways to Stay Cool

The implications stretch beyond clothing. Temperature-adaptive leather could make its way into automotive interiors, where seats exposed to direct sunlight often become uncomfortably hot. It could also be used in furniture, protective gear for workers in high-heat environments, and even outdoor equipment. With automotive manufacturers increasingly focused on energy-efficient materials, the potential is enormous. Interestingly, the PCM concept can work in the opposite direction as well. In extremely cold climates, leather equipped with suitable PCMs can release stored heat, staying warm at sub-zero temperatures. Such upholstery could remain comfortable even in a car parked at -40°C without switching on heaters immediately.

A Sustainable Step for the Leather Industry

The concept is therefore climate-adaptive in both directions, a material that responds intelligently to its environment. For an industry constantly under scrutiny for environmental impact, this innovation adds another layer of relevance. By using leather waste to create smart composites, the process not only reduces trash but also upcycles it into a high-value product. This aligns with global pushes for circular and upcycled economies, turning waste into opportunity.

Crafting the Future of Leather

The future of leather may not entirely be "cool," but it is certainly becoming smarter. As global temperatures rise and sustainability becomes central to fashion and manufacturing, climate-adaptive materials like this could usher in a new era where leather is not bound by climate, geography, or tradition. By reinventing a centuries-old material with cutting-edge material science, the India–Egypt collaboration has opened an unexpected chapter: leather that plays it cool in the hottest parts of the world.

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From Waste to Watts: CSIR's Holistic Lithium Recovery

Image Credit: blog.wika.com

From safely dismantling spent cells to recovering >99% pure battery metals, CSIR's process redefines how India mines its critical materials. This indigenous, low-waste technology is set to feed future giga-factories and push India toward sustainable electric mobility.

Your old phone battery may soon power India's clean-energy future. CSIR's lithium-recovery technology is redefining waste—not as trash, but as a national resource.

Imagine a future where every discarded smartphone battery or defunct EV cell becomes a treasure trove of critical minerals instead of an environmental burden. That future is already taking shape in India, where scientists from the Council of Scientific and Industrial Research (CSIR) have developed a pioneering green technology to extract lithium and other valuable metals from used batteries. This initiative, driven by CSIR–National Metallurgical Laboratory (CSIR-NML), Jamshedpur, is setting the stage for a sustainable battery-recycling ecosystem, one that can fuel India's growing clean-energy ambitions while cutting dependence on imports.

The Lithium Imperative

Lithium is the lifeblood of modern energy storage. From mobile phones and laptops to electric vehicles and renewable power grids, lithium-ion batteries (LIBs) form the backbone of today's electrified world. However, India imports nearly all its lithium in the form of compounds or finished batteries, making the supply chain vulnerable to geopolitical and market fluctuations.

Mining Batteries, Not the Earth

Traditional lithium extraction involves mining spodumene ores or evaporating lithium-rich brines, processes that are slow, water-intensive, and environmentally taxing. CSIR's holistic recovery technology, in contrast, turns waste batteries into raw materials for new battery making and other critical/strategic applications using a sustainable, closed-loop approach.

At CSIR-NML, researchers first discharge then dismantle spent lithium-ion batteries and separate the black mass, a fine powder containing lithium, cobalt, nickel, and manganese oxides. The dismantling setup is uniquely designed to ensure minimal contamination of Fe, Cu and Al fractions, which hitherto causes separation issues in downstream processing. This black mass is then processed using acid leaching, a technique that employs cheap and easily available reagents . The process recovers up to 97% lithium and other metals inclusive of recyclable graphite, yielding battery-grade purity exceeding 99% with high yield and recycling of reagents The process has been designed to tackle any genera of lithium based batteries, including LFPs.

A Sustainable Step Toward Circular Economy

This innovation aligns perfectly with India's vision of a "circular economy", where materials are continually reused, reducing environmental impact and import dependence. Instead of sending used batteries to landfills or exporting them for recycling, CSIR's process keeps value within the country, and ensures its application in second life battery manufacturing.

By localising the recovery of critical elements, India can drastically reduce costs in manufacturing lithium-ion cells, a key goal under the National Mission on Transformative Mobility and Battery Storage. Moreover, such holistic recycling technologies open up a new industrial segment: urban mining, extracting valuable resources from discarded electronics and batteries rather than from the Earth.

