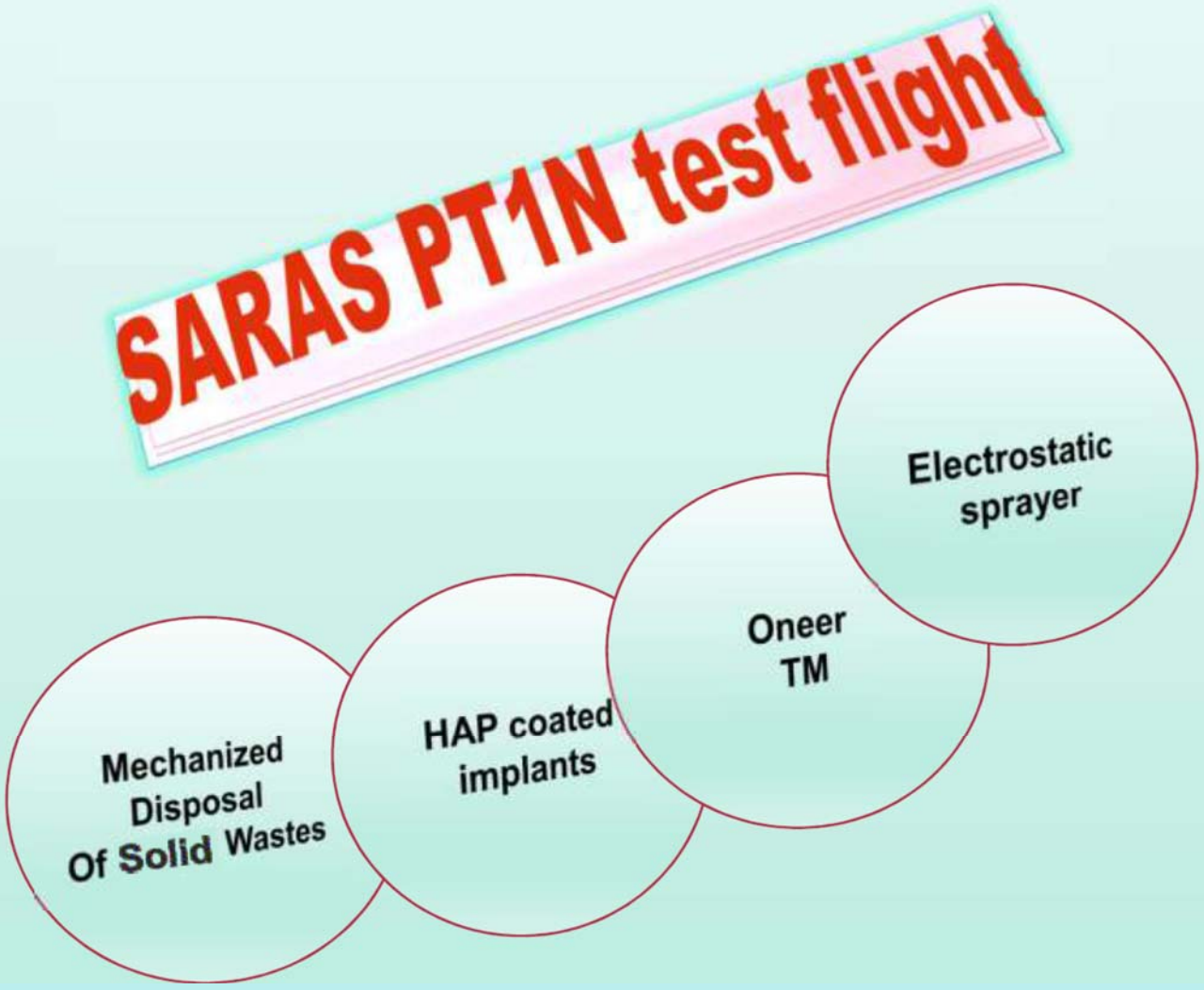
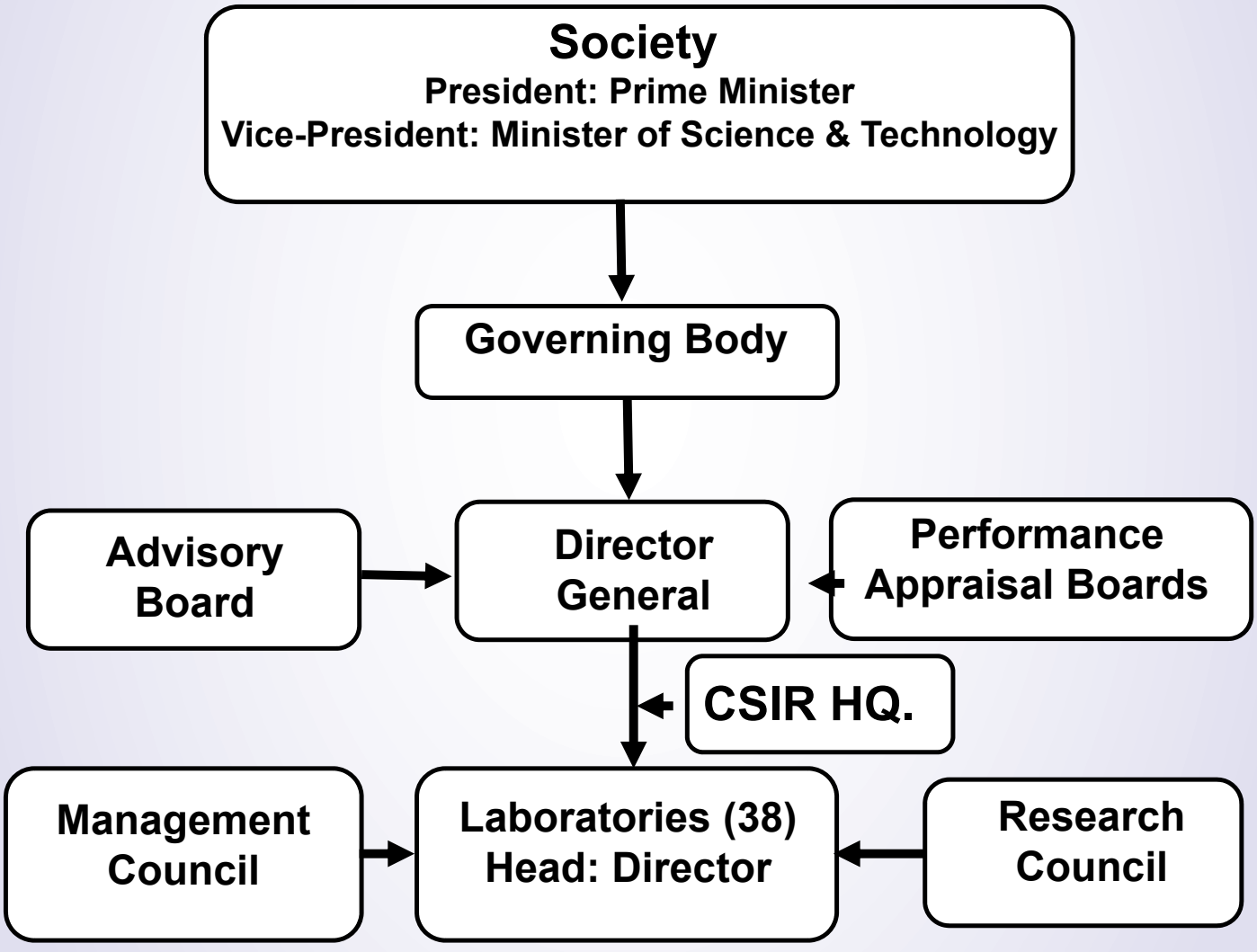
Annual Report
2017-18

Council of Scientific & Industrial Research
Rafi Marg, New Delhi-110001


SARAS PT1N test flight
Electrostatic sprayer
Oneer TM
HAP coated implants
Mechanized Disposal Of Solid Wastes

CSIR ORGANIZATIONAL STRUCTURE



Resource Base

38 Laboratories	
39 Outreach Centres	
1 Innovation Complex	
3 Units	
Budget	
GIA General	2352.22
GIA for Capital Assets	560.00
GIA General Research Scheme	225.00
GIA Salary	1444.90
Total	4582.12
Staff Strength	
Consisting of 12155 Permanent Staff (as on 01.02.2018)	
Comprising 3567 Scientist 5132 Technical and Support Staff 3456 Administrative Staff	

Performance Indicators

More than 5000 Research Publications during 2017
170 Filed in India
172 Granted in India
203 Patents Filed Abroad
423 Patents Granted Abroad

National S&T Human Resource Development
Research Fellows / Associates supported: 6492
Senior Research Associates (SRAs) in position: 151
Research Scheme Supported: 828
Emeritus Scientists in Position:109

EXECUTIVE SUMMARY

1.0 PREAMBLE

- The Council of Scientific & Industrial Research, established in 1942 is an autonomous body which is known for its excellence in R&D and S&T innovations. CSIR has pan India presence through its network of 38 national laboratories which undertake well focused basic and applied research in diverse fields of science and technology. CSIR has also established 39 outreach centres, one Innovation Complex and three units. CSIR's R&D expertise and experience is embodied in about 4000 active scientists supported by about 7000 scientific and technical personnel.
- CSIR has been playing a significant role in mentoring the scientific and technological advancement of the country. Through its technological interventions, CSIR has not only provided solutions and innovations for the industry but has also proved to be a catalyst in improving the quality of life of millions of people across the country. CSIR covers a wide spectrum of science and technology – from radio and space physics, oceanography, earth sciences, geophysics, chemicals, drugs, genomics, biotechnology and nanotechnology to mining, aeronautics, instrumentation, environmental engineering and information technology. It provides significant technological intervention in many areas with regard to societal efforts which include environment, health, drinking water, food, housing, energy, leather, farm and non-farm sectors.
- CSIR is the Nation's custodian for Measurement Standards of Mass, Distance, Time, Temperature, Current etc. CSIR has created and is the custodian of Traditional Knowledge Digital Library (TKDL) which is a powerful weapon against unethical commercial exploitation of Indian traditional knowledge. CSIR maintains Microbial Type Culture Collection (MTCC) and Gene Bank.
- Pioneer of India's intellectual property movement, CSIR today is strengthening its patent portfolio to carve out global niches for the country in select technology domains. CSIR has pursued cutting edge science and advanced knowledge frontiers. It has published around 5336 papers in SCI Journals during 2017 with average impact factor of 3.353.
- CSIR through its various constituent laboratories is also placing major focus upon creating incubation facilities for spin off and startups. CSIR would hand hold these companies so as to create a new segment of knowledge enterprises.
- CSIR has been focusing in a significant manner on the development of S&T Human Resource and provided the yeoman service through various fellowships. It has been imparting skills in diverse S&T areas so as to empower youth for better career and employment opportunities. CSIR has forged linkage with Ministry of Skill Development and Entrepreneurship to enhance and widen its contributions for Skill Development in the country.

2.0 SIGNIFICANT EVENTS

Hon'ble Prime Minister and President, CSIR Society visit to CSIR-CDRI

Shri Narendra Modi, Hon'ble Prime Minister of India and President, CSIR Society, visited the CSIR-CDRI on 20 June 2017. Shri Ram Naik, Governor of Uttar Pradesh, Shri Yogi Adityanath, Chief Minister, Uttar Pradesh and Dr. Girish Sahni, Director General, CSIR, were also present. The Hon'ble Prime Minister was shown around an exhibition showcasing the major contributions of the Institute in drug discovery and development. He was also briefed about the scientific, societal and industrial achievements of the Institute. The development of three new drugs for the treatment of osteoporosis, malaria and blood clot was explained to him. The Hon'ble Prime Minister reviewed the R&D activities and interacted with some senior scientists of the Institute.

Fig.2.1. Hon'ble Prime Minister being welcomed by DG, CSIR and Director, CSIR-CDRI

President of India Emphasizes on CSIR's Contribution to Nation Building

The conclusion of Platinum Jubilee year was celebrated during the Foundation of CSIR on 26th September, 2017. Hon'ble President of India Shri Ram Nath Kovind was the Chief Guest.

Appreciating the work of CSIR in bringing about sustainable improvements in the quality of life of Indians, as well as in helping business and industry with specific applications of science and technology, the Hon'ble President of India Shri Ram Nath Kovind called upon CSIR to continue to make new technologies as well as basic research relevant to our developmental hopes.

The President also said that it is very telling that the staff of CSIR constitutes only about three to four per cent of India's scientific manpower but contributes nearly 10 per cent of India's scientific output. "This is extremely creditable and emphasizes how important CSIR is to the nation building process," he said.

The Hon'ble President said that from the earliest days of our Independence, our country has been clear about the use and deployment of science and technology to achieve the goals of social development. This has meant both exploiting India's rich wealth of traditional knowledge and intellectual property – of which CSIR is the custodian – as well as being open to the latest in science and technology, not being afraid of cutting-edge research and its discoveries, and where possible using these to help our common citizens. The President said, "I am pleased to note the widespread social benefits of the two CSIR technologies that are being dedicated to the nation today. The first is a hand-held milk tester that will allow us to more easily identify adulterants in milk. The second is Waterless Chrome-Tanning Technology that eliminates the use of water in two processes before and after tanning – and also reduces the solids dissolved in wastewater during tanning. This has an obvious environmental impact." He also mentioned that CSIR's anaerobic digester was making a big difference to the Swachh Bharat mission, as it converts biodegradable kitchen waste to biogas and manure that can be used for family kitchen gardens.

"Another commendable CSIR creation I have been told about is DivyaNayan - a reading device for the visually challenged," he said. "Inventions and innovations such as these provide simple and user-friendly solutions to the most underprivileged and deprived sections of our people. They make science and technology so meaningful as India seeks to achieve the Sustainable Development Goals."

