

Outcomes from CSIR Mission Mode Projects

2020 – 2025



सीएसआईआर
CSIR
भारत का नवाचार इंजन
The Innovation Engine of India

**Innovation Management Directorate
Council of Scientific & Industrial Research
New Delhi, India**



Outcomes from CSIR Mission Mode Projects

2020 - 2025



सीएसआईआर
CSIR
भारत का नवाचार इंजन
The Innovation Engine of India

Innovation Management Directorate
Council of Scientific & Industrial Research, New Delhi, India

First published: January 2026 (E-version)

Web Link: <https://www.csir.res.in/en/flipbook/57>

Disclaimer:

The present publication embodies a compilation of outcomes achieved under identified CSIR Mission projects that were funded solely by CSIR and implemented during the 2020-2025 period. It has been produced by personnel of the Innovation Management Directorate of CSIR Headquarters based on inputs received and vetted by constituent laboratories. Findings, interpretations and conclusions expressed in this work do not necessarily reflect the views of CSIR Headquarters or the government. CSIR HQ does not guarantee accuracy, completeness or currency of the data or discrepancies in information or liability with respect to use or failure to use the information and conclusions set forth.

Limited Rights:

Limited rights to use the information contained in this volume for scientific, educational and research purposes and for personal use is granted subject to the fact that the information is not altered or decontextualized and the attribution is appropriately provided. No part of this work may be used for any commercial or any other purpose except those mentioned above or be stored, retrieved or transmitted in any form or by any means without the written permission of Director General, CSIR.

Attribution:

Please cite the work as follows:

'*Outcomes from CSIR Mission Mode Projects*', Council of Scientific & Industrial Research (2026), New Delhi, India

Third-party content:

CSIR does not necessarily own each component of the content contained within the work. CSIR therefore does not warrant that the use of any third-party-owned individual component or part contained in the work will not infringe on the rights of those third parties.

All queries related to this volume may be addressed to Director General, Council of Scientific & Industrial Research, Anusandhan Bhavan, Rafi Marg, New Delhi 110 001, India

Designed and published by: CSIR-NIScPR

Scan here to read online



ABOUT CSIR MISSION MODE PROJECTS

The Council of Scientific & Industrial Research is guided by a vision to 'Enhance the quality of life of the citizens of India through innovative Science and Technology, globally competitive R&D, by developing sustainable solutions and capacity building. The Mission Mode Projects endeavor aligning CSIR's unique R&D capabilities with national imperatives and the UN Sustainable Development Goals. As such, they serve as targeted R&D interventions designed to address key national priorities.

Funded in consortia mode across multiple laboratories usually for a period of three years, CSIR mission mode projects are envisaged to develop scalable leads that could be taken up further through translational research and commercialisation.

CSIR has till date supported Mission Mode Projects in diverse areas including pharmaceuticals, agrochemicals, food and consumer safety, carbon capture and utilization, recycling of battery materials, critical minerals, waste valorization, drone-based exploration technologies and healthcare diagnostics. These efforts extend to fields such as specialty chemicals, energy storage systems, advanced sensors, climate-resilient infrastructure, sustainable packaging, indigenous manufacturing, nutraceuticals, etc. reflecting CSIR's engagement across sectors of national importance.



डॉ. (श्रीमती) एन. कलैसेल्वी
सचिव, वैज्ञानिक और औद्योगिक अनुसंधान विभाग
महानिदेशक, वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद्
Dr. (Mrs.) N. Kalaiselvi
Secretary, DSIR and Director General, CSIR



भारत सरकार
विज्ञान एवं प्रौद्योगिकी मंत्रालय
वैज्ञानिक और औद्योगिक अनुसंधान विभाग
वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद्
Government of India
Ministry of Science and Technology
Department of Scientific & Industrial Research
Council of Scientific & Industrial Research



PREFACE

Great science reveals its worth not within laboratories, but among the lives changed. Across the 37 CSIR laboratories from the Himalayan foothills to southern peninsula, CSIR's Mission Mode Projects have demonstrated this paradigm in more than one way. Through targeted, outcome-driven research, formulated thoughtfully to subsume national challenges, the mission mode projects over the last five years have turned knowledge into impact.

It is with immense pride and deep satisfaction that I present this compilation of some of our key achievements from 2020 to 2025 emanated from mission projects. They stand as a testament to a convergence of India's finest scientific minds aligned with our nation's most pressing needs. Behind every innovation are stories of self-reliance of communities adopting science-led solutions, healthcare workers serving better with portable diagnostics and small businesses thriving with sustainable technologies.

This impact was made possible by an extraordinary convergence of efforts

- Our scientists who turned complex challenges into simple, scalable solutions
- Industry partners who transformed prototypes into products
- Government agencies who helped bridge the last mile
- Most importantly, the citizens who became co-creators in this journey

The outcomes presented here represent more than discrete achievements, they mark the successful completion of carefully designed scientific missions with measurable targets. Whether developing life-saving drugs that combine traditional knowledge with modern pharmacology, creating smart farming tools powered by AI and IoT, engineering advanced materials for space and defence applications, designing affordable medical devices for primary healthcare, advancing agricultural productivity, or strengthening healthcare access, each mission began with two questions: What does India need? And how can science deliver it?

As we share these results, we look at it not as a completion but a beginning. The technologies here are ready to scale, the partnerships primed to grow. We invite researchers, policymakers, and industry leaders to join us in scaling these solutions to make them more stakeholder oriented and usable.

The mission continues, and its greatest impacts remain ahead of us.

November 21, 2025
New Delhi


(N. Kalaiselvi)

CSIR Mission Mode Projects [2020 – 2025]

Index

S.No.	Title of Mission Project	Page No.
1	Active Pharmaceutical Ingredients for Affordable Health Care (API-AHC)	1
2	Advancing Technological Leads for Assuring Safety of Food (ATLAS)	2
3	Aerospace Materials and Technologies	3
4	AI-Enabled Technologies and Systems (AITS)	4
5	Aroma Mission	5
6	Bulk Chemicals	6
7	Coal-Syngas to Methanol (Cosynol)	7
8	CSIR Hydrogen Technology (H2T) Program	8
9	Development of Advanced Materials and Devices for Opto-Electronic, Biomedical and Strategic Applications	9
10	Development of Next-Generation Transgenic Cotton for Broad-Spectrum Resistance to Field Pests for Yield Protection (Cotton Mission)	10
11	Development of Processes for Active Pharmaceutical Ingredients towards COVID 19 (COVID-API)	11
12	Discovery & Pre-Clinical Development of Antivirals for Covid-19 & Other Diseases (Antiviral Mission)	12
13	Floriculture Mission	13
14	Immuno Modulatory Function of Nutritionals and Nutraceuticals for Health and Wellness (IMMUNITY)	14
15	Indigenous Development of Technologies for Advanced Devices and Laboratory Instruments (IDEAL)	15
16	Innovation Centre for Next Generation Energy Storage Solutions (ICeNGESS)	16
17	Medical Instruments and Devices (MID)	17
18	MILLET - Sustaining Health through Research and Innovation by Analysis of Nutrients and Nutraceuticals to achieve Global Awareness (SHRI-ANNA)	18
19	Phytopharmaceutical Mission - Phase II	19
20	Plastic Depolymerization and Upcycling (DEPOLUP)	20
21	Seaweed Mission Phase II: Identification of Potential Locations across India for Seaweed Cultivation and Valorization Technologies (IPL-ISEaC)	21
22	Sickle Cell Anemia - Phase II	22

Active Pharmaceutical Ingredients for Affordable Health Care (API-AHC)

CSIR has provided advanced therapeutic solutions across multiple disease areas, reflecting its commitment to addressing diverse healthcare challenges. Through the mission project, processes for APIs and KSMs have been successfully developed towards strengthening pharmaceutical manufacturing capabilities. The R&D efforts focused on treatment areas for antiviral therapies, cancer, cardiovascular diseases, and other neurological disorders. Common challenges included availability of raw materials, complex synthesis routes and toxic reagents. The processes are characterised by cost-effectiveness, environment sustainability with mostly single-step reactions and scalable methods employing green chemistry.