CSIR's method offers another critical advantage: scalability. The pilot facility established at CSIR-NML has demonstrated technical feasibility, and efforts are now underway to partner with public- and private-sector industries to deploy the process on a commercial scale. The process has been currently transferred to few recyclers in India, and is gearing up to expand its footprints across India and globally. This could enable India to establish its own network of recycling plants that feed directly into domestic giga-factories, ensuring material availability for electric-vehicle and energy-storage sectors.

How New Is This Technology?

Globally, most lithium-recovery processes involve high-temperature furnaces that result in loss of lithium and nickel are energy-intensive and environmentally taxing. Other demerits in the existing processes is their limitation to single chemistries of lithium-ion batteries (LIBs), loss of lithium during processing of LFPs, separation by precipitation yielding less purity metal salts (not suitable for battery making). What makes CSIR's approach distinctive is its recyclable reagents, low temperatures, and minimal waste generation to achieve high recovery yields. In India, this marks the first indigenous development of a complete eco-friendly lithium and other critical metals recovery cycle, from dismantling to purification.

From Waste Bin to Power Grid

In the grander view, this development is more than a metallurgical milestone. It embodies a national vision, where every battery that once powered a phone or an EV finds a new life powering the clean-energy revolution. With CSIR's holistic critical metals extraction technology, India is proving that sustainability and innovation can go hand in hand. It's a quiet revolution, one that begins not in a mine, but in a recycling plant, turning yesterday's waste into tomorrow's watts.

Battery Recycling Pilot Facility, Jamshedpur

Towards a Sickle Cell-Free India: Innovation in Action at CSIR

As India accelerates efforts to eliminate sickle cell anaemia by 2047, CSIR's science-driven interventions are bridging critical gaps in screening, care, and prevention. Together, they illuminate a clear path toward a healthier, more resilient future.

The Global Burden of Disease Study 2021 identified India as having the second-highest concentration of sickle cell disease patients after sub-Saharan Africa, with alarmingly high incidence rates, particularly among tribal populations.

Understanding Sickle Cell Disease (SCD)

Sickle Cell Disease (SCD) is a hereditary blood disorder caused by a mutation in the haemoglobin gene, leading to chronic anaemia, severe pain episodes, and organ damage. Despite its serious health impact, the disease often remains neglected due to limited awareness and underdiagnosis, especially in remote regions. It is more prevalent in communities with low socio-economic status, where the burden of treatment and long-term care is often unmanageable.

India's Rising SCD Burden and National Mission Response

India accounted for 14.5% of global SCD births in 2023, with over 42,000 newborns affected that year—highlighting the urgent need for early diagnosis, sustained care and systemic intervention. In response to these alarming statistics, the Hon'ble Prime Minister launched the National Sickle Cell Anaemia Elimination Mission (NSCAEM) in July 2023. As a mission mode programme under the National Health Mission, NSCAEM aims to eliminate sickle cell genetic transmission by the time India celebrates its Amrit Kaal in 2047. Since its launch, over 5.74 crore individuals have been screened across 17 high-focus states, marking significant progress toward early detection and intervention.

Parallel Scientific Efforts: CSIR's Leadership

While nationwide public health efforts led by NSCAEM drive early detection and awareness at the grassroots, parallel scientific initiatives have been underway to strengthen the national response through innovation and research. The Council of Scientific and Industrial Research (CSIR) had launched its Sickle Cell Anaemia (SCA) Mission as early as 2017— focusing on SCA, the most prevalent and clinically severe form of SCD. These independent yet complementary efforts reflect the nation's unwavering commitment on two vital fronts: public health and screening based scientific innovation.

Vision and Objectives of the CSIR-SCA Mission

The CSIR-SCA Mission was envisioned as a long-term, multi-pronged initiative to reduce the disease burden and improve the quality of life for those affected. Among its core objectives, a major focus has been on identifying the hidden disease burden early, particularly through large-scale screening of school children and high-risk populations using affordable and robust diagnostic methods. Furthermore, the mission also aimed to prevent transmission to future generations through genetic testing, prenatal diagnosis, and integrated genetic, social, and clinical counselling, while simultaneously exploring the development of potential cures through advanced genome editing technologies.