Fig.2.2. President of India Shri Ram Nath Kovind addressing the gathering

Shri Ram Nath Kovind also called for taking accelerated steps to promote the participation of girl students and women in science and technology. “If this disparity is not addressed,” he said, “our scientific achievements will always be less than perfect and less than desirable.” The President expressed his concern that the participation of women in science in India was distressingly small – less than two of every 10 scientific researchers in India are women. Of those who join the Indian Institutes of Technology each year, just about 10 per cent are women. “These numbers are simply not acceptable,” he said.

Fig.2.3.The President, Shri Ram Nath Kovind at the Foundation Day of CSIR and Celebration of conclusion of CSIR Platinum Jubilee Year. The Union Minister for Science & Technology, Earth Sciences and Environment, Forest & Climate Change, Dr. Harsh Vardhan; the Minister of State for Science & Technology and Earth Sciences, Shri Y.S. Chowdary

Fig.2.4. Hon’ble President of India releasing the CSIR technology “Ksheer Tester” for checking adulteration in milk

Fig.2.5. Hon'ble President of India Shri Ram Nath Kovind, Minister of S&T and ES Dr. Harsh Vardhan, Minister of State Mr. Y.S. Chowdary and Dr. Girish Sahni, DG-CSIR posing with Directors of CSIR laboratories

Welcome Address by Dr. Harsh Vardhan, Hon'ble Minister of Science & Technology and Earth Sciences

In his Welcome Address, Dr. Harsh Vardhan congratulated CSIR for having lived up to the challenge posed by Prime Minister Shri Narendra Modi a year back where he appealed to CSIR to work on at least 100 new technologies which could be delivered to the people of India. "I feel so happy that just after 365 days, we are working on at least 250 new technologies which are absolutely people-centric," he said.

Dr. Harsh Vardhan said, "amongst the 5000 private and public aided scientific institutions in the world, as per *Scimago* rating CSIR the only Indian Institution that enjoyed the 99th position. But today after one year, CSIR position has become 75th. Last year CSIR was 12th amongst a list of 1200. Today I feel so happy to announce that from that 12th also, CSIR come down to 9th position. I think this is no small achievement."

He said that during the last one year many successful events have been organized with the help of CSIR, for instance the India International Science Festival with participation of over 5 lakh people, over 10,000 scientists and hundreds and thousands of students.

Apart from the large number of exhibitions organized by CSIR laboratories all over the country, Dr. Harsh Vardhan informed that an ambitious programme *Jigyasa* was launched during the Platinum Jubilee Celebrations.

He also appreciated CSIR for taking up 75 Skill Missions ensuring that those who don't get enough of education in their life could be imparted good quality skills so that they can be adopted by industries.

Address by DG, CSIR

Presenting the CSIR Report, Dr. Girish Sahni, Director General, CSIR said, “The mission of CSIR is linked to excellence in science, development of technology and using both as a magic combination to connect to society, poorest of the poor, mightiest of the mighty, mighty industries, village industries, medium and small industries. So, it’s a very wide canvas that CSIR chose for itself and a role that our founding fathers destined for us.”

He said that through the 75 years of existence, at every junction CSIR rose to the challenges the society and the nation gave it. “From the times of import substitution, at the time when foreign exchange was a priority, we gave the foundation of not only the chemical industry of the country but the pharma industry as well,” he said. “Today India happens to be the generic drugs capital of the world, in major part due to contributions from our labs.”

DG-CSIR informed that CSIR had recently launched a herbal medicine for diabetes which is doing great. “Our contribution to the production of India’s first world class Light Combat Aircraft, the fighter Jet LCA-TEJAS is also very significant,” he said. Dr Sahni informed that the carbon-fibre body of the aircraft, the control systems, the head-up display are all from CSIR Labs.

Another contribution is standardization of coal so that the real calorific value is obtained and genuine quantification of the coal prices is made. New varieties of rice, helping the farmers, milk testing, earthquake early stage warning, India’s first transmissometer on air fields, these are among the many achievements of CSIR in recent years, he said. The socio-economic impact of only a handful of technology has been rated to be more than 30,000 crores, the combined budgetary support in the last several decades of its existence. So, the contribution towards society from CSIR is virtually immeasurable.

He said, “Now we have refocused our attention and our energy in such a way that outcomes in healthcare, outcomes in energy sector and outcomes in strategic sector are the focus of our attention, not the subject areas alone. Subject areas are the means to an end where we will deliver tangible outcomes. We have resolved to solve societal problems. Right now we are close to 300 projects in which the direct outcomes in the next two years would be of direct benefit to the society.”

Foundation Day Lecture

The CSIR Foundation Day lecture was delivered by Prof. Rajendra Srivastava, Dean of the Indian School of Business (IBS). He said, “When I hear the statistics about CSIR, it’s really amazing and aspirations are just the right aspirations. CSIR provides 3% of the manpower in research but 10% of the output. That is a great achievement.”

Prof. Rajendra Srivastava said that Globally India does not rank well in scientific research and innovation at the moment. So the country has a long way to go. We are number 1 in Central and South Asia but that number 1 is not very good when you start comparing it to global standards.

Our aspirations should to be number one in the world. We provide the talent to Silicon Valley, to Cambridge research; why can't we utilize this talent at home.

He said those companies that fail to recognize the need for change become moments in history. Kodak is still much known for the Kodak moments but that company doesn't exist anymore. Kodak was a chemical company believing in silver halide, but the new technology was digital.

He concluded that emerging markets need Innovation; Process & Product Innovation Integration; Labs and Markets Integration; Frugal & Reverse Innovation, and Innovation for Emerging Markets. He advised young scholars to focus on use-driven innovation, integrate theory and practice, seek multidisciplinary assignments and focus on impact-learning from the future.

Upgraded SARAS makes a Maiden Flight

The new upgraded version of SARAS PT1N, a 14-seater passenger aircraft developed by the CSIR-NAL completed a successful maiden flight on 24th January 2018. The primary objective is to evaluate the system performance in about 20 flights and the data collected from this would be used to freeze the design of the production version aircraft. The revised version with 14 seats instead of 19, SARAS-PTN1, has improved avionics, radar, linear wing flap actuator, environmental control system, engine flap actuators and flight control system. CSIR-NAL hopes to pitch SARAS as a feeder aircraft, light cargo aircraft and an air ambulance. SARAS PT1N took off at 11 am from the HAL airport and flew for about 40 minutes at the maximum height of 8500 feet at a speed of 145 knots. SARAS is the first Indian multi-purpose civilian aircraft in the light transport aircraft category.

On this occasion, Dr. Harsh Vardhan, Union Minister for Science & Technology, Earth Sciences and Environment Forest & Climate Change said, "Saras will give a boost to Prime Minister Narendra Modi ji's missions of regional air connectivity and air taxi services and Make in India."

Dr. Girish Sahni, Director General, CSIR called it "one of the CSIR's Make in India efforts, which will benefit both civil & military requirements".

Fig.2.6. Saras PT1N maiden flight

Inauguration of Centre for Innovation and Translational Research at CSIR-IITR

Dr. Girish Sahni, Director General, CSIR, visited CSIR-IITR, Lucknow on February 6, 2017 where he inaugurated the Centre for Innovation and Translational Research (CITAR).The center provides researchers from multidisciplinary backgrounds an opportunity to innovate, develop, probe, and translate the most important technological challenges related to health and the environment with a vision to encourage impactful societal and industrial research, enable startups and foster collaborations with researchers to fast track technological solutions. The facility is equipped with state-of-the-art instrumentation, laboratories, and computational resources.

Dr. Sahni also dedicated to the nation a Computational Toxicology Facility (high performance computing for toxicology cheminformatics and Bioinformatics – the only facility for toxicology in India), Translational Research Facility and the Cell and Molecular Biology Facility and Industrial Labs. These facilities will leverage the institute's capabilities by providing researchers, innovators, and entrepreneurs from academia and industry access to state-of-the-art platform technologies and mentorship in a multidisciplinary collaborative environment.

Fig.2.7. DG-CSIR inaugurating the Translation Research Facility and Computational Toxicology Facility at CSIR-IITR

DG, CSIR appreciated the infrastructure being created at CSIR-IITR through CITAR which will help to establish an ecosystem for nurturing innovative technology-based solutions for startups and industries.

India's First "Highway Capacity Manual" Released

Shri Nitin Gadkari, Hon'ble Minister, Ministry of Road Transport & Highways released the country's first ever "*Highway Capacity Manual*" (HCM). The manual will guide road engineers and policy makers about road expansion.

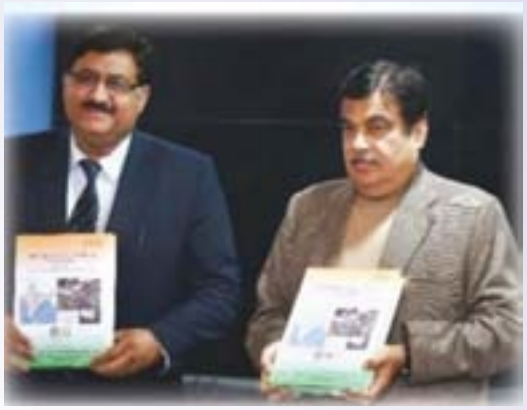


Fig.2.8. DG, CSIR and Shri Nitin Gadkari Hon'ble Minister, Ministry of Road Transport & Highways releasing the country's first ever "*Highway Capacity Manual*" (HCM)

The manual has been developed by the CSIR-CRRI on the basis of an extensive, country-wide study of the traffic characteristics on different categories of roads like single lane, two-lane, multi-lane urban roads, inter-urban highways and expressways and the associated intersections on these roads. The study was conducted in collaboration with seven academic institutions including IIT-Roorkee, Mumbai and Guwahati; School of Planning and Architecture, New Delhi; Indian Institute of Engineering and Science and Technology, Shibpur; Sardar Vallabhai Patel National Institute of Technology, Surat and Anna University, Chennai.

Countries like the US, China, Malaysia, Indonesia, Taiwan have their own Highway Capacity Manuals for quite some time. This is the first time that the manual has been developed in India. The manual lays down guidelines for when and how to expand or manage different types of roads and their intersections and the level of services to be put in place. It has been developed based on the unique nature and diversity of traffic on Indian roads. Shri Nitin Gadkari expressed the hope that the long awaited manual would help in the scientific planning and expansion of road infrastructure in the country. He also said that there was a need to popularize the use of new materials like fly-ash, plastic, oil slag and municipal waste in road construction. He also called upon researchers and engineers to expedite formulation of a good design for safe and effective speed breakers for Indian roads.

Twinning Agreement signed between CSIR and MIDI, Ethiopia

A Twinning Agreement involving six CSIR laboratories with CSIR-NML as the nodal laboratory was signed with Metals Industries Development Institute (MIDI), Ethiopia, at a total cost of ~6 million US$ for CSIR.

Fig.2.9. Signing of the Twinning Agreement in Addis Ababa, Ethiopia

CSIR-NPL and ISRO sign MoU for Time and Frequency Traceability Services

CSIR-NPL signed a Memorandum of Understanding (MoU) and the ISRO Telemetry Tracking and Command Network (ISTRAC), Indian Space Research Organization (ISRO), Department of Space, in New Delhi. The MoU was signed by Shri V.V. Srinivasan, Director, ISTRAC on behalf of ISRO and Dr. D.K. Aswal, Director, CSIR-NPL, on behalf of CSIR. The Union Minister for Science & Technology, Earth Sciences and Environment, Forest & Climate Change, Dr. Harsh Vardhan and Minister of State for Development of North Eastern Region (I/C), Prime Minister's Office, Personnel, Public Grievances & Pensions, Atomic Energy and Space, Dr. Jitendra Singh, DG,CSIR, Dr. Girish Sahni, and other senior officers from ISRO, CSIR and CSIR-NPL graced this important national event. The scope of this MoU is the rendering by CSIR-NPL of all the necessary actions to support the following:

- Time and Frequency Traceability services from National Time Scale of CSIR-NPL to IRNWT-I and IRNWT-II of ISTRAC/ISRO through Two-way Satellite Time and Frequency Transfer (TWSTFT);
- Time and Frequency Traceability services from National Time Scale of CSIR-NPL to IRNWT-I and IRNWT-II of ISTRAC/ISRO through GNSS CV; and
- Annual audit of IRNWT-I and IRNWT-II as per ISO/IEC 17025 for ensuring correctness and accuracy of the time traceability. India's indigenously developed global positioning system called NavIC, has been recently configured to synchronize its clocks to the time provided by the CSIR-NPL. Till recently, the satellites on the NavIC managed by ISRO relied on the US-based GPS system. The linking with CSIR-NPL will aid in high precision satellite-based communication, precise guidance of missiles and navigation.

3.0 SIGNIFICANT S&T ACHIEVEMENTS

Cultivation of Banana for the First Time in Jammu & Kashmir

Using tissue culture practices, CSIR-IIIM has for the first time successfully cultivated banana in Jammu and Kashmir. Samplings of high quality tissue culture variety Bhim Grand Naine(G-9) banana were cultivated over two acres' land. The plant grew to a height of 6.5 to 7.5 feet and gave yield of 20-30 kg per plant and 20-25 tonnes/acre, which translates to almost Rs. 250-300/banana plant. Farmers could get a net return of approximately Rs. 2.5 lakh by cultivation of this crop on one acre of land. This is for the first time commercial cultivation of banana has been successfully accomplished in Jammu and Kashmir making it a profitable agriculture venture for farmers of the State.