Lead(s) Portfolio

Antiviral Therapies

Darunavir Intermediate
Enzymatic 5-steps, ee >99.5%

Valganciclovir
Minimized steps
Green chemistry

Bictegravir Intermediate
Resolution-free 5 steps

Antidiabetic & Metabolic Disorders

Imeglimin
Heterogeneous 99% selectivity

Pitavastatin Intermediate
Green synthesis
Fewer steps

Bempedoic Acid
Lithium-free Cost-effective

Oncology

Alectinib KSM
High yield
No regioisomer selectivity

α -Methylproline
Daridorexant KSM
Atom-economical
High diastereoselectivity

Nintedanib/Sunitinib KSMs
Short route
Chemoselective

Lenalidomide
Green synthesis
Aqueous micellar, High purity

Anti-Inflammatory, Anti-Convulsant, Anti-Thrombotic

Ticagrelor Intermediate
Environmentally friendly cost-effective synthesis; No column purification

Lifitegrast KSMs
A novel column free cost-effective route; high yield; ee upto >99.9%

OTBN
Synthesis by Mn- and Ni-catalysed cross-coupling routes

Brivaracetam
Cost-effective, step-economic process, single chiral separation

Abrocitinib KSM
Improved and optimized five-step method for KSM synthesis; 47% overall yield

Impact

- Healthcare Access & Affordability
- Environmental sustainability through reduced production costs towards Self-reliance
- Technologies like Lenalidomide and Penicillin-G enhance public health access in low-middle income countries
- Green Chemistry & Process Innovation

Target Stakeholders / Beneficiaries

- Pharma industries, API/KSM suppliers, CROs
- Healthcare sector and hospitals
- Government agencies
- Public health organizations
- Research institutions

Applications

- Towards Cancer, Cardiovascular, Antiviral therapies
- Addressing critical and special therapeutic needs across major disease categories, supporting both domestic healthcare requirements and global pharmaceutical supply chains

Output Metrics

- Final TRL achieved
 - ◆ TRL 5: Bempedoic Acid
 - ◆ TRL 4: Alectinib, Ticagrelor Intermediate, Lifitegrast KSMs, Imeglimin
 - ◆ TRL 3: Nintedanib, Darunavir KI, OTBN, Lenalidomide, Abrocitinib KSM, Bictegravir and its KSMs, Valganciclovir, Pitavastatin Intermediate, Daridorexant KSM, Brivaracetam
- Patents: 11 Filed, 1 Granted
- Publications: 8
- HR Trained: 56



#startupindia



Advancing Technological Leads for Assuring Safety of Food (ATLAS)

The ATLAS Mission aimed to strengthen India's food safety ecosystem by developing affordable, portable, and eco-friendly technologies for detection of contaminants, improving shelf life, and ensuring authenticity of food products. It integrated innovations from multiple CSIR labs to provide indigenous, science-based solutions for enhancing food quality and safety.

Lead(s) Portfolio

Real-Time Portable Electrochemical Sensor Array

NiO-CNF based portable array for simultaneous detection of pesticides and antibiotics

Bio-fumigation Technology

Eco-friendly fumigant system using essential oils for 100% insect control in stored grains; scalable and safe

Ethylene & Oxygen Scavengers

Active packaging films/sachets & films that extend freshness of perishable produce

Electrostatic Spray Coating

Cost-effective edible coating technology enhancing fruit & vegetable shelf-life by 50–60%

FluorPCR®

Hand-held multiplex PCR platform for on-site detection of meat adulteration & pathogens; one-fifth cost of conventional RT-PCR

SenzHb® & Multianalyte E-Strips

Paper/electrochemical strips for detection of spoilage markers and haemoglobin; ready for licensing

Pesticide Detection Kit

Colorimetric nano-strip for organophosphate/carbamate detection

Impact

- Food Safety: Enables real-time, field-deployable detection of pesticides, pathogens & spoilage markers
- Shelf-life Extension: Innovative packaging & coatings reduce post-harvest losses
- Economic & Health Benefits: Supports safer food supply chains, boosts exports, empowers MSMEs & start-ups in food testing

Target Stakeholders / Beneficiaries

- Food testing laboratories
- Regulatory authorities (FSSAI)
- Food processing industries
- Consumers, MSMEs, packaging manufacturers and start-ups in food safety and agri-tech sectors

Applications

- Rapid on-site detection of contaminants in food and environment
- Shelf-life enhancement and post-harvest loss reduction
- Quality assurance in food supply chains, exports, and cold storage
- Screening tools for food safety regulators, FSSAI, and MSMEs

Output Metrics

- Final TRL achieved
 - ◆ TRL 6: Bio-fumigation Technology, Electrostatic Spray Coating, FluorPCR®
 - ◆ TRL5: Ethylene/Oxygen Scavengers, SenzHb® Multianalyte E-Strips
 - ◆ TRL 4: Pesticide Detection Kit
 - ◆ TRL 3: Electrochemical Sensor Array
- Patents: 17 Filed, 1 Granted; Copyright/Trademark: 6
- Publications: 24
- HR Trained: 50
- Technology Transfer: 2



FluorPCR®: A hand-held platform device



Lab developed prototype for simultaneous detection of antibiotics and pesticides



Pesticide Detection Kit (PESTi-KIT)



Senz Hb Platform Technology



Bio-fumigation Technology



Aerospace Materials and Technologies

The mission focuses on the design and development of advanced lightweight alloys, composites, coatings, and high-temperature materials for aerospace, space, and defence applications. It aims to enhance India's technological independence, reduce imports, and create indigenous know-how for strategic and industrial use under Atmanirbhar Bharat and Make in India.

Lead(s) Portfolio

LTCC-Based Accelerometer

Compact, high-sensitivity accelerometer using lead-free BCZT/PZT ceramics; vibration-tested

Common Aperture IR-Laser Fore-Optics

Integrated visible/IR/laser optical system for avionics range finding; flight-qualified

Miniaturized Aspheric Optics for HMD

Lightweight relay lens system for helmet-mounted displays; rig-tested

Nanostructured 2H-MoS₂ Lubricant Powder

Single-step process for high-purity 2H-MoS₂ powder for aerospace lubrication

Cf/SiC Brake Disc Composite

Oxidation-resistant Cf/SiC composite discs developed and tested for aircraft braking

Aerospace-Grade Epoxy Prepregs

Indigenous 180°C-cure epoxy prepregs with intermediate modulus carbon fiber; pilot-scale validated

Intermediate Modulus Carbon Fiber

PAN-based process for intermediate modulus carbon fiber production at pilot scale

Thermal Barrier Coatings for Turbine Vanes

Doped-YSZ coatings improving oxidation and heat resistance in small GTE nozzles

SHM for Composite Structures

Fiber-optic sensor-based system for real-time health monitoring of composite airframes

Chromate-Free Coating for Al Alloys

Eco-friendly three-layer protection system for aircraft aluminium alloys; CEMILAC compliant

Erosion-Corrosion Resistant TiCrN Coating

Multilayer TiCr/TiCrN coating improving durability of turbine compressor blades

SHM for Metallic Airframes

Embedded MFC rosette sensor system for impact event detection in metallic aircraft structures

Impact

- Strengthens self-reliance in aerospace and defence materials
- Enables cost-effective indigenous alternatives to imports
- Advances capability in alloy design, processing, and testing

Target Stakeholders / Beneficiaries

- Aerospace and defence industries
- Space organisations
- Aircraft and turbine manufacturers
- Material fabricators
- Strategic R&D partners

Applications

- Aircraft and spacecraft structures
- Thermal protection and propulsion systems
- Lightweight composites for aerospace components
- High-temperature engine parts

Output Metrics

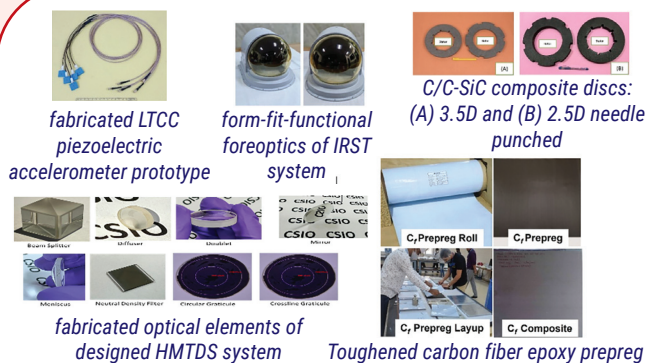
➤ Final TRL achieved

- ◆ TRL 7: Common Aperture IR-Laser Fore-Optics, Aerospace-Grade Epoxy Prepregs, Chromate-Free Coating System, SHM for Metallic Airframes
- ◆ TRL 6: LTCC-Based Accelerometer, Miniaturized Aspheric Optics for HMD, Cf/SiC Brake Disc Composite, Intermediate Modulus Carbon Fiber, Thermal Barrier Coating, SHM for Composites, TiCrN Coating
- ◆ TRL 4: Nanostructured 2H-MoS₂ Lubricant Powder

➤ Patents: 1

➤ Publications: 22

➤ HR Trained: 67



AI-Enabled Technologies and Systems (AITS)

The mission is focused on developing AI and ML-driven tools to address India's societal challenges in healthcare, agriculture, transport, and environment. It focuses on privacy-preserving frameworks, autonomous inspection systems, diagnostic platforms, and predictive analytics to enable efficient, safe, and scalable digital solutions. It also supports the development of deployable AI systems that strengthen operational capabilities and technological self-reliance across multiple sectors.

Lead(s) Portfolio

AI based Privacy Protection of Biometric Information

Secure AI framework for privacy-protected biometric data and distributed model training

AI-Based UAV Powerline Inspection

Lightweight object detector for autonomous drone-based inspection of towers and fittings

Drone Technologies for Smart Sensing & Intervention

Indigenous UAV with manipulator for waste monitoring, water sampling, and field inspection

Driver Drowsiness Detection

On-device vision and ECG-based system for real-time driver fatigue alerts

E-Mobility Battery Optimization System

AI algorithms for predicting state-of-charge, range, and health of EV batteries

Smart TPMS

AI-enabled tyre pressure monitoring system predicting burst risk and failure probability

AlaaS-AutoCeph

Cloud-based cephalometric analysis tool for orthodontic diagnostics and reporting

AI Model for Interstitial Lung Disease

Deep learning-based HRCT image classification for lung parenchyma and fibrosis scoring

SPARA – AI-based Antimicrobial Resistance Predictor

Genome analytics pipeline for AMR gene detection and drug-resistance prediction

AI-Designed High-Entropy Alloys

Material informatics tool for turbine alloy design with high strength and ductility.