Collaborative Structure of the CSIR-SCA Mission

The CSIR-SCA Mission has been a team effort of CSIR involving CSIR - Centre for Cellular and Molecular Biology (CCMB) as the nodal CSIR Laboratory, CSIR- Institute of Genomics and Integrative Biology (IGIB), CSIR - National Chemical Laboratory (NCL) and CSIR - Indian Institute of Integrative Medicine (IIIM). While CSIR-CCMB has led work on genetic biomarkers and screening models, CSIR-IGIB and CSIR-CCMB jointly have developed point-of-care (POC) diagnostic tools. On the therapeutic front, CSIR-NCL and CSIR-IIIM have focused on drug discovery and repurposing, while CSIR-IGIB has advanced research in genome editing as a potential curative pathway.

Breakthrough Diagnostic Innovation: Affordable PCR-Based Test

A breakthrough of the CSIR-SCA Mission has been the development of an affordable, PCR-based molecular test by CSIR-CCMB, using indigenously developed reagents and validated by Indian Council of Medical Research (ICMR) with 100% sensitivity and specificity. Unlike conventional HPLC or rapid tests, this method uses just a drop of blood and simultaneously identifies whether an individual is normal, a carrier, or a patient — at half the cost and without the need for invasive blood collection or additional confirmatory testing. Crucially, it also enables immediate prenatal diagnosis and counselling, enhancing early intervention. With over 99.6% accuracy demonstrated through large-scale validation, the mission now aims to expand this test nationally by upgrading existing PCR centres and training personnel.

Expanded Diagnostic Tools and Therapeutic Advances

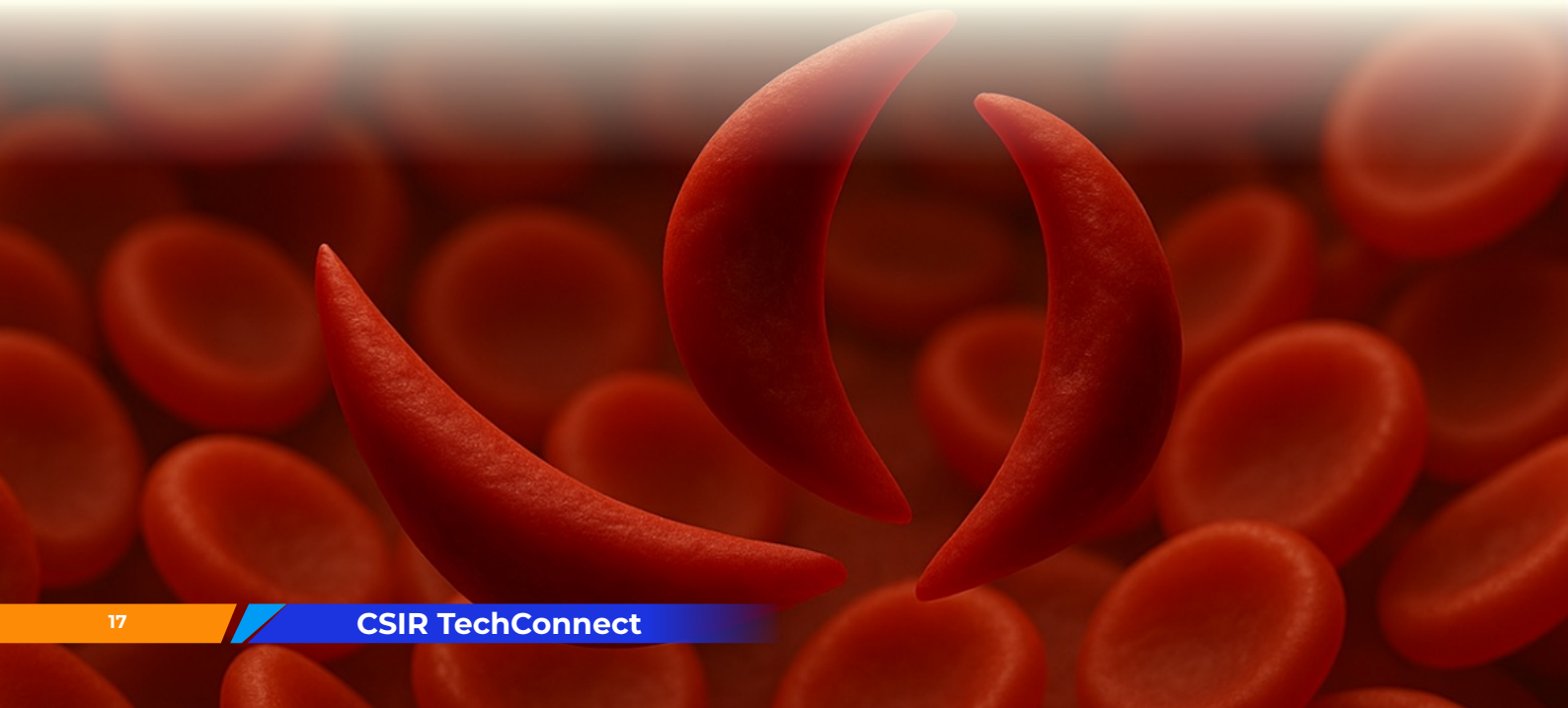
As part of its diagnostic innovations, CSIR has developed three robust and affordable point-of-care tests, including the aforesaid PCR-based test using dried blood samples, world's first commercialized paper strip diagnostic test based on CRISPR [TATA MD CHECK powered by FELUDA], and a simple paper-based test to distinguish between patients, carriers, and unaffected individuals. In terms of symptomatic treatment, the mission addressed a long-standing gap by enabling Central Drugs Standard Control Organisation/ Drugs Controller General of India (CDSCO/DCGI) approval for hydroxyurea treatment in SCA, a key drug for managing pain and related complications in SCA patients, for specific use in children and adults. The drug is now available in suitable dosages and user-friendly formulations, improving access, compliance, and long-term management outcomes. On the curative front, focused efforts are also underway to develop CRISPR-based genome editing approaches for correcting the sickle cell mutation in stem cells — offering long-term hope for a potential cure.