New Rice Variety with Low Glycemic Index Released

CSIR-CCMB in collaboration with the Indian Institute of Rice Research at Hyderabad has released a new variety of rice that resists pests and is also beneficial for those with diabetes. The new Improved Samba Masuri (ISM) rice variety is resistant to Bacterial Blight (BB) and at the same time has the lowest Glycemic Index (GI) at 50.9 among all major rice varieties. At present, almost 40 per cent of the normal Samba Masuri rice crop is being lost due to Bacterial Blight (BB). The new ISM variety of rice is, therefore, expected to significantly reduce this crop loss.

Nutraceutical for Osteoarthritis

In a new breakthrough in the area of osteoarthritis, CSIR-CDRI have developed a standardized nano-formulation from *Spinacea oleracea* (Palak) for prevention and management of osteoarthritis by preventing cartilage damage. This nutraceutical has extra health benefits for osteoarthritic joints in addition to the basic nutritional value found in *Spinacea oleracea*. It imparts no toxicity and is effective at lower doses with nano formulation. It has been launched with M/s Pharmanza Herbals Pvt. Ltd., Gujarat and its marketing partner namely, Aeran Lab (India) Pvt. Ltd., Thane for marketing, on March 13, 2018 as a Nutraceutical with brand name "Joint fresh".

Development of RO Purifier which Preserves Minerals

CSIR-IICT has designed hollow membranes which purify drinking water efficiently without causing any decrease in the mineral levels in water. The membranes look like thin plastic wires as they are made of poly-ethersulphone, a synthetic material. The water purifier developed by CSIR-IICT removes the microbes and other contaminants completely, keeping minerals intact in the water.

Fluorescent Fibers and Ink for Security

CSIR-NIIST has developed Fluorescent Fibers and Ink for Security. Invisible fluorescent fibers find important use for preventing currency/document/ consumer goods counterfeiting. Fluorescent ink formulations with unique fluorescent signatures has application for security printing.

Zero liquid discharge leather technology

A zero wastewater discharge process technology based on Electro-oxidation (EO) has been developed for the first part of the leather manufacturing process - the pre-tanning processes. The potential environmental benefits and potential social impacts for India includes: no discharge of wastewater from tanneries - the possible reduction of cost will be about Rs. 96 million per annum from reduction in the cost of wastewater treatment; the system does not result in generation of sludge and H_2S, which was about 160 tons' sludge per annum. The technology has been transferred to M/s Leayan Global Pvt ltd, Kanpur; M/s Royal Tanners, Kanpur; and AN Leathers Pvt Ltd, Agra.

New affordable and disaster-resistant house technology developed called as SERCular housing technology:

Affordable, and Disaster-resistant housing, termed as SERCular housing technology is developed by CSIR-SERC, for Pardhan Mantri Awas Yojana - Grameen (PMAY-G). This type of house consist of twin rooms of standard 4-m. dia. circular module, built with special self-locking (SL) blocks. The plinth area of 2-roomed house is about 25sq.m. It is about 20% economical when compared to conventional housing and, offers cyclone resistant technology with earthquake resistant advantages.

Discovery of Shale Gas in Central India

CSIR-CIMFR has discovered shale gas in two areas in the Gondwana basin in Central India and Godavari basin. The total shale gas discovered so far in the country in these two basins is estimated to be about 63 Trillion Cubic Feet (TCF). It is considered as one of the best sources of non-conventional natural gas. Shale gas is methane gas or natural gas trapped within beds of shale rocks that occur 400-3000 metres below the earth. The new discovered reservoirs are being explored using a consortium approach in which institutions like CSIR-NGRI and Coal India Limited will carry out characterization and potential studies of the Gondwana and Damodar basins. Shale gas, which has about 95% of methane and 2% ethane gases, can be used practically everywhere, where natural gas is used.

Sustenance studies for Indian Advanced Heavy Water Reactor (AWHR)

Reactors of BARC have an annular sectored tank named Gravity Driven Water Pool (GDWP) on its dome region of the primary containment in reactor building which provides cooling to fuel in passive mode. Shake table studies were conducted by CSIR-SERC on a scaled down model of GDWP of AHWR. The seismic responses of the container were studied for the evaluation of natural frequencies, mode shapes and damping and the pressure loads due to sloshing effects.

Safe Disposal of Municipal Solid Waste (MSW)

CSIR- CMERI has developed technology for safe disposal of Municipal Solid Waste (MSW) generated on daily basis and generation of fuel gas containing predominantly CO and H_2. Special feature of the technology is unique gas cleaning system to minimize the dust accumulation in the generated fuel gas and utility of slag as construction material.

Textile Reinforced Concrete Panels Developed

CSIR-SERC has developed a technology for manufacturing Textile Reinforced Concrete (TRC) panels for construction of rapid-built, affordable, light weight and durable toilets. The panels are also non-corrosive and durable. Compared to conventional method of construction, TRC construction is cost effective and time saving.

Genomics and other Omics Technologies for Enabling Medical Decision (GOMED)

CSIR-IGIB has set up a pilot platform entitled "Genomics and other omics technologies for Enabling Medical Decision (GOMED)". CSIR-IGIB has developed low-cost molecular genetic diagnostic tests for common genetic disorders specific to India. Through the GOMED initiative, CSIR-IGIB's in-house expertise is made available to a larger community of clinicians to enable precise diagnosis and prognostication. Assays for 27 diseases, developed at CSIR-IGIB were licensed to M/s. Dr. Lal Path Lab Pvt. Ltd. for commercial application.

Spent Wash Technology Management

CSIR-CSMCRI, in collaboration with engineering partner M/s. Chem Process Systems Private Limited, have developed complete technology solution for valorization of spent wash generated in sugarcane molasses based alcohol distillery. The process allows utilization of spent wash for production of value-added by products, viz., potash fertilizer, animal feed ingredient etc., while achieving statutory compliance with 'zero liquid discharge' norms. Preliminary economic analysis for implementation of the technology in a 100 klpd distillery, suggest a CAPEX payback period of about 3.5 years.

Setting up 1 TPD pilot plant for converting waste plastics to diesel

As a potential solution to address the growing menace of plastic usage and the associated waste generation in the country, CSIR-IIP has developed a facile process for the conversion of waste plastics (polyolefins) to value added hydrocarbons e.g. gasoline, diesel and aromatics. A 1 TPD plant is being set up at CSIR-IIP for converting waste plastics to automotive grade (Euro IV/VI diesel) with support from GAIL. The development requires pre-treatment facilities for validation of the bench-scale studies for production of diesel and establishment of various technological and process parameters that would facilitate successful commercialization/licensing of technology.

Technology for Extraction of Tungsten from Variety of Scraps

India is deprived of primary ore deposits for tungsten, which is an industrially important ore.Currently most of the Indian tungsten demand is met through imports.The technology developed at CSIR-NML is aimed at tungsten metal production through recycling of available scraps. 500 kg/day scale W-powder production plant by M/s Wolfram MetChem Pvt. Ltd has been commissioned under the supervision of CSIR-NML

4.0 SCIENTIFIC EXCELLENCE

CSIR has published 5336 research papers during 2017 in SCI journals of repute.:

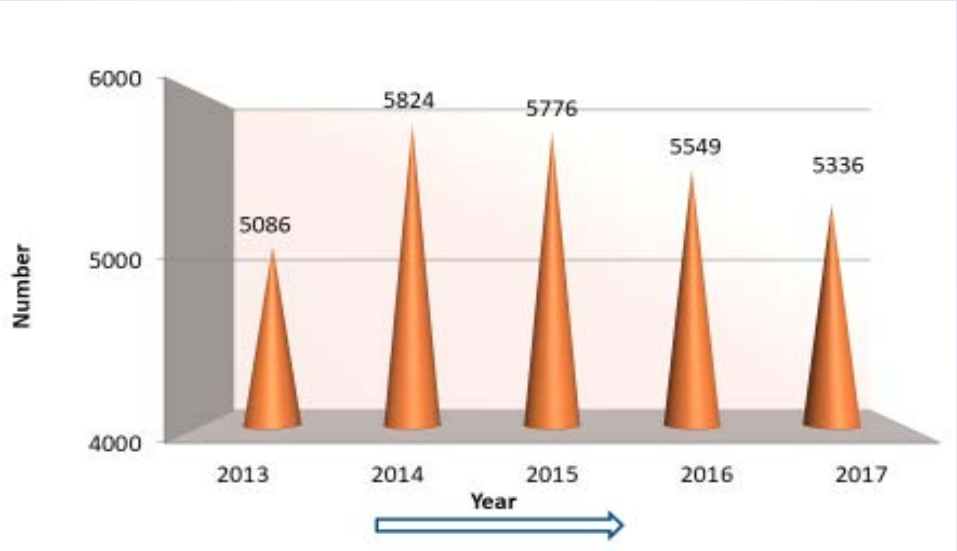


Fig.4.1. Research papers during 2013-17

The new knowledge generated from CSIR laboratories is reflected in terms of high average Impact Factor (3.353). Following graphs shows the trend of research over the last five years.

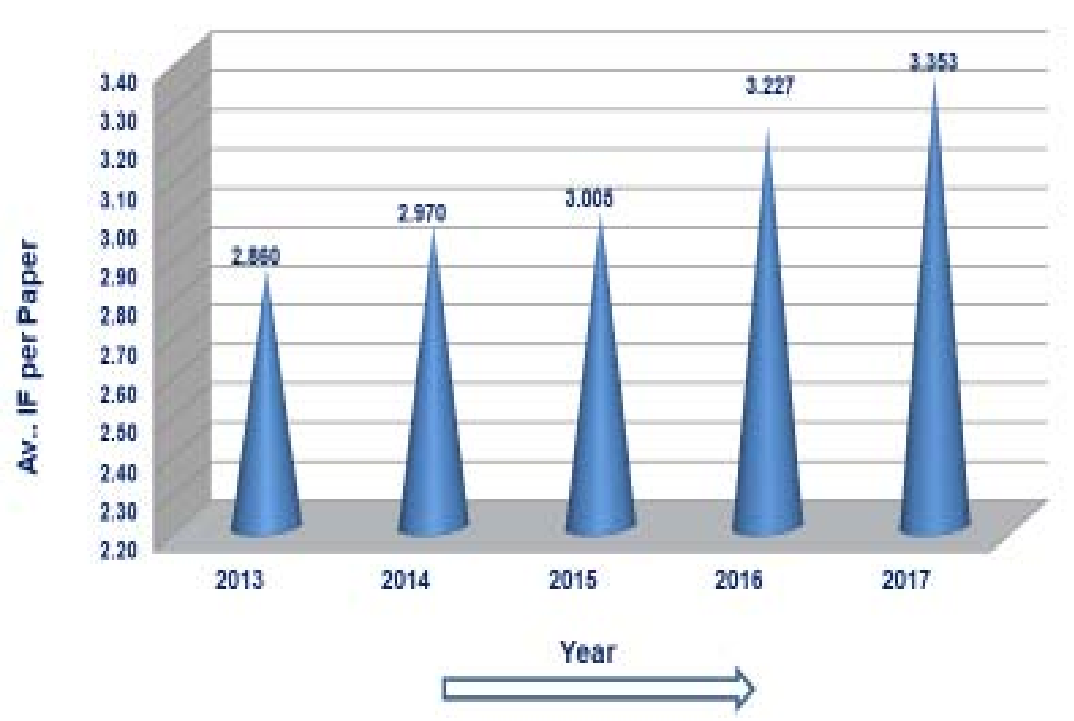


Fig.4.2. Average impact factor per paper, during 2013-17

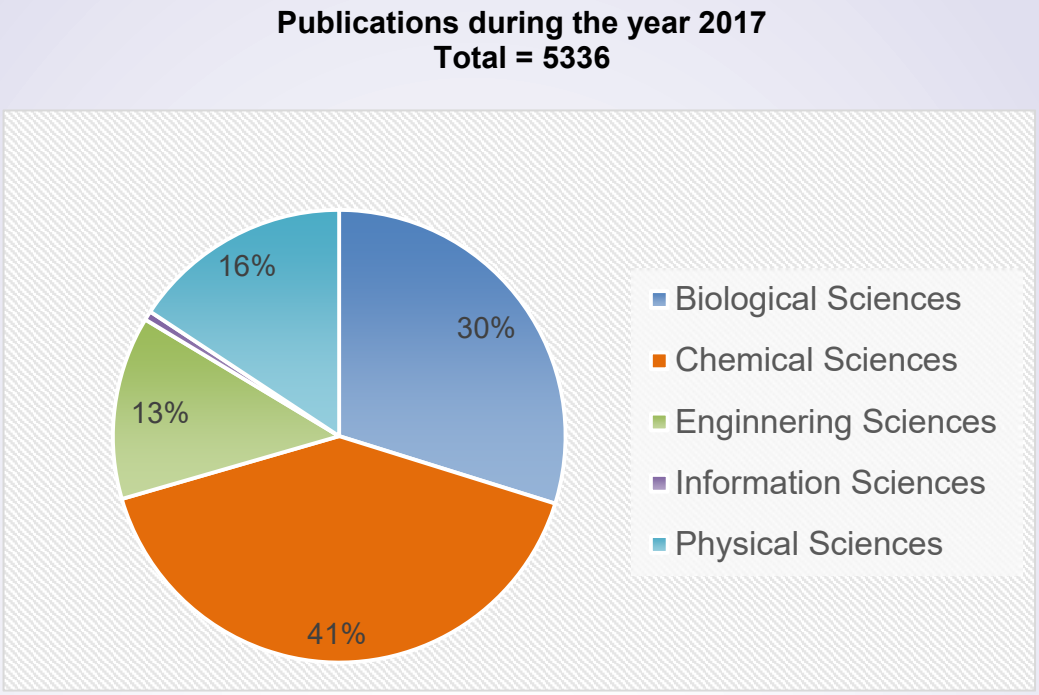


Fig.4.3. Clusterwise poublication in 2017

Excellence in Intellectual Property

CSIR has filed 200 patents abroad and 170 patents in India during 2017-18, and it has been granted 172 patents abroad and 423 patents in India. Following graphs provide data on patents filed and patents granted over the last five years:

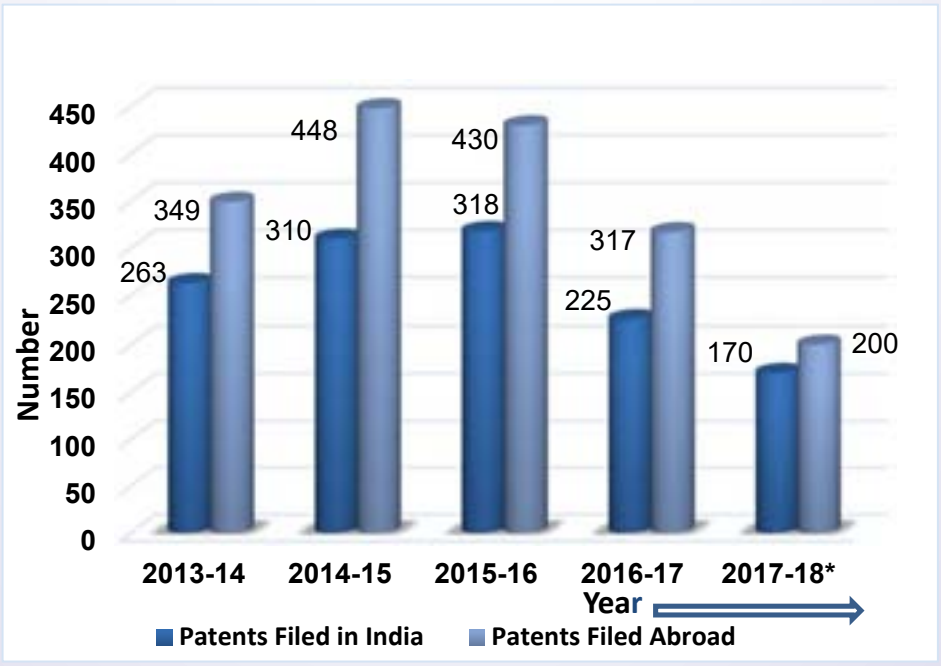


Fig.4.4. Patents filed in numbers from FY2013-14 to FY2017-18

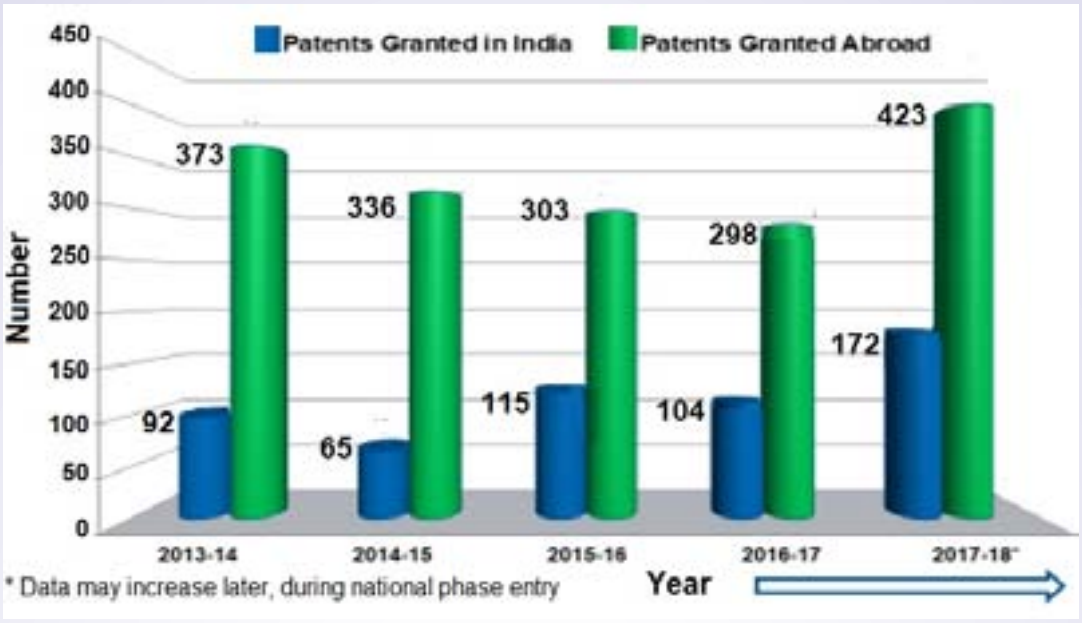


Fig.4.5. Patents granted from FY2013-14 to FY2017-18

4.1 Value Generation through External Cash Flow (ECF)

CSIR has generated External Cash Flow of Rs 963.06 crore during 2017-18 (up to 31-3-2018), through working with various Govt/non-Govt Indian and foreign organizations. Following graphs provide data on ECF generated over the last five years:

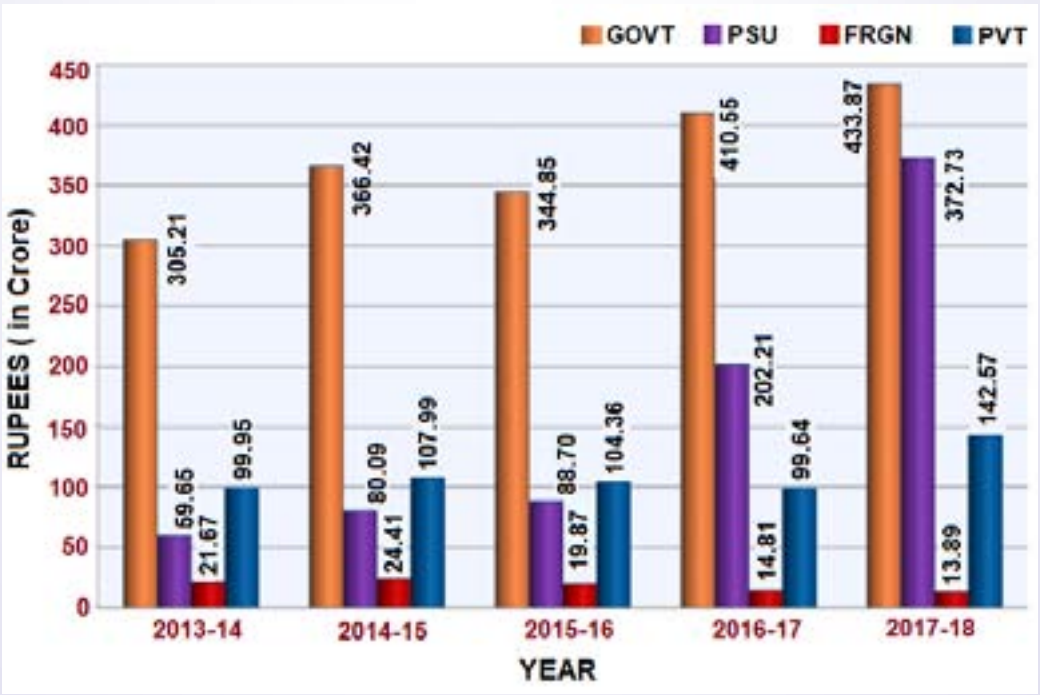


Fig.4.6. External Cash Flow from FY2013-14 to FY2017-18

5.0 SIGNIFICANT S&T CONTRIBUTIONS

Integrative Benefits - Cluster Wise

5.1 Strategic and Industrial Impact

The constituent laboratories of CSIR have been making consistent and significant technological contributions towards the strategic and industrial sector across various domains. The notable contribution during the year 2017-18 are briefed as below:

- **Major services and support**
  - CSIR-IHBT recorded spectral reflectance of 48 important forest tree species of tropic, sub-tropic and temperate regions of Kangra and Chamba districts of Himachal Pradesh using 350-2500 nm wavelength spectroradiometer to create Hyperspectral signatures. These recorded spectra were processed and a spectral library of 48 tree species were prepared.
  - CSIR-CIMAP has developed various technologies/products/services for cultivation & conservation of rare aromatic and medicinal plants and popularized the same amongst target user industries/clients growers through print/electronic media scientist-industry meets, participation in expo, trade fairs and international exhibitions. CSIR-CIMAP also has been working for utilization of wastelands/under-utilized lands by cultivating stress-tolerant aromatic crops. The institute was accredited by ICS-UNIDO and associated with Indian-Ocean Rim Association (IORA) during 2017-18 as a focal point for research and training on medicinal plants.
  - CSIR-CCMB at its LaCONES R&D facility carried out DNA-based identification of species and provided services for rehabilitation of wild life and scientific support for wildlife crime investigation.
  - CSIR-IICT also participated in 42nd official international proficiency tests conducted by OPCW, Netherlands, in coordination with National Authority Chemical Weapons Convention, New Delhi.
- **Process development for the enrichment of GLA (98%) from Borage Oil:** CSIR-IICT has developed an efficient process for the enrichment and purification of Gamma Linolenic Acid (GLA) to 97-98% purity from borage oil containing ~22% GLA. This methodology involves transesterification, distillation, crystallization & column purification techniques to obtain ~97-98% GLA. The process has been developed for the first time. The technology was transferred to M/s Fermish Clinical Technologies at 2 Kg/batch scale of borage oil for further formulation & pre-clinical studies at their end as an anti-cancer drug.

- **Modification of C-BRICK machine for mass housing:** CSIR-CBRI undertook R&D for modification of machine for production of prefab components as per market requirement for mass housing & mechanization in wall plastering. The institute identified suitable spraying components along with compressor, motorized planner & accessories for wall plastering mechanized system & prepared design concept for mass industry and also developed improved version of lever mechanism for up-down pressing mechanism of C-BRICK Machine.
- **Prototype of optical protein film:** CSIR-IMTECH has developed a prototype of optical protein film which shows reversible colour shift effect. This Laminated colour shift protein film could be used as a confidential security code for the Defence, Army, Navy personal to avoid infiltration in the borders by the enemy nations.
- **Unique facility established for Chalcogenide glasses:** Chalcogenide glasses are generally known for their extended infrared transmission up to 20 μm which makes them indispensable for IR optical components, especially for thermal imaging applications. CSIR-CGCRI has established a unique facility for the development and moderate scale production of such important class of infrared transmitting glass materials by adopting melt quenching technique. Two types of glass systems such as As – Se and As – Se – Ge have been considered initially.

Fig. 5.1. Processed Chalcogenide glasses (cut and polished)

- **Health monitoring of railway structure:** Fiber Bragg grating sensors has been developed by CSIR-CGCRI for health monitoring of overhead railway infrastructure. Under this activity, an optical strain sensor using indigenously developed fiber Bragg grating (FBG) technology has been developed which is usable at high voltage environment for health monitoring of overhead railway infrastructure and to prevent catastrophic damage of the infrastructure.

Fig.5.2. Test bed for evaluation of optical strain sensors for measurement of control force and control location

- **Soil Nailing Technique:** CSIR-CBRI has developed "Soil Nailing Technique" for stabilisation of soil slope for the construction of underpass intersection below Road traffic. The technology has been evaluated and established for construction of intersection without disturbing the traffic.
- **Fe-P powder for automobile application:** CSIR-IMMT has developed a process for producing a spherical Fe-P powder from the cast iron blocks and predicted the feasibility of coating this powder on stainless steel /mild steel components for automobile application. The Fe-P coatings have a very good adhesion property that also makes it suitable as a base layer for coating.
- **Wind tunnel studies on cable stayed bridge:** A new cable stayed bridge of 640 m connecting Panjim and Mangalore has been proposed. CSIR-SERC has carried out the first of its kind wind tunnel studies on scaled down model of the proposed bridge to assess wind induced aerodynamic force coefficients. Wind tunnel tests have been conducted for single bridge deck with and without crash barriers and hand and also when both decks are placed parallel to each other for various combinations of angles of wind attack. This work was sponsored by M/s. Dilip Buildcon Ltd, MP.
- **Support studies for Indian Advanced Heavy Water Reactor (AWHR):** Reactors of BARC have an annular sectored tank named Gravity Driven Water Pool (GDWP) on its dome region of the primary containment in reactor building which provides cooling to fuel in passive mode. Shake table studies were conducted by CSIR-SERC on a scaled down model of GDWP of AHWR. The seismic responses of the container were studied for the evaluation of natural frequencies, mode shapes and damping and the pressure loads due to sloshing effects.

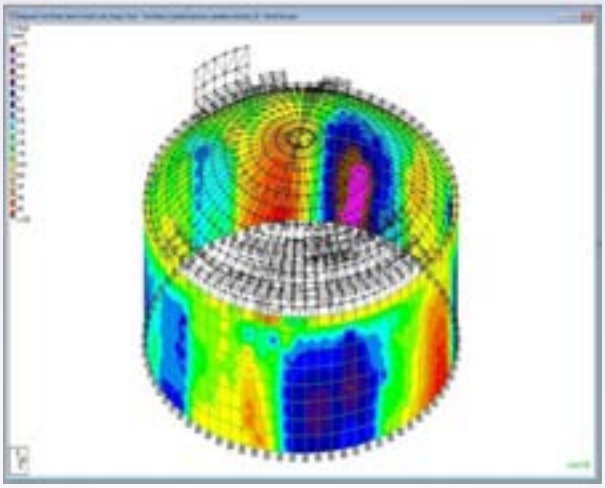


Fig. 5.3. Gravity Driven Water Pool (GDWP)

- **Advanced Coating Technology:** An advanced coating technology, based on electrophoretic deposition (EPD) has been developed at CSIR-IMMT, which has the potential for application in a variety of industries. A robotic device has been designed and developed to carry out the electrophoretic deposition (EPD) to perform in-situ coating inside the long tube.