AI-Based Materials Property Prediction

Machine learning framework for mechanical property and fatigue life estimation of alloys

AquaAI

Automated Zooplankton Enumeration: AI-based system for rapid aquatic biodiversity assessment and monitoring

Target Stakeholders / Beneficiaries

- Healthcare providers
- EV and transport sectors
- Power utilities and UAV inspection agencies
- Aerospace and materials manufacturers
- Environmental and fisheries agencies
- Defence and energy utilities, AI start-ups
- Public health and environment agencies

Applications

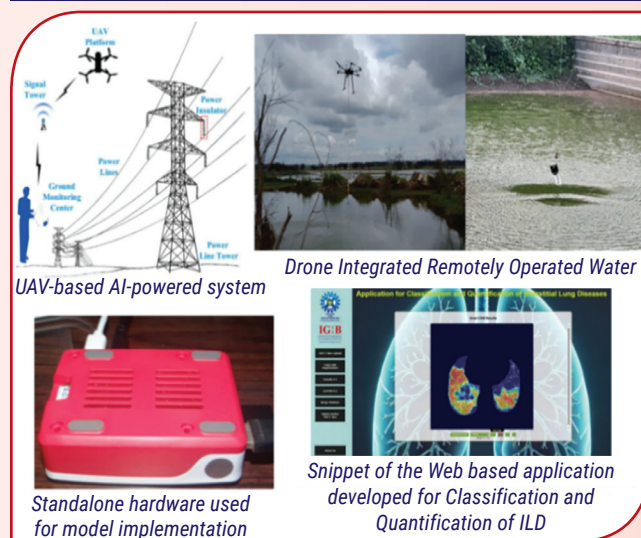
- Disease diagnosis and healthcare decision support
- Smart transport, e-mobility and infrastructure safety
- Privacy-compliant data analytics and environmental monitoring

Output Metrics

- Final TRL achieved
 - ◆ TRL 7: AI-Based Materials Property Prediction
 - ◆ TRL 6: Smart TPMS, AlaaS (AutoCeph)
 - ◆ TRL 5: SPARA, AquaAI
 - ◆ TRL 4: Privacy-Preserved AI, UAV Inspection, E-Mobility Battery System, ILD Model, HEA Design
 - ◆ TRL 3: Driver Drowsiness Detection
- Patents: 1; Copyright: 1
- Publications: 14
- HR Trained: 57

Impact

- Enables AI-driven diagnostics, monitoring, and safety systems
- Enhances data privacy and autonomous operations
- Reduces human risk in inspection and mobility sectors
- Builds indigenous AI tools for national use cases



AROMA Mission

CSIR's aromatic and medicinal plant technologies address critical national needs including import substitution, environmental sustainability, and farmer income enhancement. Conventional essential oil extraction methods are time-consuming, energy-intensive, and rely on harmful chemicals. India faces significant supply-demand gaps despite suitable cultivation conditions, necessitating imports. The developed eco-friendly technologies by CSIR use renewable energy, natural formulations, and waste valorization. The initiatives support rural entrepreneurship, women's health, disease control, and sustainable agriculture while meeting growing industrial demand for natural, high-quality products.

Lead(s) Portfolio

- ◆ Artificial Intelligent Enabled Multi-Sensory Fusion Platform for Quality Analysis of Essential Oils
- ◆ Microwave Assisted Essential Oil Extraction System
- ◆ Castor oil to Food-Flavor Perspective (+)- γ -Decalactone
- ◆ CIM-Larvishield - Novel Polymeric Bead Formulation for Mosquito Larvicidal Action
- ◆ CIM-Sukhda
- ◆ CIM-Suvaas
- ◆ Cleangerm: A Natural Aromatic Floor Cleaner
- ◆ Eco-Friendly Solar Hybrid Distillation Unit for Essential Oil Extraction
- ◆ Incense Sticks and Fragrant Cones from Offered Flowers/Geranium spent materials
- ◆ Lemongrass
- ◆ Medicated Sanitary Pad (NAARI+)
- ◆ Novel Chemical Process for Vanillin Production from Eugenol and Eugenol Rich Essential Oils
- ◆ Ocimum
- ◆ Patchouli
- ◆ Psoria-CIM
- ◆ Rose Scented Geranium
- ◆ Spearmint
- ◆ Aromatic Marigold
- ◆ Damask Rose
- ◆ Herbal Floor Cleaner & Disinfectant
- ◆ HerboPeel
- ◆ Polyherbal Toothpaste for Oral Hygiene
- ◆ Turmeric
- ◆ Lemongrass, Java Citronella and Patchouli



Impact

Economic Impact

- Employment & Livelihood Creation
- Farmer Income Enhancement

Social & Health Impact

- Public Health Benefits
- Capacity Building & Skills Development
- Gender Empowerment

Environmental Impact

- Carbon Footprint Reduction
- Waste Management & Circular Economy
- Biodiversity & Ecosystem Conservation

Technology & Innovation Impact

- Quality & Standards Enhancement
- Rural Development & Inclusive Growth

Industry Development Impact

- Import Substitution & Export Promotion
- Value Chain Development
- Industrial Ecosystem Strengthening

Target Stakeholders / Beneficiaries

- **Processing & Manufacturing:** Aroma, Perfume & Fragrance Industries, Food, Pharmaceutical & Cosmetic Industries, Personal Care & Herbal Companies
- **Allied Industries:** Agarbatti & Soap Industries, Chemical & Repellent Industries, Agricultural Community
- **Primary Producers:** Farmers & Marginal Farmers, Plant varieties, cultivation technologies
- **Business Development:** MSME Start-ups, Rural Women/SHGs, Agri-Entrepreneurs

Applications

- Fragrance & Perfumery, Food & Beverage Applications
- Healthcare & Pharmaceutical, Personal Care & Hygiene Applications
- Industrial & Chemical, Agricultural & Processing Applications
- Consumer Products Applications

Output Metrics

- Final TRL achieved
 - ◆ 3-9 across technologies
- Patents: 9 Filed, 1 Granted
- Publications: 75+
- HR Trained: 20000+



Bulk Chemicals

The Indian chemical sector is vital, contributing significantly to the country's GDP but remains a net importer due to demand outpacing local capacity. Bulk chemicals, central in global trade and product manufacturing, present a key opportunity for R&D intervention. The Bulk Chemicals mission project focused on developing technologies for lithium extraction, battery metal recovery, DCDA, production of Bisphenol-A etc. The initiatives under the project collectively represent a comprehensive strategy addressing India's technological sovereignty and sustainable development goals.

Lead(s) Portfolio

Holistic Recycling Process for Mixed Battery Chemistries

Developed and patented CSIR's first holistic hybrid mechanical-hydrometallurgical process that generates high quality black mass
Can tackle any type of Lithium based batteries to extract and separate high pure salt products

Dicyandiamide (DCDA) Production from Calcium Carbide

Indigenously developed a cost-effective and green bench-scale process for DCDA, a metformin drug raw material, through calcium carbide route

Processes for Lithium-Ion Battery Recovery

- ◆ Zero Discharge eco-friendly Hydrometallurgy based leaching and downstream process for comprehensive recovery of all metals from NCM-type cathode materials in mixed mobile phone batteries
- ◆ Developed cost-effective process for selectively recovering valuable metals from LCO and NMC lithium-ion battery cathodes, using three-step precipitation method avoiding solvent extraction route

Continuous Catalytic Process for Bisphenol-A (BPA)

Developed a continuous pilot-scale catalytic process for selective production of BPA, achieving over 95% yield and 85–90% selectivity

Impact

- Environmental Sustainability and Circular Economy
- Economic Value Creation and Market
- Industrial Development and Employment Generation
- Technologies demonstrate strong commercialization potential

Target Stakeholders / Beneficiaries

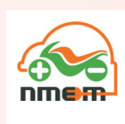
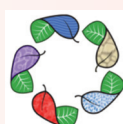
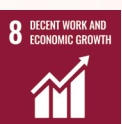
- Battery, metal, and recycling industries
- Chemical and manufacturing industries
- Automotive, electronics, and petrochemical industries

Applications

- Battery Recycling & Materials Recovery
- Chemical Manufacturing; metals and chemical intermediates for energy storage, EVs, electronics, and catalysis; production of melamine (for plastics/resins), metformin (diabetes medication), polycarbonate (>70% global BPA demand), and flame retardants.
- Advanced Materials & Industrial Uses: Epoxy laminates and resins for electrical, industrial, and automotive uses; paints, coatings, protective finishes; electronic components and packaging.

Output Metrics

- Final TRL achieved
 - ◆ TRL 6: Catalytic process for BPA
 - ◆ TRL 5: Holistic Recycling Process for Mixed Batteries
 - ◆ TRL 4: Zero discharge hydrometallurgy process; Production of DCDA
- Patents: 5
- Publications: 9
- HR Trained: 35



Coal-Syngas to Methanol (CoSynol)

India imports over 85% of crude oil, necessitating alternative fuels to reduce import dependency. Methanol offers clean blending potential with petrol/LPG. Being the world's second-largest coal producer, India can leverage CSIR-CIMFR's technology for gasifying high ash coal into syngas, thereafter, converting it to methanol through integrated processing systems.