Field Implementation and Public Health Impact

Focusing initially on Maharashtra and Chhattisgarh, CSIR developed a comprehensive screening model targeting school children, pregnant women, and newborns. Over 30 lakh people have been screened, with hundreds of high-risk couples identified and supported through prenatal diagnosis and counselling to prevent the birth of affected children. Regular patient follow-ups, a modified severity scoring system for clinical management, and the establishment of local social support networks have enhanced the program's impact. Building on its success, the model is now being extended to parts of Madhya Pradesh and Jharkhand.

The Road Ahead

As we continue to address the burden of Sickle Cell Anaemia, it is important not only to raise awareness of the challenges posed by the disease but also to recognise the remarkable strides being made by India's scientific community to fight against it. Public support and awareness must go hand-in-hand with innovation, as they are vital in sustaining these efforts and ensuring their reach to every corner of the country.



Tea in India: From Ancient Origins to Indigenous Decaf Innovation

What if your daily chai came without the caffeine jitters? A breakthrough from Assam is making that a reality.

Tea, one of the world's most consumed beverages, originated in ancient China over 4,000 years ago, with legend crediting Emperor Shen Nong for its accidental discovery when wild leaves fell into boiling water. Initially prized for its medicinal value, tea became integral to Chinese culture before spreading across Asia, inspiring unique traditions in Japan and Korea.

In India, though wild tea grew naturally in Assam and was used by local tribes, large-scale cultivation began in the early 19th century under British rule. Seeking to break China's monopoly, the British East India Company introduced organized plantations in Assam and Darjeeling using Chinese seeds and expertise. By the late 1800s, India had become a global tea powerhouse.

Today, producing over 1.3 million tonnes annually, India is the world's second-largest tea producer. From Assam's strong brews to Darjeeling's delicate aroma, tea remains both an economic lifeline and a cherished part of Indian daily life.