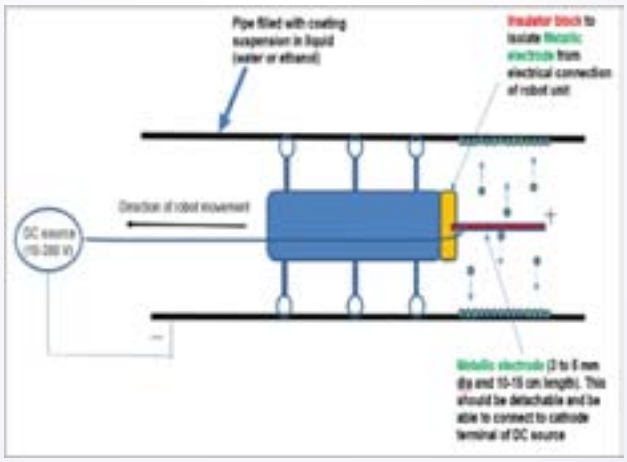


Fig. 5.4. In-situ Coating Technology Process

- **Mirage aircraft upgradation programme of IAF:** CSIR-NAL has significantly contributed towards:

  (a) Integration of various missiles and stores, certification of safe separation of the weapons in the identified envelope using indigenously developed mesh-free method based store separation suite;

  (b) The aero-mechanical load analysis was carried out on the High Speed Low Drag (HSLD) configuration of Mirage aircraft with revised HSLD; and

(c) Flutter clearance of Mirage 2000 aircraft with FOC stores, and (d) aeromechanical studies of new stores on the Mirage aircraft to provide data for stability and control (S&C) analysis in support of flight clearance. FOC was completed and phase 2 has started.

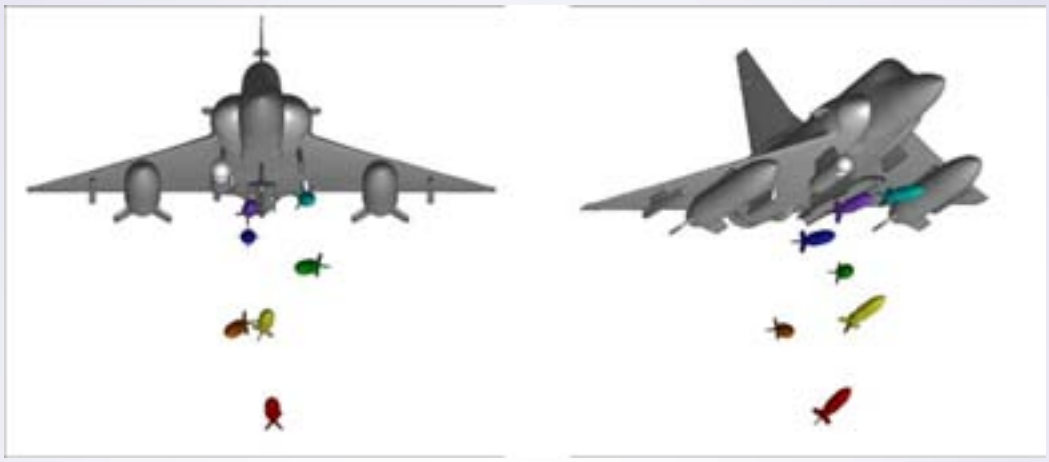


Fig. 5.5. Simulated positions of store for 7 store salvo release simulation

- **Certification of Indigenous Carbon Fiber:** CSIR-NAL developed carbon fibre received certification for aerospace grade by CEMILAC in May 2017 from the Ministry of Defence (MoD). This would be utilized in technology for establishing 100 TPA carbon fibre plant through MIDHANI. Process developments along with modifications in equipment have resulted intermediate modulus grade carbon fibers with improved tensile strength. Development of dry jet wet spinning technology has been initiated to further improve the quality of precursor fibers.

Fig.5.6. Uni-directional and bi-directional fabric prepared from CSIR-NAL's carbon fiber

- **Fluorescent Fibers and Ink for Security:** CSIR-NIIST has developed Fluorescent Fibers and Ink for Security. Invisible fluorescent fibers find important use for preventing currency/document/ consumer goods counterfeiting. Fluorescent ink formulations with unique fluorescent signatures has application for security printing.

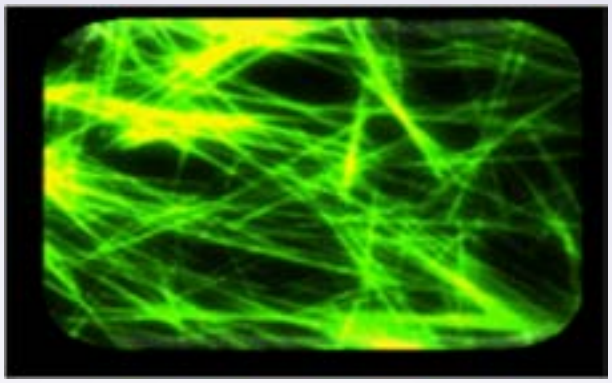


Fig. 5.7. Fluorescent Fibers

- **Design and Development of Microcantilever- based Sensing Platform:** In-line with the country's strategic requirements, CSIR-CEERI has designed and developed SOI-based piezo resistive cantilever platform devices for the detection of biological agents. MEMS cantilever are smaller in dimension and can be easily integrated with the on-chip readout electronics to make it a portable platform desired for point-of-care (POC) devices. The device platform has two cantilever beams where one cantilever is kept as a reference cantilever whereas the other cantilever is a sensing cantilever having gold layer for the bio-functionalization. Packaged device is shown in figures given below.

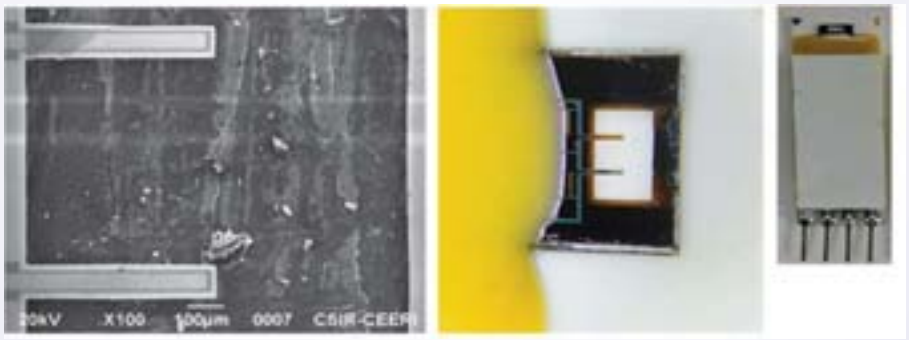


Fig.5.8. (i) SEM image of the micro cantilever based sensing platform (ii) Final two deliverable prototype (close-up view) (iii) Final deliver prototypes

- **Development of Capacitive RF MEMS Switches:** High frequency communication system use coaxial switches and wave guides which have the size and weight disadvantage for space bound systems. CSIR-CEERI has developed RF MEMS switches which offer the advantages on size and scale commensurate with solid state devices with lower power consumption and superior RF response. CSIR-CEERI developed RF MEMS switches are compact and reliable with insertion loss less than 0.5 dB. The RF MEMS switches can be used for space communication and security application and also can be used a basic building block for complex

structures e.g. phase shifters required for strategic application such as space communication and system automation.

- **Design and Development of Ku-band 140 W Short-length Space Traveling-wave Tube:** For indigenization of the technology, few prototypes have been developed by CSIR-CEERI for repeatability of both performance and technology. Two final prototypes (deliverable models) were developed, characterized, and inspected by SAC-ISRO for QA. Finally, both the prototypes have been potted with space grade material and packaged. After final bench test and endurance test, both the prototypes have been delivered to SAC-ISRO, Ahmedabad.

- **Development of 35kV/3kA Thyratron for Line-type Pulse Modulator for Linear Accelerator:** CSIR-CEERI undertook R&D for development of 35kV/3kA thyratron. Three numbers of Deuterium thyratrons for line-type pulse modulator for linear accelerator at BARC Mumbai have been developed. Thyratron is a low-pressure gas discharge based plasma switching device used as a unipolar closing switch in high-power pulsed systems. The switching action is achieved by transfer from insulating gas to the conducting properties of ionized gas. Due to plasma fill, thyratrons can handle much greater currents than hard vacuum valves/tubes. It finds wide applications for driving pulse laser systems, crowbar systems, pulse modulators, accelerators, synchrotrons, Radars, high energy physics research, etc.

  Two thyratron tubes had already been successfully tested and delivered to BARC, Mumbai. The third prototype of 35kV/3kA Thyratron (LPT-03) has been successfully tested at CSIR-CEERI for time duration of more than 40 hours at different forward voltages 20-36 kV, current: 2.07 kA, pulse of ~ 1μs FWHM, 10- 50 Hz pps. The performance of the thyratron has been satisfactory throughout its testing. The prototype thyratron (LPT-03) was also then been delivered to BARC Mumbai for further testing. The testing/ conditioning of the thyratron was performed jointly by BARC and CSIR-CEERI during January 8-12, 2018 for duration of ~30 hours. The performance of the thyratron (LPT-03) has been satisfactory and delivered successfully to BARC, Mumbai.

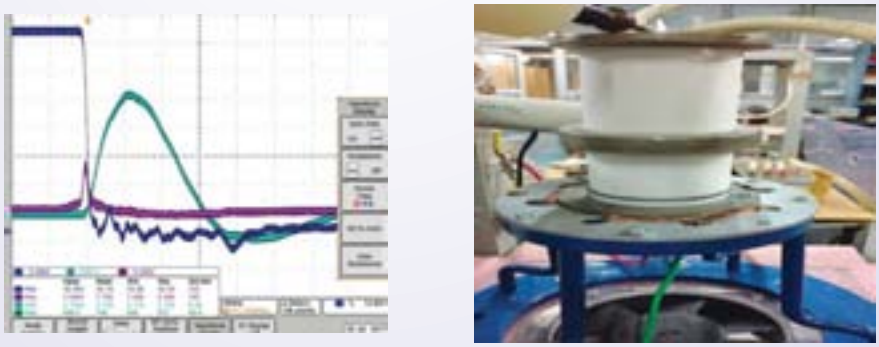


Fig. 5.9. Anode voltage, trigger voltage and current waveforms of the thyratron (LPT03)

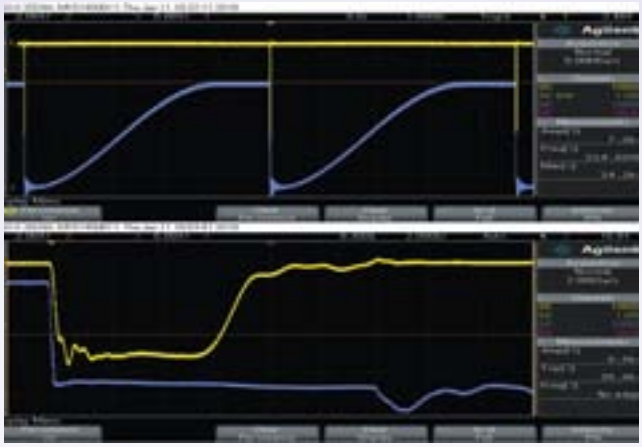


Fig. 5.10. Developed third prototype of 35kV/3kA thyratron under testing at CSIR-CEERI test results of thyratron (LPT-03)

- **3.0 MW S-Band Tunable Pulse Magnetron:** CSIR-CEERI has developed three nos. of 3 MW Magnetron and continuous hard conditioning and aging of these prototypes was carried out as per user requirements. The performance of these lab-prototypes met all the electrical specifications as per requirements. Subsequently, CSIR-CEERI successfully transferred three numbers of developed 3 MW S-Band tunable pulsed magnetrons with their complete know-how, indigenously developed electromagnet, and a motorized tuning mechanism system to EBC Kharghar of BARC, Mumbai.

Fig. 5.11. 3 MW Magnetron prototypes with electromagnet

5.2 Social fulfilment

- **Support to farmers and society:** CSIR-CCMB has significantly contribution towards farmer's benefit through distribution of ISM Rice variety in Andra Pradesh, Telangana, Tamilnadu & Uttar Pradesh; as well as popularization of low-chill apple cultivars in Telangana & Andhra Pradesh.

- **Cultivation of medicinal and aromatic plants in the country:**
  - With the efforts of CSIR-CIMAP, an additional area of 10,000 ha is brought under cultivation of medicinal and aromatic plants in the country which produces the raw material worth of about Rs.140 crore for industry. Through the cultivation of these crops in the rural areas, about 25 lakh man-days were generated worth of around Rs.50 crore.
  - 122 ha has been covered by CSIR-IHBT for cultivation of aromatic plants. Eighteeen awareness programs on cultivation and processing of aromatics were conducted & 532 unemployed youth, rural women and farmers were trained in agro-processing of MAPs by CSIR-IHBT. Empowered farmers to produce 4 ton oil of wild marigold for the 1st time in HP. Each farmer got Rs. 1.5 lakh/ha from unutilized land, about 2.5 times than conventional crops.
  - Floriculture: CSIR-IHBT is actively promoting cultivation of cut flowers like gerbera, *lilum*, carnation, alestromeria, marigold, gladiolus. Regular training are imparted to famers and technical support are rendered. This year about 24.5-acre area was brought under floriculture by setting up of 20 demonstration plots (Kanbadi, Chadiyar, Dharamshal, Kurli, Panapad, Baijnath, Bhawarna Pathankot, Pune etc). Quality planting material generated and distributed to farmers.
  - Promoting stevia cultivation:During the year CSIR-IHBT promoted large scale cultivation of Stevia in Punjab, Uttar Pradesh, Haryana and Chattisgarh. Improved variety, HIMSTEVIA developed by the institute with higher RebA content was transferred to industry through MTA for its mass multiplication. The net income return from stevia is about 2-2.5 times higher than conventional crops as a result of sustained effort of interventions.
  - Introduction of saffron: CSIR-IHBT successfully introduced commercial scale cultivation of saffron in Himachal Pradesh. An efficient tissue culture protocol was established for the production of disease free and healthy planting materials (corms) of saffron. Maximization of corm size up to 5.5-6.0g was achieved. These corms have the potential to grow up to the commercial size of >10 g within two years of growth in the field.
  - CSIR-IIIM has introduced high value essential oil bearing Lavender crop to the farmers of temperate regions of Jammu viz., Doda, Kishtwar, Rajouri, Ramban and Udhampur districts. Quality planting material (QPM) of Lavender (> 4,50,000 plants) was provided free of cost to 269 farmers for 71.13 acres of land. Besides free QPM, detailed agro-technology, technical knowledge and essential oil distillation facilities are also being provided to the farmers.