Lead(s) Portfolio

High-Ash Coal Gasification Process

An operational process established for gasifying high-ash Indian coal in a 1.5 TPD oxy-blown Pressurized Fluidized Bed Gasifier (PFBG)

Pilot-Scale Methanol Synthesis Plant

Developed an in-house pilot facility with a capacity of 30-40 kg/day to convert syngas into methanol

Syngas Conditioning and Purification Systems

Capabilities established at both bench and pilot scales for

- A high-temperature Water-Gas Shift (WGS) system
- Amine-based CO₂ separation module



1.5 TPD Oxy-blown PFBG Pilot Plant



Syngas to Methanol Pilot Plant

Impact

- Help reduce import dependency by creating a domestic alternative to foreign crude oil and natural gas
- Lowers fuel costs as it can be blended with gasoline, cutting the national oil import bill
- Acts as a versatile energy source by serving as an efficient hydrogen carrier and a valuable chemical feedstock.

Target Stakeholders / Beneficiaries

- Public Sector Enterprises / Coal based Companies
- Industrial end users in Automotive Sector, Fertilizer Industries
- Chemical & Petrochemical Industries
- Companies adopting methanol as fuel

Applications

- Transport Sector – Coal derived methanol can be used as fuel
- Power Generation – Can fuel DG (Diesel Generator) sets
- Industrial Feedstock – As a raw material for the chemical and fertilizer industries

Output Metrics

- Final TRL achieved
 - ◆ TRL 6: Coal gasification
 - ◆ TRL 5: Syngas cleaning, conditioning and syngas to methanol
- Patents: 1 Filed
- Publications: 7
- HR Trained: 40



CSIR Hydrogen Technology (H2T) Program

The CSIR Hydrogen Technology (H2T) Program strategically supports India's National Green Hydrogen Mission through multiple critical indigenous technologies designed to achieve comprehensive hydrogen production, storage, and utilisation. The program emphasised developing efficient, cost-effective materials and processes that minimise system costs while maximising operational efficiency, covering hydrogen generation, storage and utilisation aspects. Through these advanced technologies, the program enables hydrogen production as a clean substitute for conventional petrol and aviation fuels, representing the next critical phase in global decarbonization efforts.

Lead(s) Portfolio

Hydrogen Generation

- ◆ High Temperature Solid Oxide Electrolyser
- ◆ 30 kW Proton Exchange Membrane Electrolyser
- ◆ Next Generation Low Temperature Proton Exchange Membrane Fuel Cell Technology
- ◆ Catalyst and Electrocatalyst for Electrolyser
- ◆ Anion Exchange Membrane (AEM) Water Electrolyser
- ◆ Seawater Electrocatalysis

Hydrogen Utilisation

- ◆ Microwave Plasma Based Methane Reforming System
- ◆ Bio-Electrochemical (BEC) Technology for Bio-Hydrogen Production

Hydrogen Storage

- ◆ Type-IV Hydrogen Storage Tank, Safety Valve and Leak Detectors
- ◆ Preparation of Bulk Alloy Dominated by Laves Phases
- ◆ Versatile Liquid Organic Hydrogen Carriers (VLOHC)
- ◆ Development of Epoxy Vitrimers

Output Metrics

- Final TRL achieved
 - ◆ TRL 6: PEM Electrolyser (30 kW)
 - ◆ TRL 5: AEM Electrolyser, Solid Oxide Electrolyser, Next Gen LT PEMFC, Type-IV Hydrogen Storage Tank
 - ◆ TRL 4: Bio-hydrogen from wastewater, MW Plasma-based Methane Reforming, Fabrication of Electrode Supported R-SOCs, Epoxy Vitrimers
 - ◆ TRL 3: Catalyst and Electrocatalysts for Electrolyser, Hydrogen Generation by Seawater Electrocatalysis, Preparation of Bulk Alloy Dominated by Laves Phases
- Patents: 25 Filed, 2 Granted
- Publications: 63
- HR Trained: 113

Impact

The CSIR H2T Mission serves as a cornerstone for India's transition to a hydrogen-based economy, simultaneously addressing energy security, environmental sustainability, economic development, import substitution, and technological sovereignty.

Target Stakeholders / Beneficiaries

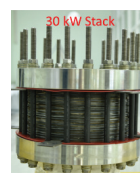
- Carborundum Universal Limited
- OIL Companies
- KPIT, Pune
- MNRE
- Kerala Hydrogen Valley, Pune Hydrogen Valley
- Steel, Chemical, Petrochemical Transport Industries
- Electrolyser manufacturing industries

Applications

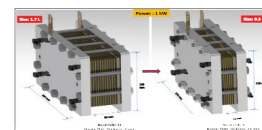
- Green hydrogen generation
- Feedstock for ammonia production
- Type-IV composite hydrogen storage tanks
- Bio-electrochemical technology for producing hydrogen from municipal and industrial wastewater
- Catalyst development for electrolyzers benefiting NH₃ producing industries, Automobile industries, etc.
- Hydrogen safety valves, fiber optic sensors, and electronic leak detectors for safety and monitoring



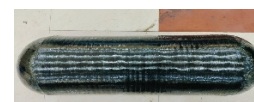
Multi cell SOE



30kW PEM



PEMFC with graphite BP



Type IV Storage H₂ Tank



#startupindia



Development of Advanced Materials and Devices for Opto-Electronic, Biomedical and Strategic Applications

India's growing demand for smart electronics, green buildings, biomedical implants, and portable energy solutions requires indigenous development of advanced materials. Current technologies are often import-dependent and expensive, limiting access and scalability. This mission focuses on creating cost-effective, multifunctional and energy-efficient materials and devices that address national needs in health, energy, and strategic sectors, while strengthening India's innovation ecosystem while achieving energy security through indigenous innovation.

Lead(s) Portfolio

Electrochromic Coatings

Cost-effective, tunable smart coatings for glass and flexible substrates; fast switching (<10 s); retrofit capability for smart windows, displays, sunroofs

Flexible Electrochromic Supercapacitor

Combines energy storage & electrochromism; vanadium-doped nanostructures; ultra-high cyclic stability (30,000+ cycles); prevents overcharging

White Light Emitting Phosphors

Single-phase, high CRI (95 Ra), eliminates bluish tinge; low-cost, energy-efficient alternative for safe, long-lasting LEDs & displays

Mg-Ca Biodegradable Implants

Biocompatible, bone-like mechanical properties; resorbable, avoids secondary surgery; safe and patient-friendly orthopaedic implants

Composite Smart Glass

Indigenous electrochromic glass; energy-efficient, glare-free, aesthetically tunable; supports sustainable building design

Flexible Dye-sensitized Solar Cells

Self-powered, flexible photovoltaics; 30% indoor efficiency under LED/CFL; supports IoT, wearables, portable electronics

Impact

- Energy Efficiency: Smart windows, flexible solar cells, and electrochromic devices reduce power consumption
- Healthcare: Biodegradable implants improve patient outcomes, lower healthcare costs
- Electronics & Display: Safer, efficient LEDs and smart displays strengthen consumer & strategic applications
- Strategic: Reduces import reliance; aligns with Make in India, Digital India and sustainability goals

Target Stakeholders / Beneficiaries

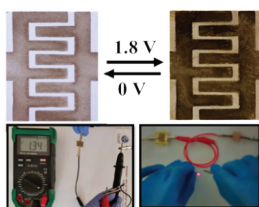
- Glass & construction industries
- Electronics & display manufacturers
- Medical device industry & healthcare providers
- Energy storage and photovoltaic sectors

Applications

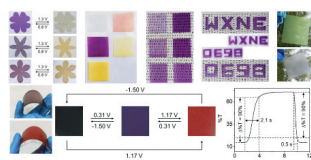
- Green & smart buildings
- Flexible/wearable electronics & IoT devices
- High-performance displays & lighting
- Biomedical applications
- Strategic defence & aerospace applications

Output Metrics

- Final TRL achieved
 - ◆ TRL 6: Composite Smart Glass, Flexible Dye-sensitized Solar Cells
 - ◆ TRL 4: Electrochromic Coatings, Flexible Electrochromic Supercapacitor, White Light Emitting Phosphors, Mg-Ca Biodegradable Implants
- Patents: 7
- Publications: 23
- HR Trained: 20



Flexible/wearable electrochromic micro-supercapacitor device



Smart glass technology



Development of Next-Generation Transgenic Cotton for Broad-Spectrum Resistance to Field Pests for Yield Protection (COTTON Mission)

India's cotton productivity continues to face serious threats from insect pests like whitefly, pink bollworm, and cotton leafworm, causing heavy yield losses and pesticide dependence. The mission aims to develop next-generation transgenic cotton with broad-spectrum and sustainable insect resistance. Through indigenous biotechnological interventions, CSIR has introduced fern-derived and engineered insecticidal proteins that provide stable, heritable pest protection, thereby enhancing yields and reducing environmental and economic burdens from pesticide use.