While tea offers numerous health benefits, it is not without drawbacks. Tea is rich in antioxidants, can improve digestion, and provides a mild alertness boost due to its caffeine content. However, excessive tea consumption can lead to acidity, restlessness, anxiety, headaches, and sleep disturbances, particularly if consumed in the evening. Regular heavy intake may also lead to mild caffeine dependence, making it harder to function without the drink. These concerns have prompted both consumers and researchers to explore alternatives that retain tea's flavor and health benefits while minimizing caffeine-related side effects.
In this context, India has recently taken a major step forward. CSIR-NEIST (North East Institute of Science and Technology), Jorhat, Assam, has developed India's first indigenously produced decaffeinated black tea. The product was officially launched on September 24, 2025, at the 'CSIR Super Model Store' in New Delhi, organized as a pre-celebration event of the 84th CSIR Foundation Day. The unique decaffeination process removes nearly 90–95% of caffeine while retaining the tea's natural anti-oxidants, flavour, and aroma. This innovation aims to offer a healthier alternative for people sensitive to caffeine, such as children, the elderly, or individuals with digestive issues, without relying on imported decaf teas or chemical-based decaffeination methods.

CSIR-NEIST has also taken steps to bring the product to market. The technology has been transferred to two Indian companies: Jalan Investments Pvt. Ltd. in Assam and Gangwal Healthcare Pvt. Ltd. in Mumbai. Jalan Investments plans to establish India's first decaf black tea production facility in Dibrugarh, Assam, leveraging this homegrown technology. Gangwal Health-care will use the process to extract pharmaceutical-grade caffeine from tea waste, creating an additional revenue stream while reducing environmental impact. This initiative is expected to reduce India's dependence on imported decaf tea and create new business opportunities for tea producers in Assam and beyond.

Although decaffeinated tea has been available in India in the past, it was almost entirely imported, primarily from China and Sri Lanka, and sold through niche, high-end stores. What makes the CSIR-NEIST achievement significant is that it is the first large-scale decaffeination technology developed and implemented in India, specifically for black tea. NEIST's innovation not only addresses health concerns associated with caffeine but also represents a major step toward self-reliance in specialty tea production.

The implications of this development are substantial. For Assam, the home of India's tea heartland, it provides an opportunity to diversify production, add value to locally grown leaves, and attract premium markets both in India and abroad. For consumers, it offers a caffeine-conscious option without compromising on taste or antioxidant content. For the industry as a whole, the technology represents a move toward sustainable, environmentally friendly, and locally developed solutions, reducing the reliance on imported decaffeinated tea while creating potential export opport-unities. The move could also encourage more research into other specialty teas, including health-oriented and functional variants, strengthening India's position in the global tea market.

Tea in India is more than a beverage, it is a cultural staple, a major economic sector, and now a field of scientific innovation. From its historical introduction under British colonial rule to the development of an indigenous decaffeinated black tea by CSIR-NEIST, India has continuously adapted tea to meet evolving consumer needs. The NEIST initiative exemplifies the country's capability to blend tradition, science, and entrepreneurship, offering healthier options while supporting local growers and industries. As this technology scales up, India is poised not only to meet domestic demand but also to expand its presence in the global decaf tea market, marking a new chapter in the long and flavourful journey of tea in India.

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Image Credit: https://www.boutindia.com/blog/discover-indias-most-scenic-tea-plantations

Listening to Nature's whispers: CSIR's SODAR Technology for Better Weather and Cleaner Skies

What if we could listen to the sky and predict pollution before it even rises? CSIR's SODAR technology turns sound waves into a powerful tool for cleaner air and smarter weather forecasting.

Imagine a device that can hear the nature whispers, see the invisible layers of the atmosphere, and predict the pollutant load before they spread. Behind this remarkable capability is SODAR (Sound Detection and Ranging), a breakthrough atmospheric sensing technology developed by CSIR–Advanced Materials and Processes Research Institute (CSIR–AMPRI), Bhopal.

With this innovation, India joins a selected group of nations capable of designing and deploying indigenous acoustic remote-sensing systems to study and forecast boundary-layer dynamics, a critical element for weather prediction, climate research, and environmental safety.

Decoding the Sky with Sound

Just as SONAR (Sound Navigation and Ranging) maps the ocean using sound waves, SODAR listens to the sky. It emits acoustic pulses upward and analyses the echoes scattered back by temperature fluctuations in the atmosphere. This enables scientists to measure thermal structures, turbulence, and mixing heights up to several hundred meters above the surface. These parameters are crucial for weather prediction, air quality assessment, aviation safety, and urban environmental management.