Fig. 5.12. Introduction of Lavender crops to farmers

- CSIR-IIIM conducted 27 awareness programmes on Value Addition of High Value Aroma Ingredients for Socio-Economic Upliftment and Rural Prosperity in different parts of J&K (24), Maharashra (2) and Chatisgarh (1). Detailed information on aromatic crops under CSIR-Aroma Mission, their cultivation, processing and marketing were given to the participants. More than 4000 from J&K participant attended these programmes.

Fig. 5.13. Awareness programmes under Aroma mission of CSIR

- A high yielding variety of Rose-scented geranium (*Pelargonium graveolens L'Hér.*) suitable for temperate and sub-tropical climates has been developed by CSIR-IIIM through biotechnological interventions. The variety developed (PG-IIIM-101) is superior in terms of oil content (0.14-0.18%), essential oil profile

and fresh herb yield. It has been registered as a national variety (INGR17054; Oct. 2017) with ICAR-NBPGR (Indian Council of Agricultural Research-National Bureau of Plant Genetic Resources).

- **Inculcating scientific temper in children:** CSIR-IITR organized various events on National Science Day, Technology Day, World Environment Day and so on. During these days the institute was open for common people and students from different schools to give exposure of scientific tools and methods to school children and motivates them towards science. Around 500 students visited CSIR-IITR campus during this programme.

Fig. 5.14. Training programme on scientific temper

- **Microbial Type Culture Collection and Gene Bank (MTCC):** CSIR-IMTECH is catering to the needs of about 12000 researchers of this country. MTCC is an international depositary (IDA), and as per the assurance given by the Govt. of India to World Intellectual Property Organization (WIPO), it has to be continued as a depositary for accepting the patent deposit of microbial resources, documenting the microbial diversity of the country.
- **Diagnostic tests for genetic disorders:** Through GOMED low-cost molecular genetic diagnostic tests for common genetic disorders specific to India have been made available by CSIR-IGIB. GOMED enables genetic testing for wide range of genetic disorders accessible through CSIR-IGIB encompassing over 90 genes, which has already benefitted a >4000 patients.
- **Health awareness programme:** CSIR-IICT conducted malaria awareness program in endemic areas of Arunachal Pradesh and trained the public health authorities on spatial mapping and database management system on malaria. Long lasting insecticide treated bed nets (LLINS) were distributed in endemic areas of Lower Subansiri district of Arunachal Pradesh. These LLINs avoid human-vector contact and arrest further spreading of malaria. Hence by using LLINs nearly 1500 people were directly benefitted in this endemic village.
- **Improved Gur making plant:** CSIR-IIP further improved Gur making plant with the features like 20 – 25% reduction in fuel consumption for the same production;

10-15% increase in daily Gur production capacity; significant reduction in smoke and emissions; Improved life of furnace; and ease of fuel charging for efficient and cost effective by the uses.

Fig. 5.15. Gur making plant

- **Science communication for the society:** CSIR-NISCAIR's communication initiatives reach a wide spectrum of the society in the country ranging from students and teachers to scientists, professionals, and policy makers, and from industries and research institutions to even farmers and the common masses. It has been spreading scientific awareness through its 3 popular science magazines in English, Hindi and Urdu.
- **Pilot study on compilation of characteristics of medicinal plants for therapeutic uses:** Wide acceptance of herbal health care is due to several reasons-diversity, flexibility, easy accessibility, relative low cost, low levels of technological input, relative low side effects and growing economic importance etc. CSIR-NISTADS has developed a prototype Ayur Vatika with 100 herbs, an herbal vertical garden, which is an attempt to bring the herbal healthcare to home.

Fig. 5.16. Prototype Ayur Vatika

- **Safe drinking water:**
  - The Kuda village/ Mangal Bharthi Loksala in Hatab village of Bhavnagar had been suffering with serious drinking water crisis. The available brackish water has TDS of 2,000 to 4,000 ppm. CSIR-CSMCRI built solar powered, community operated electrodialysis unit for providing drinking water in Hatab Village of Bhavnagar. The electrodialysis plant with indigenous design and fabricated with a capacity of 300-400 LPH and provides safe drinking water daily to nearly 1,000-1,200 villagers.
  - In order to provide safe and potable drinking water in Patalkot valley of Chinndwara district, Madhya Pradesh, CSIR-IMMT in collaboration with CSIR-AMPRI, Bhopal installed 04 Nos. of FRP (Fibre Reinforced Plastic) based 1000 LPD capacity community size Terafil water purification system. The initiative will benefit about 100 tribal families in accessing safe drinking water in the long run.

Fig. 5.17. FRP Terafill System

- **Wind Solar Hybrid (WiSH) for societal benefit**: CSIR-NAL has installed and commissioned at three more 1 kW WiSH systems at educational institutes (a) East West College of Engineering (b) Christ University and (c) AMC College of Engineering. With this, five WiSH systems have become operational at S&T institutions in and around Bengaluru. This initiative is in association with M/s ARES Pvt. Ltd, which is presently facilitating to market the WiSH system in northern districts of Karnataka. Continuing with this effort, four Wind Solar Hybrid systems were commissioned at CSIR-IMMT under the technical supervision of CSIR-NAL. These systems were inaugurated on 3rd June, 2017. The energy generated is utilized to power the lighting loads at the CSIR-IMMT-cricket ground.

Fig. 5.18. Installation of Wish system at S&T Institutes around Bengaluru

- **Need assessment study at Howrah Sewing Machine Clusters for possible R&D intervention:** CSIR-NML carried out a technical need assessment study at Howrah Sewing Machine Clusters to understand the current practices of the Zn and Ni plating activities for small machine parts and the possible R&D intervention as well as training needs. A report, highlighting the current practices, state of the art knowledge of Zn and Ni plating and the recommendations for possible technology interventions, was prepared.
- **Condition assessment of existing TV towers for suspension and quad tension strings:** CSIR-SERC has undertaken condition assessment of existing TV towers for the addition of UHF, DTT antenna for Prasar Bharati, All India Radio and Doordarshan and also carried out Mechanical Strength Assessment of +/- 500 kV HVDC Composite Silicon Rubber Long Rod Single 'V' Suspension and Quad tension strings used in the 989 kms long ± 500 kV HVDC Mundra – Mohindergarh, Transmission Line for HVDC transmission project traversing three states i.e. Gujarat, Rajasthan and Haryana and carried out testing of 765kV-120kN single V suspension pilot and Double V strings for 765 kV transmission line in Western Region of India.

Fig. 5.19. Assessment of Transmission Towers

- **New affordable and disaster-resistant house technology developed called as SERCular housing technology:** Affordable, and Disaster-resistant housing, termed as SERCular housing technology is developed by CSIR-SERC, for Pardhan Mantri Awas Yojana - Grameen (PMAY-G). This type of house consist of twin rooms of standard 4m.dia. circular module, built with special self-locking (SL) blocks. The plinth area of 2-roomed house is about 25sq.m. It is about 20% economical when compared to conventional housing and, offers cyclone resistant technology with earthquake resistant advantages.

Fig. 5.20. SERcular Housing Technology

- **Fatigue life evaluation of 54 kg UIC alumino-thermit welded rail joints:** Fatigue life evaluation has been undertaken by CSIR-SERC of 54 kg UIC alumino-thermit welded rail joints up to two million cycles of loading or failure whichever is earlier. The result of the studies were useful to the client in assessing the performance of welded rail joints, being used in railway tracks in India, for increasing the speed of the rolling stock and for better travel comfort.

Fig. 5.21. Fatigue life evaluation on welded rail joints

- **Software for seismic preliminary vulnerability assessment:** A methodology for seismic vulnerability assessment of Open Ground Storey (OGS) buildings and software for preliminary seismic vulnerability assessment of OGS buildings has been developed by CSIR-SERC. Improved design and retrofit methodology for OGS buildings and design guidelines were prepared.

Fig. 5.22. Vulnerability assessment of Open Ground Storey (OGS) buildings

- **Hand held drives for milk tester:** CSIR-CEERI has developed, tested and demonstrated the devices like field integrated milk quality analyser, milk adulteration ester, milk fat tester, which have significant impact in the society.
- **Design of an Embedded System for Low cost Haptic Rendering of Emotion Expression for the Blind:** CSIR-CEERI has developed and implemented a Deep Learning based emotion expression recognition algorithm for classification of emotion expressions into seven different categories. A prototype of haptic device (hardware) has been developed using micro-vibrators. The developed device is capable of communicating different expressions of visually handicapped persons through different vibration patterns. The developed hardware has been integrated with NVIDIA TX2 embedded platform. The integrated system successfully generates different vibration patterns for different expressions. The input to the system is from live webcam. The communication between the haptic device and the NVIDIA TX2 embedded platform which runs emotion expression recognition algorithm is through Bluetooth (i.e. wireless communication).

5.3 Environmental Impact

- **Conservation of biodiversity:**
  - Discovery of a new frog species from the Western Ghats by CSIR-CCMB reinforces the continental drift & significance of the Western Ghats as a Hot-spot of Mega biodiversity and highlights the urgency for conservation of Natural Habitats and biodiversity.
  - CSIR-CCMB reintroduced confiscated star turtles in to their original habitat and endangered Mouse Deer (Spotted Chevrotain) into the Nallamalla forests in Amrabad Tiger Reserve after a successful breeding program.


Times of India 16 May 2018

470 rescued star tortoises brought to Vandalur zoo

P Oneib | TNN | Updated: May 17, 2018, 06:11 IST

Fig. 5.23. Rescued Star Turtles

- A study was conducted on *Dactylorhiza hatagirea* for assessment of its populations and threats in the region by CSIR-IHBT. This is a food deceptive orchid and categorized as 'Critically Endangered'. An enhanced populations tend to reduce the probability of population extinction and have the capability to recover rapidly if conserved in time. The study has important ramifications in the conservation of medicinal plants in their natural habitats in the Indian Himalaya.
- **Forest fire mapping:** The forest fire mapping was done by CSIR-IHBT using LANDSAT 8 images of 2016 in Dharamshala and Palampur regions of Himachal Pradesh. The forest fire was identified in 8.97% of forest of Dharamshala and 8.49% of forest of Palampur tehsil using satellite images of fire seasons. Forest-wise, 22.89% of tropical forest, 13.49% of sub-tropical forest and 0.81% of temperate forest of the study area were affected by fire.
- **Studied on maintenance community structure of tropical monsoonal estuary:** CSIR-NIO studied the impact of maintenance dredging activities on the macrobenthic community structure of a tropical monsoonal estuary (Cochin estuary), located in the southwest coast of India for three consecutive years. The results of the study indicates apparent differences in benthic fauna and sediment characteristics between dredging and non-dredging sites, while most of the hydrographical parameters (temperature, pH, DO and BOD) exhibited inconspicuous variations. The study reveals the extent of impacts associated with maintenance dredging activities in a tropical estuary, which can be used to formulate effective management strategies for the protection of ecologically and economically significant benthic communities of estuarine ecosystems.

- **Efficient bioremediation of tannery wastewater by monostrains and consortium of marine *Chlorella sp.* and *Phormidium sp.*:** CSIR-NIO evaluated the bioremediation potential of two marine microalgae *Chlorella sp.* and *Phormidium sp.,* both individually and in consortium, to reduce various pollutants in tannery wastewater (TW). The microalgae were grown in hazardous 100% TW for 20 days, and the reductions in biochemical oxygen demand (BOD), chemical oxygen demand (COD), total nitrogen (TN), total phosphorous (TP), chromium (Cr) and total dissolved solids (TDS) of the wastewater monitored periodically. The novel consortium developed in this study reduced most of the ecologically harmful components in the TW to within the permissible limits of discharge in about 5 to 15 days of treatment. Thus, both the tested marine strains of *Chlorella* and *Phormidium sp.* are promising for bioremediating/detoxifying TW and adequately improve the water quality for safe discharge into open water bodies, in particular when used as a consortium.

- **Airboat for Cleaning Lakes:** CSIR-NAL has developed airboat for cleaning lakes Maruti 800 using old engine. The first-of-its-kind airboat, developed in India by CSIR-NAL, which was built to clear out weeds from Ulsoor Lake, has successfully undergone trials.

Fig. 5.24. NAL airboat clearing weeds at Ulsoor Lake

- **Technologies for effluent treatment and safe disposal for clean environment:**
  - CSIR-CECRI has developed electro-oxidation treatment of effluents to reduce COD & chlorides in effluents and recovery of important chemicals i.e. Na_2SO_4 and NaOH from the effluents. The process is used by Hindustan Zinc Limited, Udaipur.
  - Dry tan product /Waterless chrome tanning process technology developed by CSIR-CLRI has created a tremendous impact towards cleaner environment; chromium free wastewater; elimination of salt/mineral acid used in pickling; eco friendly process for shop floor workers as handling of dangerous sulfuric acid is averted and conservation of water saving about 75 million liters water per year are the important contributions of the technology.