Lead(s) Portfolio

FIP08 GM Cotton

Expresses a novel fern-derived insecticidal protein; controls whitefly population (50–70% mortality); stable integration up to T4 generation; suitable for North Indian cotton varieties

FIP14 GM Cotton

Dual-action GM cotton attracting whiteflies and their parasitoid *Eretmocerus* sp.; reduces insect population >90%; acts as a border crop protecting neighbouring fields

mCry1EC GM Cotton

Engineered Cry1EC protein effective against pink bollworm and cotton leafworm; long-lasting expression; stable up to T6 generation; provides season-long pest resistance

Tma12 / iTma12 GM Cotton

Utilizes LPMO enzyme from fern *Tectaria macrodonta* for whitefly control; improved version (iTma12) ensures proper protein folding in ER; reduces whitefly population and pesticide sprays



Pink bollworm-resistant mCry1EC GM cotton

Impact

- Agricultural: Reduces pest infestation and pesticide use
- Economic: Saves ₹50–100 crores in pesticide costs and enhances yield by ₹5,000 crores in North India
- Environmental: Promotes sustainable pest management and biodiversity
- Strategic: Strengthens indigenous biotech capability and farmer income security

Target Stakeholders / Beneficiaries

- Indian and multinational seed companies
- ICAR institutions & agricultural universities
- Cotton farmers and biotech industries

Applications

- Cultivation in pest-prone regions of North India
- Integrated pest management (IPM) systems
- Border crop use for pest protection of other cash crops
- Screening tools for food safety regulators, FSSAI, and MSMEs

Output Metrics

- Final TRL achieved
 - ◆ TRL 6: mCry1EC GM Cotton
 - ◆ TRL 4: FIP08 GM Cotton, FIP14 GM Cotton, Tma12 / iTma12 GM Cotton



Development of Processes for Active Pharmaceutical Ingredients Towards COVID 19 (COVID-API)

CSIR's COVID-API mission strategically addressed pandemic healthcare challenges through drug repurposing, leveraging medications like Camostat Mesylate, Tilorone intermediate, Hydroxychloroquine, and Remdesivir etc. with anti COVID-19 potential. Project targeted mechanism-based approaches including JAK1/2 inhibitors for cytokine storm mitigation, broad-spectrum antivirals against RNA viruses, and tissue regeneration compounds. Project emphasized on developing cost-effective, scalable indigenous processes to ensure accessibility while securing domestic supply chains.

Lead(s) Portfolio

Camostat Mesylate

Simple, novel process for key intermediates
High yield, high purity

Tilorone Intermediate

Mild conditions; No harsh reagents; No column chromatography

Dalargin

Efficient process, Avoids allergenic conventional agents

Hydroxychloroquine KSM

Synthesis from natural feedstock

Dapagliflozin

Process with reduced steps; easy purification

Remdesivir

Avoids hazardous BCl_3 , Higher coupling yield, no additives

Baricitinib

Ligand-free efficient gram-scale process with indigenous materials

Ruxolitinib

Cost effective process using indigenous raw materials

Molnupiravir

A short synthetic route from D-Ribose

Impact

- Healthcare accessibility
- Cost Reduction
- Technology innovation
- Supply chain security
- High-Purity production
- Targeted to help in import substitution

Target Stakeholders / Beneficiaries

- Pharma industries, API/KSM suppliers, CROs
- Generic pharma companies
- Healthcare sector and hospitals
- Government agencies
- Public health organizations
- Research institutions

Applications

- Viral infections
- Cardiovascular Applications
- Specialized Therapeutic Applications
- Addressing critical therapeutic needs across major disease categories, supporting both domestic healthcare requirements and global pharmaceutical supply chains

Output Metrics

- Final TRL achieved
 - ◆ TRL 6: Tilorone Intermediate
 - ◆ TRL 5: Molnupiravir
 - ◆ TRL 4: Dalargin, Hydroxychloroquine KSM, Baricitinib, Ruxolitinib
 - ◆ TRL 3: Camostat Mesylate, Dapagliflozin, Remdesivir
- Patents: 6
- Publications: 4
- HR Trained: 32



Discovery and Pre-Clinical Development of Antivirals for COVID-19 and Other Diseases (Antiviral Mission)

The COVID-19 pandemic highlighted critical gaps in therapeutic preparedness. While vaccines and repurposed medicines provided some relief, their effectiveness was limited and often short-lived particularly against emerging variants. Recognising this challenge, the Antiviral Mission was launched to create a pipeline of indigenous small-molecule drugs that are safe, affordable and capable of broad-spectrum action. By advancing leads that target both viral proteins and host mechanisms, the mission seeks to reduce dependence on imports, strengthen national capacity in drug discovery, and build long-term resilience against future outbreaks.

Lead(s) Portfolio

IICB-TBT-2-127 & TBT-2-63 (Entry Inhibitor, bazedoxifene scaffold)

Blocks hACE2-Spike interaction, active across multiple SARS-CoV-2 variants, orally bioavailable

IICB-TIH-200 (Entry Inhibitor, arbidol scaffold)

Targets viral spike protein, shows efficacy in animal models, oral delivery.

IICB-SP-14 (Mpro Inhibitor, andrographolide scaffold)

Inhibits viral protease essential for replication, low toxicity, oral candidate.

Favipiravir + XO Inhibitor Combo (Fixed Dose Combination)

Enhances bioavailability, lowers required dose, reduces side effects.

IICT-SBS-1919 (Host-targeted, marine scaffold)

Inhibits PIKfyve kinase in host cells, broad-spectrum potential, orally bioavailable

IIIM-B-490-S (fluvoxamine scaffold)

Demonstrates strong anti-SARS-CoV-2 activity, efficacy confirmed in animal model

IIIM-RS-46 (andrographolide scaffold)

Natural product-based, effective against SARS-CoV-2, validated in animal studies

IMT-VC-347 (benzimidazole scaffold)

Very high potency (nM activity), retains efficacy across variants, oral candidate

Impact

- Healthcare: Expands India's antiviral pipeline for COVID-19 & future outbreaks
- Preparedness: Broad-spectrum activity across variants, host-targeted approaches for reduced resistance
- Economic: Reduces dependency on costly imports; enables licensing to Indian pharma

Target Stakeholders / Beneficiaries

- Indian pharmaceutical industry & biotech start-ups
- Public health authorities
- Healthcare providers & patients

Applications

- Potential treatments for SARS-CoV-2 infection and future viral pandemics
- Clinical translation through licensing/industry partnerships

Output Metrics

- Final TRL achieved
 - ◆ TRL 4: IICB-TBT-2-127 & TBT-2-63 (Entry Inhibitors), IICB-TIH-200 (Entry Inhibitor), Favipiravir + XO Inhibitor Combo (FDC), IICT-SBS-1919 (Host-targeted), IIIM-B-490-S (fluvoxamine scaffold), IIIM-RS-46 (andrographolide scaffold), IMT-VC-347 (benzimidazole scaffold)
 - ◆ TRL 3: IICB-SP-14 (Mpro Inhibitor, andrographolide scaffold)
- Patents: 7
- Publications: 2
- HR Trained: 17



Floriculture Mission

India's floriculture sector faces challenges of post-harvest losses, waste generation, and limited value addition. This mission focuses on sustainable, eco-friendly, and livelihood-generating technologies across the floriculture value chain, from extending flower shelf life to creating high-value products like perfumes, herbal colors and natural cosmetics. These interventions promote circular bio economy and create employment for rural and women-led enterprises.

Lead(s) Portfolio

Freshness Keeper Paper

Bioactive kraft paper coated with natural plant and spice extracts that extend the shelf life of cut roses from 10–12 to 18–20 days; biodegradable and non-toxic

Bio-preservative Formulation for Cut Flowers

Combination of herbal bioactives that delay wilting and extend vase life; validated by molecular and physiological studies

Lutein Extraction Process

Green, two-step solvent-free process yielding 90–95% pure lutein from *Tagetes erecta*; scalable and transferred to industry

Herbal Incense Cones from Temple Flowers

Converts floral waste into charcoal-free, aromatic incense; eco-friendly, promotes circular economy and women-led entrepreneurship

Lotus Fibre Apparel

Eco-friendly lotus silk blended with cotton; supports sustainable fashion and artisanal weaving

FROTUS Lotus Perfume

Natural, unisex fragrance developed from lotus extract; dermatologically safe and commercial-ready

Herbal Gulal and Herbal Liquid Sindoor

Non-toxic, plant-based festival and cosmetic products promoting traditional, safe practices

Floral Vase-Life Spray – FloriGuard

Herbal spray delays senescence by 33–56%; downregulates ethylene biosynthesis genes; patented and commercialized

Impact

- Economic: Strengthens rural and women-led entrepreneurship; enhances export potential of floriculture-based products
- Social: Generates sustainable livelihoods and skill development opportunities for local communities
- Environmental: Converts floral waste into value-added eco-products, reducing waste and pollution
- Health: Promotes safe, non-toxic, and plant-based alternatives for daily and cultural use.

Target Stakeholders / Beneficiaries

- Floriculture growers, exporters, and retailers
- MSMEs, women SHGs, and artisans
- Cosmetic, aroma, and packaging industries
- Event management and hospitality sectors

Applications

- Extension of cut flower shelf life for domestic and export markets
- Natural perfumery, herbal cosmetics, and textile applications
- Floral waste valorization and eco-product manufacturing
- Green entrepreneurship and rural bio-based industries

Output Metrics

- Final TRL achieved
 - ◆ TRL 7: Lutein Extraction Process, FROTUS Perfume
 - ◆ TRL 6: Freshness Keeper Paper, Herbal Gulal, Herbal Sindoor, Herbal Incense Cones
 - ◆ TRL 5: FloriGuard Herbal Spray
 - ◆ TRL 4: Bio-preservative Formulation, Lotus Fibre Apparel
- Patents: 2
- Publications: 3
- HR Trained: 16
- Technology Transfer: 3



Immuno Modulatory Function of Nutritionals and Nutraceuticals for Health and Wellness (IMMUNITY)

The Immunity Mission focused on developing scientifically validated nutraceuticals, teas, and herbal formulations to enhance immune function through everyday diets. It combined traditional Indian knowledge with modern science to produce functional foods and databases supporting preventive healthcare. It also developed a national digital portal integrating information on immunomodulatory fruits, vegetables, and plant-based bioactive compounds.