The system provides continuous, real-time data of the atmospheric boundary layer, the turbulent region between the Earth's surface and the free atmosphere that governs pollutant dispersion, fog formation, and local weather changes. For meteorologists, environmental regulators, and renewable energy planners, such insights are indispensable.

The AMPRI Advantage

CSIR–AMPRI's SODAR stands out for its compact design, rugged construction, and cost-effectiveness, making it ideal for India's diverse climatic conditions. Unlike imported systems that are costly and maintenance-intensive, AMPRI's version is fully indigenous, energy-efficient, and built with locally sourced components.

Equipped with advanced signal processing and real-time visualization, it can be deployed in industrial zones, airports, and urban regions. The system also supports the establishment of industrial operational hours, local atmospheric stability, turbulence, stack plume monitoring in industries and a diagnostics tool for urban air quality and the health care system.

From Pollution Monitoring to Disaster Management

SODAR provides critical support to air quality management agencies, tracking how pollutants disperse under different weather conditions. This enables proactive control measures and accurate urban pollution forecasts.

During events like smog episodes, crop-residue burning, or the Bhopal gas tragedy, SODAR data serves as a real-time decision-making tool for emergency response teams. It also enhances weather forecasting and early warning systems for hazards such as dust storms, fog, and heat waves, particularly in regions lacking dense sensor networks.

Empowering a Self-Reliant Atmospheric Research Ecosystem

This development reflects India's growing strength in making its own environmental monitoring technologies. By developing SODAR domestically, CSIR–AMPRI is reducing import dependence and empowering national agencies with scalable, customizable solutions.

The installation of the first SODAR facility at CSIR–AMPRI, Bhopal, marks a significant stride toward strengthening India's meteorological and environmental data infrastructure, offering valuable support to the India Meteorological Department (IMD), Central Pollution Control Board (CPCB), and Environment management planner, Air-traffic controller.

How New Is This Technology?

While acoustic remote sensing exists globally, CSIR–AMPRI's innovation lies in making it affordable, accessible, and adaptable for Indian needs. Most commercial SODARs are proprietary, expensive, and built for uniform climates. AMPRI's system uses optimized signal processing, low-noise transducers, and modular electronics, ensuring high precision with minimal maintenance.

By indigenizing both hardware and software, CSIR–AMPRI has paved the way for mass production and widespread deployment, advancing India's Atmanirbhar Bharat mission in climate and environmental technologies.

From Sound Waves to Sustainable Futures

In the grander vision, this innovation is not just about measuring the atmospheric turbulence; it's about understanding and harnessing it. With CSIR's SODAR technology, India gains a powerful instrument to decode the interplay between weather, air quality, and atmospheric characteristics.

By listening to the whispers of nature using SODAR, we are learning to predict, protect, and plan, shaping cleaner cities and safer skies. It's a quiet revolution that doesn't just hear the atmosphere; it understands it.

SODAR facility at CSIR-AMPRI

Cleaning the Air We Breathe: The MultiPLE-ATMoS Breakthrough by CSIR–IITR

Picture a mobile air-washing station that rolls into polluted streets and begins scrubbing the air clean. That vision now exists in the form of CSIR–IITR's MultiPLE-ATMoS device.

Imagine a machine that can be wheeled into a polluted street and begin cleaning the air around it, removing dust, toxic gases, heavy metals, and even harmful microbes. A device that acts like a mobile "air-washing station," giving cities battling smog a breath of relief. This vision is becoming real through Multi-Pollutant Legerity Effective Air Treatment Movable System (MultiPLE-ATMoS), a new air-purification system developed by scientists at the CSIR–Indian Institute of Toxicology Research (CSIR–IITR), Lucknow. Unveiled at the EARTH conference, this homegrown innovation promises to reduce some of the most dangerous urban pollutants and make India's fight against air pollution smarter and more effective.

How MultiPLE-ATMOS Cleans the Air

At its core, MultiPLE-ATMoS works by combining multiple purification technologies inside a single compact system. The machine uses mechanical separation to capture fine dust like PM2.5 and PM10, photocatalytic oxidation to break down toxic chemical pollutants, and a wet scrubber to absorb harmful gases such as nitrogen dioxide, sulphur compounds, and carbon monoxide. The system tackles everything from tiny particulate matter to heavy metals, including lead, arsenic, and nickel, and even airborne pathogens that pose health risks. During field trials, the prototype demonstrated a remarkable 83–94% reduction in pollutants, treating nearly 1,000 cubic metres of air every hour, all while operating on a budget-friendly build cost of just ₹5 lakh (which will drastically be come-down when it is developed at a large scale).