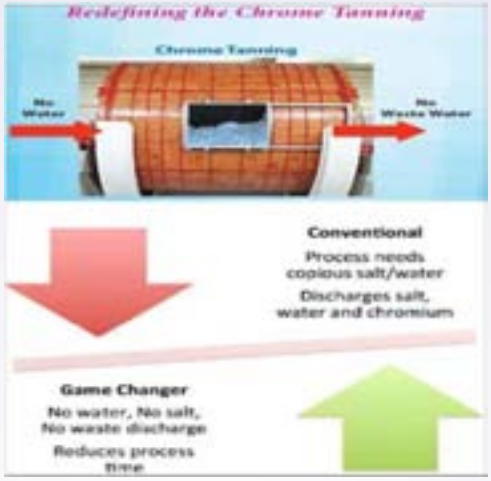


Fig. 5.25. Electro-oxidation treatment

- Spent wash management technology developed by CSIR-CSMCRI is being used by sugarcane molasses based distilleries of the country. This technology, besides recovering value-added products like potash, organics (as animal feed) & water is also a complete ZLD (zero-liquid discharge) process that renders cleaner environment (no discharge of waste)
- CSIR-NIIST developed a process for treating perchlorate (rocket fuel) which is eco-friendly and economic. This process uses a specific microbial system capable of converting perchlorate into non-toxic chloride and oxygen. The removal efficiency was almost 100% without any secondary treatment. Being anaerobic, it requires less energy input and no secondary treatment.

Fig. 5.26. Process for Treating Perchlorate

- **Gas biofiltration system:** CSIR-NIIST has developed Gas biofiltration system for odour control through the use of microbes on porous filter media to remove odour.

The gas biofiltration is presently being used in several industries i.e. fish meal, meat and bone, sewage treatment, rubber processing, municipal solid waste.

Fig. 5.27. Gas biofiltration system

- **Sensing System and devices:**

CSIR-CEERI has developed an Amonia Gas Sensing System. The correct estimation of air quality is very important as it can affect our lives directly or indirectly. CSIR-CEERI developed metal oxide based gas sensing platform for Ammonia (NH_3), Carbon Monoxide (H_2S), Nitrogen dioxide (NO_2), Ethanol (C2H5OH), and Propanol (C_3H_7OH) and demonstrated developed gas sensors. The technology has transferred to M/s Macwin, New Delhi.

Fig. 5.28 Hand held Amonia Gas Sensing System

A nanostructured material for applications in sensing devices to detect toxic and hazardous gases has been developed at CSIR-IICT. Using nanotechnology, materials can effectively be made stronger, lighter, more durable, more reactive and better electrical conductors, smaller particle size with high surface to volume ratio, high bandgap which are advantageous for developing gas sensors.

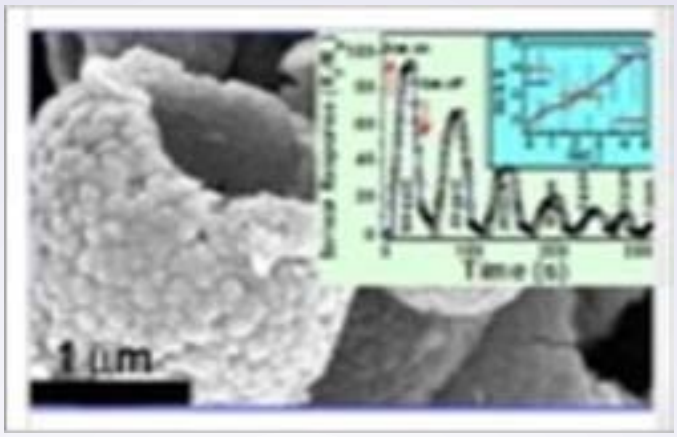


Fig. 5.29.Toxic and hazardous gases detect

- **Primary Reference Gas Standards:** CSIR-NPL has undertaken R&D for realization of mole in gas measurements through gravimetric preparation of Primary Reference Gas Standards and to provide traceability for Vehicle emission, greenhouse gases and air quality measurements as per NAAQS (12 parameters). This is aimed towards providing services for reliable measurement of air quality data which are directly related to environment, and have indirect impact on health and society.
- **Pathogenic multiple antimicrobial resistant *Escherichia coli* serotypes in recreational waters of Mumbai, India - A potential public health risk:** The study by CSIR-NIO underscores the presence of multiple antibiotic resistant pathogenic serotypes and pathotypes of *Escherichia coli,* the predominant faecal indicator bacteria (FIB), in surface water and sediment samples of famous recreational beaches (Juhu, Versova, Mahim, Dadar, and Girgaon) of Mumbai. Out of 65 faecal coliforms (FC) randomly selected, 38 isolates were biochemically characterized, serotyped (for 'O' antigen), antibiogram-phenotyped (for 22 antimicrobial agents), and genotyped by polymerase chain reaction (for virulence factors). Preliminary findings revealed the presence of enterotoxin-encoding genes in pathogenic serotypes. Thus, government authorities and environmental planners need to create public awareness and adopt effective measures for coastal management to prevent serious health risks associated with these contaminated coastal waters.
- **Greenhouse Gas Reference Station:** CSIR-4PI established Greenhouse Gas Reference Station at Hosakote undertaken continuous measurement of Greenhouse gases(GHG) at four (4) stations in India for robust estimation of GHG Fluxes. Numerical Simulations of marine biogeochemical model for estimation of marine living resources, air-sea carbon flux and oxygen deficient zones in North Indian Ocean.

- **Role of heavy metals in structuring the microbial community in a tropical estuary:** Particulate matter (PM), which are chemically and biochemically complicated particles, accommodate a plethora of microorganisms. CSIR-NIO studied the influence of heavy metal pollution on the abundance and community structure of archaea and bacteria associated with PM samples collected from polluted and non-polluted regions of Cochin Estuary (CE), Southwest coast of India. Community structure of PM-bacteria varied between polluted and non-polluted stations, while their abundance does not show a drastic difference. This could be attributed to the selective enrichment of bacteria by heavy metals in PM. Such enrichment may only promote the growth of metal resistant archaea and bacteria, which may not participate in the processing of PM. In such cases, the PM may remain without remineralization in the system arresting the food web dynamics and biogeochemical cycles.
- ***Trichodesmium* blooms and warm-core ocean surface features in the Arabian Sea and the Bay of Bengal:** *Trichodesmium* is a bloom-forming, diazotrophic, non-heterocystous cyanobacteria widely distributed in the warmer oceans, and their bloom is considered a “biological indication” of stratification and nitrogen limitation in the ocean surface layer. Based on the retrospective analyses of the ocean surface mesoscale features associated with *Trichodesmium* bloom incidences was recorded from the Arabian Sea and the Bay of Bengal, and from the rest of the world. CSIR-NIO showed that warm-core features have an inducing effect on bloom formation It was proposed that the subsurface waters of warm-core features maintain more likely chances for the conducive nutrient and light conditions required for the triggering of the blooms.
- **River discharge as a major driving force on spatial and temporal variations in zooplankton biomass and community structure in the Godavari estuary India:** CSIR-NIO investigated variability in horizontal distribution of zooplankton biomass distribution for over 13 months in the Godavari estuary, along with physical (river discharge, temperature, salinity), chemical (nutrients, particulate organic matter), biological (phytoplankton biomass), and geological (suspended matter) properties to examine the influencing factors on their spatial and temporal variabilities. This study suggests that significant modification of physico-chemical properties by river discharge led to changes in phytoplankton composition and dead organic matter concentrations that alters biomass, abundance, and composition of zooplankton in the Godavari estuary.
- **Exploration of bacteria with efficient organic waste degradation in cold regions:** Degradation of organic waste in cold region is a major problem. After large scale survey and exploration in cold areas, CSIR-IHBT has developed a Consortium of selected bacterial cultures for biodegradation of organic wastes in

low temperature. Scaling up and field trial of the bacterial formulations are under progress.

- **Extrapolations of the crop production data:** CSIR-NBRI undertook the extrapolations of the crop production data from 2002-2016 in Indo-Gangetic Plains and showed that application of rice straw residue will be helpful in regaining soil organic carbon and could partially fulfil the need of nutrients such as potassium and phosphorus to improve soil fertility. The institute is also prospecting microbial application to ensure judicious use of the agricultural residues.
- **CSIR technologies for zero waste/ clean environment:**

Fig.5.30. Solid waste management technologies of CSIR-CLRI for clean environment

- CSIR-CLRI dry tan /waterless chrome tanning technology; zero wastewater discharge technology and solid waste management technologies such as high-grade gelatin from trimmings waste; compost from animal hair waste, activated carbon and biogas from fleshings waste; are significantly contributing towards clean India mission.

- CSIR-CSMCRI has developed spent wash management technology for sugarcane molasses based distilleries that besides recovering value-added products like potash, organics (as animal feed) & water thereby making a complete ZLD (zero-liquid discharge) process renders cleaner environment (no discharge of waste)
- CSIR-CSMCRI has developed a cost effective process to recover pure sodium sulfate and sodium chloride from the solid waste of tanneries. This work has been done for AISHTMA for Tamil Nadu leather industries and demonstrated at the pilot scale who are setting up TPD scale plants. This technology would have far reaching impacts in other states having tanneries such as Uttar Pradesh and West Bengal.
- CSIR-IICT has developed Accelerated Anaerobic Composting technology for the conversion of organic waste to nutrient rich organic fertilizer/soil conditioner

Fig.5.31. Accelerated Anaerobic Composting technology

- Hydrodynamic cavitation technology was developed by CSIR-NCL for industrial wastewater treatment by using vortex diode for the removal of refractory pollutants. The technology is effective in the treatment of dye wastewaters for removal of variety of dyes, fertilizer industrial wastewaters and has immense potential for other wastewater treatment applications including disinfection.
- CSIR-NIIST has significantly contribution to the comprehensive Municipal Waste Management Scheme for Kerala through the optimal treatment process which has the components like BMT plant for biodrying mixed waste & dry waste with recovery of RDF and Anaerobic digestion of waste with power generation, dewatering and drying of digestate. Biodrying is a simple and cost-effective method of using self-generated heat to dry municipal solid waste.

Fig.5.32. Municipal Waste Management at Kerala

- **Safe disposal of Municipal Solid Waste (MSW):** CSIR- CMERI gas developed technology for safe disposal of Municipal Solid Waste (MSW) generated on daily basis and generation of fuel gas containing predominantly CO and H_2.Special feature of the technology is unique gas cleaning system to minimize the dust accumulation in the generated fuel gas and utility of slag as construction material.

Fig.5.33. Safe Disposal Of Municipal Solid Waste (MSW)

- **Dioxin stack gas sampling facility:** CSIR-NIIST is equipped with dioxin stack gas sampling system (Method 23) and ambient high volume PUF sampler (TO- 09) for the periodic air sampling at industrial stacks, biomedical/ waste incinerators, open burning sites etc. Presently the facility is equipped to carry out the analysis of dioxins in environmental and food samples.

Fig.5.34. Dioxin Stack Gas Sampling Facility

- **Environment Impact Assessment (EIA) study for Mining Sector**: CSIR-NIIST undertook EIA study for Mining Sector and for Ports & Harbour in Kerala State. The focus of the study was to evaluate the environmental aspects and their possible associated impacts due to the proposed heavy mineral sand mining and mineral separation and to work out environmental monitoring programme to prevent,

control, minimize or eliminate the adverse environmental impacts envisaged from the proposed mining and mineral separation.

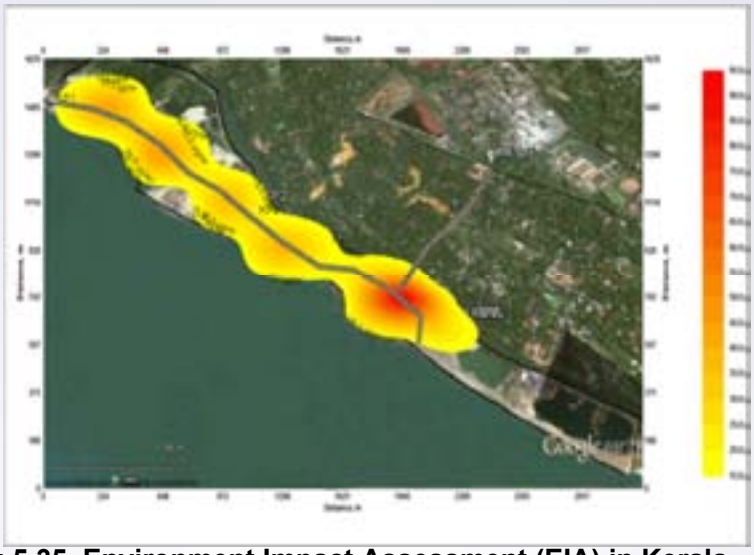


Fig.5.35. Environment Impact Assessment (EIA) in Kerala

- **Mercury-free healthcare devices:** CSIR-NPL has developed devices such as Clinical thermometers and BP Measurement apparatus and carries out LED calibrations in support of WHO and Minamata conventions. CSIR-NPL also helped to measure the noise in urban and industrial areas, especially metro and airport noise and supporting the Govt. to make the guidelines.
- **Journals and magazines**: CSIR-NISCAIR brought out research papers and articles/reports in journals and magazines on areas conforming to Govt. of India's Mission programmes. The article "Asia's Cleanest Village-Mawlynnong" was published in Science Reporter in April 2017.