Lead(s) Portfolio

Spice-Enriched Nutraceuticals

Spice mix dip bags, cookies, and extracts with proven antioxidant and immunomodulatory activity; first-of-its-kind validated formulation for daily consumption

Digital Immunity Portal

National database of 111 vegetables, 76 fruits, and 1500 bioactive compounds with immunity-boosting potential

Immunomodulatory Teas

Regional tea blends (Kangra, Assam, Munnar) fortified with cardamom/ginger; demonstrated T-cell and cytokine modulation

Mono-Herbal Nutraceuticals

Herbal-based drops, spreads, and drinks (*Bunium persicum*, *Brassica napus*, *Buchanania lanzan*) supporting antioxidant and respiratory health

Polyherbal Formulations

Standardized combinations for immunity, liver, and renal health; developed as syrup and tablet dosage forms

Impact

- Promotes safe, evidence-based immune-boosting nutrition
- Strengthens India's herbal and nutraceutical innovation base
- Integrates traditional knowledge with scientific validation

Target Stakeholders / Beneficiaries

- Consumers
- Nutraceutical & food industries
- Tea Processing Industry
- Researchers and public health organizations.

Applications

- Functional foods, nutraceuticals, herbal beverages, and dietary supplements for enhancing immunity and wellbeing;
- Digital portal as an educational and R&D resource

Output Metrics

- Final TRL achieved
 - ◆ TRL 7: Spice-Enriched Nutraceuticals
 - ◆ TRL 4: Polyherbal immunomodulatory products, Mono-Herbal Nutraceuticals, Immunomodulatory Teas
- Patents: 8
- Publications: 21
- HR Trained: 45



Indigenous Development of Technologies for Advanced Devices and Laboratory Instruments (IDEAL)

The Mission Mode Project aimed at the indigenous development of analytical and scientific instruments, high-power microwave devices, and semiconductor-based optoelectronic devices to enhance domestic capability and help reduce dependence on imports. It focused on improving system efficiency and developing end-to-end solutions for strategic, industrial, and societal applications. The technologies developed under the Mission will cater to areas such as communication infrastructure, defense applications, and precision measurement systems, supporting national requirements in these critical sectors.

Lead(s) Portfolio

Analytical and Scientific Instruments Technologies

- ◆ Portable Spectrophotometers Suite
- ◆ Portable Quadrupole Mass Analyzer
- ◆ High-Resolution Magnetic Force Microscope (MFM)
- ◆ Electromagnetic Radiation Power Meter
- ◆ Precious Metals Testing Machine
- ◆ Advanced Colorimetry Systems

High-Power Microwave Devices

- ◆ Medical/Industrial Magnetron Systems
- ◆ High-Power Klystron Technology
- ◆ Space-Qualified TWT Systems
- ◆ Industrial Heating Gyrotron
- ◆ Eco-friendly VUV Excimer Source

Semiconductor-based Optoelectronic Devices

- ◆ High-Power LED Technologies
- ◆ UV-LED Disinfection Systems
- ◆ Advanced IR Sensing Technologies

Impact

- Contribute to India's technological self-sufficiency, economic growth, and strategic autonomy
- Address critical needs in defence, healthcare, manufacturing, environmental monitoring, and communication
- Support sustainable industrial practices
- Provide comprehensive solutions benefiting diverse stakeholders, including MSMEs and large-scale industries

Target Stakeholders / Beneficiaries

- Aerospace, Defence & Strategic Electronics industries: Encompassing automation, semiconductors, and microwave technologies
- Advanced Materials & Industrial Manufacturing sector: Covering specialized R&D, nanotechnology, and general manufacturing, including MSMEs
- Healthcare & Consumer Goods: Spanning medical products, commercial lighting, and other enterprise sectors

Applications

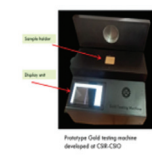
- Analytical & Scientific Instruments: For industrial materials analysis, research and education, and health and safety monitoring
- High-Power Microwave Devices: For strategic communication systems and industrial applications like surface activation and modification
- Semiconductor & Optoelectronic Devices: For applications spanning solid-state lighting, advanced industrial tools, and systems for defense, healthcare, and communication

Output Metrics

- Final TRL achieved
 - ◆ TRL 4: High-Power Microwave Devices; Semiconductor-based Optoelectronic Devices
 - ◆ TRL 3: Analytical and Scientific Instruments
- Patents: 7
- Publications: 29
- HR Trained: 70



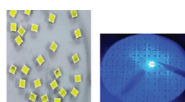
Portable NIR Spectrophotometer



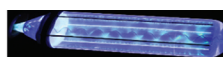
Gold Testing Machine



250 W Ku-band TWT



Blue and White LED Devices



Vacuum ultraviolet (VUV-172nm) excimer Source



Innovation Centre for Next Generation Energy Storage Solutions (ICeNGESS)

India's 80% import dependency on energy storage components creates critical strategic and economic vulnerabilities, threatening energy security and manufacturing competitiveness. Mission ICeNGESS directly addresses this challenge by establishing comprehensive indigenous capabilities across the entire value chain—from advanced materials research to large-scale manufacturing infrastructure. This platform-based mission strategically helps bridging the persistent research-commercialization gap through dedicated pilot facilities, demonstration platforms, and mid-TRL development capabilities.

Lead(s) Portfolio

Lithium-Ion Battery Technology

The Innovation Centre serves as a one-stop hub for advancing scalable, high-impact energy storage technologies including lithium ion battery technology. The Centre features -

- ◆ **Advanced Battery Chemistries**
LiFePO₄, NMC, solid-state Li-ion, sodium-ion, zinc-air, and flow batteries for diverse performance requirements
- ◆ **Next-Generation Materials**
Nano-engineered electrodes, gel and solid electrolytes, plus cathode recycling strategies for circular economy integration
- ◆ **Intelligent Systems & AI**
Smart Battery Management Systems (BMS) with AI/ML optimization, real-time degradation monitoring, and predictive fault detection
- ◆ **Manufacturing Infrastructure**
Pilot-scale battery production units upto 1000 cells/day, specialized BMS development laboratories, and comprehensive safety testing facilities
- ◆ **Multi-Sector Applications**
Tailored energy storage solutions for electric vehicles, renewable energy integration, and grid balancing technologies



Lithium-ion Battery Facility at CSIR-CECRI

Impact

- Technology shall help in reduction of import dependency through indigenous battery value chain
- Accelerate EV adoption, renewable integration, cathode recycling
- Development of Multi-Chemistry Platform - LiFePO₄, NMC, solid-state, sodium-ion batteries

Target Stakeholders / Beneficiaries

- Godi Energy Pvt. Ltd.
- Other Battery Industries.

Applications

- Electric Vehicles
- Consumer Electronics
- Renewable Energy Integration

Output Metrics

- Final TRL Achieved: 6
- Patents: 5
- Production Capacity: 1000 cells/day for 18650 Li-ion cells
- Cathode Material Production: Scaled to pilot scale of 20-30 kg
- Industrial scale-up and technology transferred to GODI Energy Pvt. Ltd. with 1000 cells/day capacity



Medical Instruments and Devices (MID)

One of India's major challenges in providing affordable healthcare, particularly in rural areas is its reliance on imported Medical devices. The Mission focused on developing indigenous, cost-effective Medical devices to improve accessibility, reduce dependence on imports and build self-reliance in healthcare solutions by valorizing the Medical Instruments and Devices Sector. The mission supported the translation of laboratory innovations into deployable products and enabled collaborations between laboratories, clinicians, and industry to ensure that the devices addressed real healthcare needs.