Built for India's Pollution Hotspots

What makes MultiPLE-ATMoS particularly valuable is its mobility and adaptability. Mounted on a sturdy four-wheel trolley, it can be transported to traffic junctions, industrial areas, construction sites, or densely populated urban pockets, locations where pollution tends to spike. Unlike stationary air-purification towers, this device can be positioned precisely where the pollution load is highest. Once the treatment is complete, the system's by-products are environmentally safe and recyclable; one of them, gypsum, can be reused in construction and industrial applications, ensuring that the cleaning process itself leaves no harmful traces.

MultiPLE-ATMoS

Is This Technology New to the World?

Globally, experiments with outdoor air-cleaning systems exist, but they are often large, expensive, and limited in effectiveness. What makes MultiPLE-ATMoS stand out is its multi-process integration in a low-cost, portable system — something not commonly seen in international prototypes. While wet scrubbers and photocatalysis are known technologies, combining them into a compact mobile platform designed specifically for urban smog control is a distinctive Indian innovation. Most global solutions focus on either particulate removal or gaseous pollutants; MultiPLE-ATMOS addresses both, along with heavy metals and pathogens.

A First for India's Pollution-Fighting Toolkit

In India, large outdoor purification systems have usually been imported, expensive, or limited to experimental deployments in a few cities. CSIR–IITR's system marks one of the first fully indigenous, mobile, multi-contaminant air-cleaning devices developed by a national scientific institution. Earlier efforts mostly relied on filter-based towers or single-technology systems, whereas MultiPLE-ATMS brings an integrated scientific approach designed around Indian pollution profiles, especially smog conditions dominated by dust, vehicular emissions, industrial gases, and construction debris.

Impact Beyond the Laboratory

The potential applications of MultiPLE-ATMoS extend far beyond initial trials. City administrations can deploy fleets of these units at choke points during high-smog periods, industrial zones can use them to reduce local air contamination, and construction sites can operate them to comply with environmental norms. The device also opens new opportunities for low-cost air-quality management in Tier-II and Tier-III cities that lack access to sophisticated pollution-control infrastructure. Its low build cost encourages domestic manufacturing, supporting India's environmental technologies market while ensuring that clean air solutions remain accessible and scalable.

Breathing Towards a Cleaner Tomorrow

MultiPLE-ATMoS represents more than a piece of equipment, it signals a new way of thinking about air purification. Instead of relying solely on long-term policy measures or massive fixed installations, CSIR–IITR has created a nimble, science-driven solution that can respond quickly to the realities of Indian urban pollution. By transforming proven scientific principles into a mobile, practical device, the institute has taken a significant step toward cleaner cities and healthier citizens. It is a quiet, hopeful innovation, one that doesn't just measure air quality but actively improves it, offering a clearer horizon for the India of tomorrow.

CSIR TRIVIA

1. Which material is used inside the OBOGS (On-Board Oxygen Generation System) to separate oxygen from air in aircraft developed with support from CSIR-NCL?

a) Plastic
b) Steel
c) Zeolite
d) Rubber

2. Which safer chemical replaced acetic anhydride in the new paracetamol manufacturing process developed by CSIR-NCL?

a) Acetone
b) Acetic acid
c) Hydrochloric acid
d) Sulphuric acid

3. Which indigenously developed small gas turbine engine by CSIR-NAL delivers around 1000 N of thrust and is designed for tactical UAVs, loitering munitions, and compact cruise missiles?

a) Kaveri
b) NJ-5
c) NJ-100
d) PTAE-7

4. Which technology developed and demonstrated by CSIR-NIIST enables small devices like sensors to run entirely on ambient indoor light?

a) Silicon rooftop solar panels
b) Thermoelectric generators
c) Dye-sensitized solar cells (DSCs) using organic dyes
d) Lithium-ion micro-batteries