Lead(s) Portfolio

Diagnostic & Therapeutic Devices

- ◆ Indigenous Dialysis Machine for Hemodialysis of Chronic Kidney Disease (CKD) Patients
- ◆ Hollow Fiber Hemodialyzer for Chronic Kidney Disease (CKD) treatment
- ◆ Plasmonic Photothermal Sterilization Device for surgical tools

Rehabilitation & Assistive Technologies

- ◆ E-Assist Tricycle for differently abled mobility
- ◆ Robotic Gait Trainer (ROBOG) for Spinal Cord Injury Patients
- ◆ Actuated Exoskeleton-based Hand Rehab Device (AEROH)
- ◆ IoT-enabled Handheld Colposcope

Imaging-based Medical Devices

- ◆ Vascu-Guide: AI-assisted vein visualization for sclerotherapy

Advanced Manufacturing-based Implants

- ◆ Additive manufactured pelvic revision implants

Impact

- Healthcare Access: Affordable diagnostics, treatment and mobility aids
- Economic: Lower treatment costs, reduced import reliance
- Social: Improved quality of life for elderly, differently abled and chronic patients
- Technology: Boost to indigenous R&D, Make in India

Target Stakeholders / Beneficiaries

- Patients (CKD, cancer, stroke, SCI, differently abled)
- Hospitals, clinics, rehabilitation centres
- Start-ups, MSMEs & Medical device industry
- Public health organizations & government programs

Applications

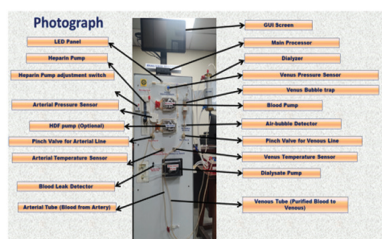
- Rural and urban healthcare delivery
- Rehabilitation & assistive devices for patients
- Imaging & surgical support for hospitals
- Affordable implants for orthopaedics care

Output Metrics

- Final TRL achieved
 - ◆ TRL 8: IoT-enabled Handheld Colposcope
 - ◆ TRL 6: E-Assist Tricycle
 - ◆ TRL 5: Pelvic Revision Implants
 - ◆ TRL 4: Indigenous Dialysis Machine, Hollow Fiber Hemodialyzer, Exoskeleton Hand Rehab, Robotic Gait Trainer, Vascu-Guide, Plasmonic Photothermal Sterilization Device
- Patents: 6; Designs: 5; Copyrights: 4
- Publications: 5
- HR Trained: 58
- Technology Transfer: 2



Handheld Colposcope



Prototype of Dialysis Machine



Control Module integrated with e-tricycle



MILLET -Sustaining Health through Research and Innovation by Analysis of Nutrients and Nutraceuticals to achieve Global Awareness (SHRI-ANNA)

The mission promotes millet-based innovations to enhance nutritional security, develop value-added products and strengthen post-harvest and safety technologies. It addresses gaps in processing, storage, packaging, and traceability through sustainable, science-driven solutions and supports improving the usability of millets across food and processing sectors. It also advances supporting technologies for enhancing quality, safety, shelf-life, and supply-chain transparency within the millet ecosystem

Lead(s) Portfolio

- ◆ Millet-Based Instant Noodles
- ◆ Nutritional Profiling of Indian Millets
- ◆ Millet Processing & Flour Functionality
- ◆ Precision Bio-Fumigation System
- ◆ Oil Extraction from Pearl Millet Bran
- ◆ On-Site Mycotoxin Detection Device
- ◆ Hydrodynamic Cavitation Assisted Process
- ◆ Non-Wetted Industrial Packaging from Millet Residue
- ◆ Pheromone Technology for Safe Millet Storage
- ◆ Capsule-Based Gluten Detection System
- ◆ Biodegradable Tableware from Millets
- ◆ Blockchain Traceability for Millet Supply Chain
- ◆ Life Cycle Assessment (LCA) of Millets
- ◆ Nutritional & Safety Assessment Technologies for Millets

Applications

- Instant and RTE millet foods
- Nutraceuticals and fortified products
- Sustainable packaging and tableware
- Safe grain storage
- Quality assessment & traceability platforms



Noodles from proso millet



Edible millet-based cutlery

Impact

- Strengthens millet-based food security and sustainable value chains
- Enhances farmer income through value addition and product diversification
- Reduces food losses and environmental impact via green processing and packaging
- Supports entrepreneurship, nutrition awareness and industrial scale-up

Target Stakeholders / Beneficiaries

- Food processing industries
- Farmers and FPOs
- Startups and MSMEs
- Nutrition and health sectors
- Regulatory and certification bodies
- Research and academic institutions

Output Metrics

- Final TRL achieved
 - ◆ TRL 7: PAT Technology for Millet storage
 - ◆ TRL 6: Biodegradable Tableware from Millets; Hydrodynamic Cavitation Assisted Process
 - ◆ TRL 5: Millet Processing & Flour Functionality, Oil Extraction from Pearl Millet Bran, LCA of Millets, Non-Wetted Packaging
 - ◆ TRL 4: Precision Biofumigation system, Nutritional & Safety Assessment Technologies for Millets
 - ◆ TRL 3: Mycotoxin estimation, Capsule-Based Gluten Detection System, Blockchain technologies
- Patents: 1; Design Registration - 1
- Publications: 11
- HR Trained: 63
- Technology Transfer: 2



Phytopharmaceutical Mission - Phase II

CSIR's *Crocus sativus*-based IIIM-141 addresses critical unmet medical needs in Alzheimer's treatment. Current approved drugs show limited efficacy and cannot prevent disease progression in over 55 million global dementia patients. IIIM-141's polypharmacological approach uniquely targets multiple AD pathways simultaneously—enhancing amyloid- β clearance, protecting neurons, and providing antioxidant effects—unlike existing single-target therapies. This comprehensive mechanism promises superior clinical outcomes for AD's complex pathology.

Lead(s) Portfolio

IIIM-141: A *Crocus Sativus* based Phytopharmaceutical Lead for the Treatment of Alzheimer's Disease

- ◆ A crocin-enriched standardized extract of the stigma (Kesar) of *Crocus sativus* flowers
- ◆ Phytopharmaceutical lead IIIM-141 follows a polypharmacology approach, which hits multiple targets of AD pathology

Output Metrics

- Final TRL achieved: 7
- Patents: 1 Granted
- Publications: 4
- HR Trained: 10

Impact

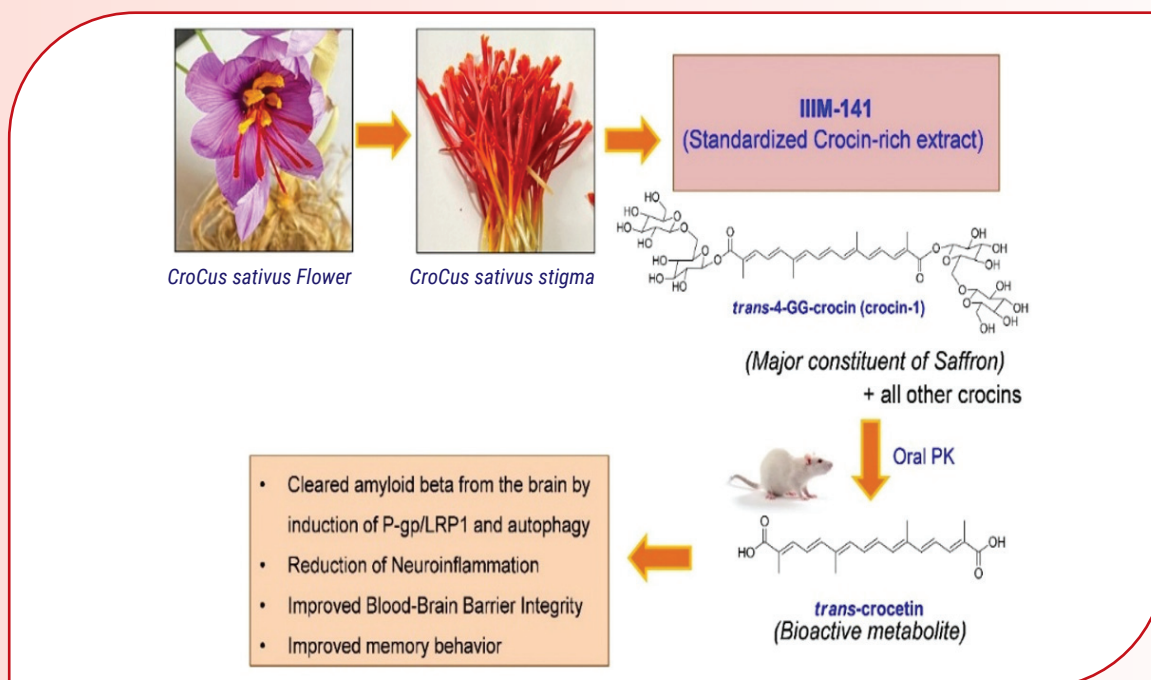
- Addresses unmet need for millions of dementia patients providing affordable treatment
- Alternative to seven current AD drugs with limited efficacy
- Possess excellent market opportunity
- Indigenous drug development using traditional medicine

Target Stakeholders / Beneficiaries

- Alzheimer's patients
- Pharmaceutical industries

Applications

- With clearing all clinical trial studies in humans, it is expected to help in the treatment/management of Alzheimer's disease



Plastic Depolymerization and Upcycling (DEPOLUP)

India consumes ~20 million tons of plastics annually, with PE and PP making up ~12 million tons, but only ~10% is recycled due to supply chain gaps and limited technologies. Most polyolefins end up in landfills or water bodies, posing serious environmental concerns. Waste polyolefins present a valuable resource to address both waste management and energy needs. Through the mission project, CSIR endeavoured developing the end-to-end technology value chain to transform India's plastic waste crisis and turning environmental pollution into economic prosperity through indigenous innovation.

Lead(s) Portfolio

AI-Enabled NIR Optical Sorter for Waste Plastics

Technology uses NIR spectroscopy coupled with Artificial Intelligence data modelling
Provides automatic, in-line identification and segregation of singulated plastics (PET, HDPE, PVC, LDPE, PP, PS)

Downstream Processing of Waste Pyrolysis Oil

Hydrotreatment of pyrolysis oil
Chemical treatment without hydrogenation

Waste Plastic to Automotive Grade Diesel using CSIR-IIP & GAIL Process

A patented thermo-catalytic process to convert waste PE/PP plastics into diesel-grade hydrocarbons
Diesel meets BS-IV/VI specs from waste PE & PP
1 TPD Pilot plant operational at CSIR-IIP

Upcycling of Waste Polyolefins to Long-Chain Alkenes, Waxes, Etc.

Ruthenium catalysed conversion of waste polyethylene to dodecene

Impact

- Environmental: Boosts plastic recycling, cuts pollution, lowers carbon footprint
- Economic: Reduces costs, improves quality, creates jobs, curbs crude oil imports
- Waste Management: Enhances municipal systems, promotes sorting, ensures adaptability
- Circular Economy: Transforms waste into valuable products, driving sustainability

Target Stakeholders / Beneficiaries

- Recycling Companies
- Waste Management Firms
- Government & Regulatory Bodies
- Technology Providers - AI Developers, optical sensor manufacturers, Robotics companies contributing to sorter technology

Applications

- Plastic producers, processors
- Waste Sorting: Real-time sorting of mixed plastics into value-added fractions
- Fuel Production: Pyrolysis oil to LDO fuels and BS-IV/VI diesel from waste PE/PP
- High-Value Chemicals: Dodecene for crude transport additives and ethylene as feedstock
- Industrial Applications: End-to-end solutions for recycling, feedstock, and specialty chemicals in energy sectors

Output Metrics

- Final TRL achieved
 - ◆ TRL 6: Waste Plastic to Automotive Grade Diesel
 - ◆ TRL 3: NIR Sorter, Pyrolysis Oil Processing
- Patents: 4 Filed; Design Registration: 1 Filed, 1 Granted; Copyright: 1 Filed, 1 Granted
- Publications: 7
- HR Trained: 73



AI-enabled NIR optical sorter system



1 TPD waste plastic diesel plant at CSIR-IIP



Seaweed Mission Phase II: Identification of Potential Locations across India for Seaweed Cultivation and Valorization Technologies (IPL-ISeaC)

Seaweed farming presents a sustainable and profitable alternative for advancing economic stability and growth by reducing dependence on traditional fishing and diversifying the livelihood options available to coastal communities. Despite global success and clear growth potential, the seaweed sector in India remains largely underappreciated and unexploited. Against this backdrop, the mission project was undertaken under the outreach program of CSIR to promote commercial seaweed cultivation, enabling livelihood diversification and assured income generation in coastal rural areas.

Lead(s) Portfolio

A Zero-Waste Discharge Process for the Preparation of Bacteriological and Food Grade Agar from Indian Seaweed Biomass

Ecofriendly technology with no waste generation; Food and bacteriological grade agar with low turbidity

A Zero-Waste Discharge Process to Produce Alginic Acid and its Different Salts from Alginophytes

Na-, NH₄-, K-alginate from Sargassum; Effluent-free extraction; 25–30% yield (dry seaweed basis)

Bio Stimulants from Red and Brown Seaweeds for Enhancing Crop Productivity and Quality

Climate resilience, eco-friendly with 11–38% yield boost; Region-specific formulation/dosing; Biochemical marker-based standardization

Isolation of R-Phycoerythrin with Multiple High Value Commercially Important Additional Products

Low waste generation; R-Phycoerythrin with good purity; R-PE extraction via biorefinery ensuring maximum biomass utilization

Kappahycus alvarezii Elite Seedling Production through Clonal Propagation

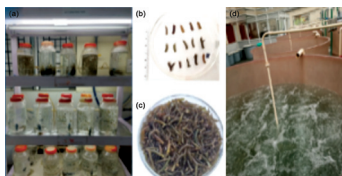
Clonal propagation for high-quality K. alvarezii seedlings with better growth; carrageenan quality suited for Indian seawater; Resistant to seasonal variability

Process of Production of Seedlings in Agarose Yielding Red Seaweed Gracilaria dura for Commercial Exploitation

Enhanced regeneration and survival of non-apical/basal propagules; Non-polluting technology scalable in any Indian maritime state; Successful adoption on Gujarat coast



Seaweed biostimulant



Kappahycus alvarezii Elite Seedling Production through Clonal Propagation

Impact

- Environmental Sustainability: Zero-waste processes eliminate harmful effluents.
- Boosted Agricultural Yields: Seaweed biostimulants enhance crop yields by 11–38% supporting climate-resilient farming.
- Value Addition: Advanced extraction enables isolation of high-value compounds like R-Phycoerythrin and co-production of agar, carrageenan, biostimulants, cellulose.
- Increased Farmer Income

Target Stakeholders / Beneficiaries

- Food & Pharmaceutical Industries
- Agriculture & Textile Industries
- Biotech Industries, Agricultural Sector, Farmers and horticulturists
- Startups and MSMEs working in marine bioresources or organic inputs
- Fisheries Department, Government & Policy Makers

Applications

- Food and Biotech: Production of high-quality agar, alginic acid, natural food additives for food processing and biotechnology uses.
- Agriculture: Seaweed-based biostimulants and soil conditioners enhance crop yield and quality.
- Pharma and industry: Alginates aid in pharmaceutical formulations, welding rods, and textiles.
- Seaweed sector: Year-round elite seedling production provides consistent feedstock for industrial purposes.
- Waste valorization: Process waste is converted into biostimulants, soil conditioners, biochar, and cellulose.

Output Metrics

- Final TRL achieved
 - ◆ TRL 6: Alginic Acid and its Different Salts
 - ◆ TRL 5: Kappahycus alvarezii Elite Seedling Production, Production of Seedlings in Agarose
 - ◆ TRL 4: Bacteriological and Food Grade Agar, Bio Stimulants from Red and Brown Seaweeds, Isolation of R-Phycoerythrin
- Patents: 5 Filed, 2 Granted
- Publications: 19
- HR Trained: 41; Community Training: ~505 fishermen



#startupindia



Sickle Cell Anemia – Phase II

India has the second-highest global Sickle Cell Disease burden after Sub-Saharan Africa, affecting low socio-economic communities. Current screening methods are cumbersome and non-confirmatory, requiring additional testing. CSIR developed two solutions: DBS PCR provides rapid, affordable screening with 99.4% sensitivity and 100% specificity, while CRISPR/Cas9 gene-editing offers curative treatment by correcting mutations in hematopoietic stem cells through US-patented Homology Directed Repair technology with minimal insertions / deletions.

Lead(s) Portfolio

CSIR SCAN DBS Molecular Test Kit

- ◆ First molecular test and diagnostic method providing quick and robust screening and molecular confirmation
- ◆ The WB/DBS-PCR test has been validated by ICMR with 100% sensitivity and specificity

CRISPR Gene-based Editing Technologies

- ◆ A patented technology developed on an engineered CRISPR system consisting of Kinetically enhanced engineered fncas9 along with method and kit for detection of polynucleotide
- ◆ Extremely robust editing and safety profile platform technology is successfully applied notably in eye disorder LCA and neuropathology FENIB



CSIR SCAN DBS Molecular Test Kit



FELUDA TEST Commercialized by TATA MD

Impact

- CSIR SCAN DBS Molecular Test Kit
 - ◆ Enables informed clinical decisions without delay
 - ◆ Eliminates multiple testing rounds, reducing healthcare costs and logistics
- CRISPR Gene-based Editing Technologies
 - ◆ World's first commercially available, DCGI-approved paper strip CRISPR test
 - ◆ Detects nucleic acids (DNA/RNA) and single nucleotide variants across multiple readout modes
 - ◆ Offers curative gene therapy potential for SCD patients

Target Stakeholders / Beneficiaries

- Patients with Sickle Cell Anemia and carriers
- Pharmaceutical companies developing gene therapies
- Biotechnology firms specializing in gene editing
- Government / Private Hospitals/ Clinics/ Diagnostic Centers /CRO
- Medical Device manufacturers

Applications

- Comprehensive screening and confirmation for sickle cell anemia patients, carriers, and unaffected individuals in a single test
- Prenatal diagnosis and genetic counseling for high-risk couples to prevent birth of affected children
- Multi-disease diagnostic platform including paper strip-based testing (FELUDA/RAY) for nucleic acid detection and single nucleotide variants
- Therapeutic applications for other genetic disorders

Output Metrics

- Final TRL achieved
 - ◆ TRL 7: CRISPR Gene-based Editing Technologies
 - ◆ TRL 6: CSIR SCAN DBS Molecular Test Kit
- Patents: 2 Filed, 2 Granted
- Publications: 10
- HR Trained: 120



Contributions & Acknowledgement

The present document has been published as a team effort from CSIR HQ anchored at the Innovation Management Directorate (IMD). Technology Management Directorate (TMD) is also acknowledged for providing inputs to the relevant missions handled by them.

CSIR-NIScPR is acknowledged for production and publication of the document.

Directors of all concerned CSIR laboratories are acknowledged for going through and vetting the contents.

DG, CSIR is acknowledged for patronizing the initiative.

Editors

Deepti Sharma Dullu
Nidhi Behl Jugia

Contribution of Contents

Vandana Bisht
Mahesh Kumar
Preeti Srivastava
A.S. Nirmala Devi
Pooja Aggarwal
Vibha Malhotra Sawhney
MP Darokar
Meenakshi Singh

Technical Support

IT Team
Menaka Chauhan

Production

Ashwini Brahmi

Coordinator

Debashis Bandyopadhyay



Council of Scientific & Industrial Research
Ministry of Science & Technology, Govt. of India