5. What process causes wet sand to act like a fluid during an earthquake?

a) Erosion
b) Liquefaction
c) Sedimentation
d) Compression

6. What key problem in reinforced concrete construction does CSIR-SERC's Head-T threaded rebar anchor primarily solve?

a) Cracking of concrete due to temperature changes
b) Corrosion of steel rebars
c) Reinforcement congestion at joints caused by bent rebar ends
d) Low compressive strength of concrete

7. Which two CSIR institutes played key roles in successfully cultivating exotic flowers like tulips in Himachal Pradesh and Eustoma in Odisha?

a) CSIR-NAL and CSIR-SERC
b) CSIR-IHBT and CSIR-NBRI
c) CSIR-NCL and CSIR-NIIST
d) CSIR-NGRI and CSIR-AMPRI

8. What makes CSIR–CRRI's ECOFIX pothole repair technology especially effective during the monsoon season?

a) It requires high-temperature heating for faster setting
b) It uses imported asphalt for extra strength
c) It can repair even waterlogged potholes without dewatering and opens to traffic in about 20 minutes
d) It needs heavy machinery for compaction

9. Why is the Al-Mg-Sc alloy useful for rockets and satellites?

a) Very cheap
b) Heavy and dense
c) Light and strong
d) Soft and flexible

10. Besides clothing, where could this temperature-adaptive leather potentially be used?

a) Automotive interiors and furniture
b) Plastic bottles
c) Ceramic tiles
d) Paper packaging

11. What makes CSIR–NML's lithium-recovery technology a game changer compared to most existing global battery-recycling processes?

a) It relies on high-temperature furnaces to melt battery materials
b) It is limited to only one lithium-ion battery chemistry
c) It uses low-temperature, recyclable reagents to recover >99% pure battery-grade metals from multiple battery chemistries
d) It focuses only on cobalt recovery, not lithium

12. Which form of Sickle Cell Disease (SCD) is the most prevalent and severe in India?

a) Sickle Cell Anaemia
b) Sickle Beta-Thalassemia
c) HbC Disease
d) Thalassemia Minor

CSIR TRIVIA

13. What makes CSIR-NEIST's decaffeinated black tea a first-of-its-kind innovation in India?

a) It is India's first green tea processed without caffeine
b) It completely eliminates caffeine while increasing bitterness
c) It relies on imported Chinese decaffeination technology
d) It is the first indigenously developed, large-scale decaffeination technology for black tea, retaining flavour and antioxidants

14. What is the core principle behind CSIR–AMPRI's SODAR technology?

a) Using laser beams to track particulate matter in the upper atmosphere
b) Emitting sound waves upward and analysing their echoes scattered by temperature fluctuations
c) Measuring atmospheric gases through chemical sensors mounted on towers
d) Detecting weather patterns using satellite-based infrared imaging

15. What is a key feature of CSIR–IITR's MultiPLE-ATMoS device in combating urban air pollution?

a) It relies solely on high-cost, stationary air towers imported from abroad
b) It is a mobile, low-cost, multi-process air purification system that removes dust, gases, heavy metals, and pathogens
c) It only targets particulate matter like PM2.5 and ignores gaseous pollutants
d) It functions by planting urban trees and green walls automatically

16. What is the main advantage of adding scandium to the Al-Mg alloy?

a) Reduces the cost of aluminium significantly
b) Improves the alloy's strength, weldability, and resistance to fatigue
c) Makes the metal magnetic
d) Converts it into a liquid at room temperature

17. Which two countries collaborated on developing the "cool leather"?

a) India and Egypt
b) India and China
c) Egypt and Saudi Arabia
d) India and USA

18. What concept does CSIR's lithium recovery support in India?

a) Linear economy
b) Fossil fuel expansion
c) Circular economy
d) Import-only strategy

19. What is a special feature of the MultiPLE-ATMoS device?

a) Fixed tower
b) Underground system
c) Mobile machine
d) Home purifier

20. What is the main benefit of decaffeinated tea developed by CSIR-NEIST?

a) Stronger taste
b) More caffeine
c) Less caffeine
d) Darker colour

Answers: 1. (c), 2. (b), 3. (c), 4. (c), 5. (b), 6. (c), 7. (b), 8. (c), 9. (c), 10. (a), 11. (c), 12. (a), 13. (d), 14. (b), 15. (b), 16. (b), 17. (a), 18. (c), 19. (c), 20. (c)

सीएसआईआर
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