Fig: 5.36. Article in Science Reporter for April 2017

6.0 CONTRIBUTIONS TO GOI MISSION

6.1 Swasth Bharat

- **Joint Fresh:** CSIR-CDRI has developed a nutraceutical formulation from *Spinacea oleracea* commonly known as Palak for the joint health. The product was launched for marketing on 13 March 2018 by the licensee Pharmanza Herbal Pvt. Ltd., Dharmaj, Gujarat, with a brand name as 'Joint Fresh'. A nutraceutical formulation for joint health is a first ever breakthrough in the area of osteoarthritis.
- **GLP test facility for safety pharmacology & toxicology studies:** CSIR-CDRI established NGCMA certified GLP test facility for safety pharmacology & toxicology studies. This facility has the distinction of being the only government laboratory with complete knowledge of drug discovery and development. Good Laboratory Practice ensures generation of high quality and reproducible data required of global acceptance. This facility is also open for users from industries.
- **To combat malnutrition and health management:** CSIR-IHBT has developed iron and calcium fortified products like mango bar, nutribar and nutrimix form widely available plant resources. The initial result from pilot study appears promising as the products substantially improved haemoglobin content and weight of growing children suffering from malnutrition.
- **Better health management:** CSIR-IHBT has developed Multigrain high protein beverage mixes. It is 100% Natural high energy drink, non-hygroscopic for ease of storage. Devoid of malt extract or processed sugar like fructose syrup, corn syrup. It is a ready to mix formulation. Also to combat malnutrition microalgae based product has been developed enriched with iron, zinc and Vit A.
- CSIR-CSMCRI has developed an innovative process for fortification of salt with iodine and iron using inorganic matrix compound. This inventive process helps in retaining the white colour of the salt and preserving the effective concentration of iodine and iron intact over a long period of time for an extended shelf-life.
- **Chemical process for nanocurcumin:** CSIR-IHBT has developed process to increase the solubility and photo-stability of the poorly water soluble molecule, curcumin. The nanocurcumin showed enhanced anti-bacterial activity against both gram-positive and gram-negative bacteria.
- **Big data analytics:** CSIR-IHBT carried out a first time large scale big data analytics over the publicly available molecular data on Idiopathic Pulmonary Fibrosis (IPF). The study led to deciphering of signature genes and most critical components of these disease which if therapeutically intervened may suppress the

traits of IPF. This lits a ray of hope to control this erstwhile uncontrollable deadly disease. Diagnosing IPF is a big challenge as there is no successful drug against it so far.

- **Toxicity / safety evaluation of chemicals and products**: CSIR-IITR is carrying out the toxicity / safety evaluation of chemicals and products being introduced in Indian market under GLP & Non-GLP mode. This is mandatory to safeguard environment and human health. R&D activities of CSIR-IITR are helping in saving life through interventions, environmental impact assessment of Lucknow city and EIA studies in leading industries/ companies.
- **CSIR-IITR has developed:**
  i. Oneer- a novel low cost water purification device has been developed for disinfection of drinking water for household and community use.
  ii. A Portable Water Analysis Kit developed for the drinking water quality assessment in rural areas.
  iii. AO-kit has been developed for the detection of Argemone oil contamination in the Mustard oil. The test is simple, cost effective and takes about 20 minutes with sensitivity of 0.01%.
  iv. MO-Check strip, a handy, quick, easy and affordable spot adulteration test paper strip (MO Check) coated with chemicals to monitor the adulteration of mustard oil with Butter Yellow up to a detection limit of 0.001% (10 ppm).
- **Combo-pack for Acne Cure:** CSIR-CIMAP launched a combo-pack of herbal formulations for acne prevention and acne cure. Acne Preventive Face Wash is an *Aloe vera*-based herbal formulation intended for the control of pimples and acne. Gentle formula in the form of gel functions as a cleanser and purifies pores.

  The Acne Cure Gel is an herbal lead-based gel formulation, which is highly active against acne causing bacteria *viz. Propionibacterium acnes.* Anti-acne gel is also very effective against a wide range of microorganisms causing and/or supporting acne.

Fig. 6.1. (a) Acne Cure Gel (b) Acne preventive

- **Development of new herbal formulations and new leads for further evaluation and value-addition**. CSIR-NBRI has developed:
  - A herbal formulation to alleviate urolithiasis
  - Two novel herbal acaricides to control cattle ticks (jointly developed with ICAR-Indian Veterinary Research Institute, Izatnagar - Bareilly).
- **Unique probiotic curd**: CSIR-CFTRI developed a unique probiotic curd by using bifidobacteria which can replenish bifidobacterial count in colon and provide microbial homeostasis. High viability is ensured satisfying the Minimum Biological Value (MBV) for probiotic product.
- **Biosimilar of Humira:** CSIR-IMTECH has made a significant progress in making biosimilar of Humira, which is widely used for treatment of various forms of arthritis and Crohn's disease. The institute has cloned and expressed anti-TNFα mAb with a sequence identical to that of Humira in suspension of CHO cells and generated single cell clone (IMT_anti-TNFα mAb) with protein expression at the shake flask level of about 200 mg/L (under unfed condition), which is well within industry accepted range.
- **Prediction of extrinsic incubation period (EIP) for Dengue Virus:** The number of dengue cases has gradually increases in India and become major public health threat. CSIR-IICT has predicted extrinsic incubation period (EIP) and its variability in different climatic zones of India. The EIP was calculated by using climate data for different states of India. The output provides days requires for virus development in mosquito and which helps the public health authorities to implement necessary control measures well in advance to reduce the mortality and morbidity due to dengue.
- **Studies to identify potential leads for development of new antimalarial drugs:** A complete library of stereoisomers (cladologs) of cladosporin was built by CSIR-NCL using a novel general divergent synthetic route. The inhibitory potential was assessed using parasite, enzyme, and structure-based assays. This work provided a new foundation for focusing on inhibitor stereochemistry as a facet of antimicrobial drug development.
- **Spent wash management technology**: CSIR-CSMCRI has developed spent wash management technology for sugarcane molasses based distilleries that besides recovering value-added products like potash, organics (as animal feed) & water thereby making a complete ZLD (zero-liquid discharge) process renders cleaner environment (no discharge of waste).
- **Kit for on-site detection of bacteria in water:** CSIR-CSMCRI has developed a PVDF based composite membrane based kit for on-site easy detection system of

bacteria in water samples that can be used by any personnel in remote location like small villages, without requirement of any microbiology laboratory or trained personnel that assures safe drinking water for good health.

- **Robo-Rehab:** A portable device developed by CSIR-CSIO for therapy assistance to acute spinal cord injury patients. The device is a robotic mechanism controlled with the help of an embedded control and graphic user interface. The device is capable of providing bedside assistance for physiotherapy exercises to the spinal cord injury patients. The prototype of developed device was tested at PGI, Chandigarh.
- **Marine natural products for therapeutic applications:** CSIR-NIO carried out research on marine natural products for therapeutic applications and isolated two anti-inflammatory molecules Butyrolactone I and (+) terrein from marine fungus *Aspergillus flavipes*. (+) terrein was found to be the most active. Mass production of these molecules from marine fungi *Aspergillus flavipes* is underway. A molecule purpurealidin K (bromotyrosine derived metabolite) was isolated from the marine sponge *Psammaplysilla purpurea*, which showed 85% pro-apoptose HepPS activity.
- **Defibrillator Analyzer:** First biomedical equipment standard of Defibrillator Analyzer was developed by CSIR-NPL for teachable calibration of defibrillator machines to provide services to the national healthcare sector e.g. hospitals, clinical and test laboratories and medical device manufacturers/industries. The facility is developed for the calibration of following parameters for defibrillator analyzer: Discharge energy in joule (J); Discharge time (sec), Defibrillator load resistance (Ω) and pacer resistance (Ω).
- **Improved Iron Removal Plant:** CSIR-CMERI developed improved plant for removal of iron from drinking water. The salient features are: Naturally available sand and gravels is used for removal of iron from water; no electric power requirement- Implementable in remote villages; useful to community service: a small village may cover for drinking purpose only; instant iron free water; and cost effective.

Fig. 6.2. Improved Iron Removal Plant

- **Domestic Iron Removal Filter:** This green technology developed by CSIR-CMERI removes iron to the desired permissible limit (0.3ppm) for drinking water. No electricity, chemicals required. It can also remove foul odour, bad taste of iron water. Twenty numbers of such unit has been installed successfully at different Panchayats and Health Blocks of West Bangal Govt. in the district of Bankura, Burdwan & Howrah.

Fig. 6.3. Domestic Iron Removal Filter

- **Domestic Arsenic Removal Water Filter:** Domestic type adsorption based multi-stage water filtration unit than can remove both arsenic (III) and arsenic (V) to the desired permissible limit (~10 ppb) of drinking water. The filter developed by CSIR-CMERI can remove arsenic upto 30 times of the safety limit as mentioned by WHO. The cost of the filtration cartridge is just Rs. 200 including all processing fees

Fig. 6.4. Domestic Arsenic Removal Water Filter

- **Domestic Fluoride Removal Filter.** The filter developed by CSIR-CMERI finds application in filtration of fluoride contaminated water for drinking purpose. The special features are: domestic type adsorption based multi-stage water filtration unit; comprised of AA+FIA+SIAC adsorbents; effective reduction of F-

concentration from ~ 5 ppm to below permissible limit (~1.5 ppm); simultaneously useful for bacterial remediation since standard SIAC is used; no electricity required; flow rate: ~ 5-6 L / hour; and adsorbent life (average) is ~2000 L,

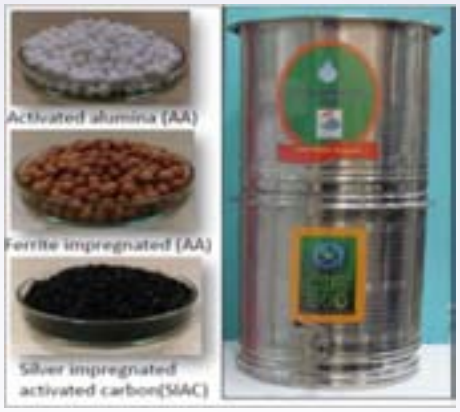


Fig.6.5. Domestic Fluoride Removal Filter

- **Salivary Fluoride Detection Kit:** CSIR-CMERI has developed the indigenous salivary fluoride level detection kit and sensor station is unprecedented in its kind towards diagnosis of salivary fluoride level for the welfare and betterment of the society. Protects from Dental Caries & tooth decay, prevent premature tooth loss. The Technology has been transferred successfully.
- **HAp coated implants:** Phase pure Hydroxyapatite (HAP) with spherical shape (both doped and undoped) have been successfully synthesized and characterized by CSIR-CGCRI. Composition of HAP is as per ASTM spec., cost-effective. If used clinically it is proposed that there would be significant improvement in quality of patients' life with HAp coated implants due to faster healing, increased bonding and overall increase in the service life.

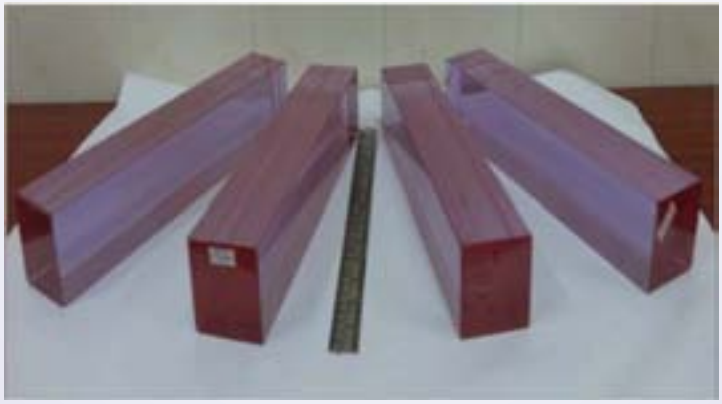


Fig. 6.6. HAp coated implants

6.2 Swatch Bharat

CSIR Laboratories beside undertaking R&D and technological developments, organized “Swatch Bharat Abhiyan Pakhwara” during the year 2017-18 and organized activities like essay writing, quiz, tree plantation, cleanliness of premises, offices and laboratories, public awareness programmes, to contribute in the mission.

Events and training programmes:

CSIR-CDRI, Lucknow organized “Swachh Bharat Abhiyan Pakhwara” from 01-15 November 2017, activities like essay writing, Quiz, plantaion and for cleanliness of Premises, offices and laboratories were also organized during this Pakhwara.

- CSIR-IITR contributed to "Swachh Bharat" mission by public awarness programmes. Students from this institute are creating awareness regarding cleanliness and neatness among rural population under CSIR-800 programme. Four number of coloured brouchers have been printed on major issues of health viz. पानी हमारा जीवन है, आदर्श गाँव, महिलाएं हों स्वस्थ तो परिवार आश्वस्त, जब स्वस्थ हो पर्यावरण तब स्वस्थ हो जीवन and distributed during visit to the rural areas.
- CSIR-CIMAP conducted training programmes on the conversion of floral waste from temples into incense sticks in areas around major temples of India such as Chandrika Devi Temple at Bakshi Ka Talab, Lucknow, Shirdi, Pune and Mata Vaishno Devi Shrine. Besides, training and demonstration of the same was also conducted at Central Reserve Police Force, Lucknow.

Fig. 6.7. Training programmes

- CSIR-CBRI observed Swachhta Pakhwada during November 1-15, 2017 wherein various activities were organized under various drives including Swachhta Jagrukta, Swachh Parisar, Swachh Anubhag, Swachh Neelami, Swachh Ahaar, Swachh Karyalya, Swachh Paryavaran & Swachh Samvad. CSIR-CBRI made the ‘Swachhta Pledge’ to donate minimum 100 hours/year to keep the country clean.

6.3 Sashakt Bharat

CSIR laboratories across the country are making impactful contributions in this mission by strengthening farmers, students, entrepreneurs, industries etc. brief about few notable contributions are:

Trainings/ support to farmers and students:

- CSIR-CCMB distributed a non-transgenic Improved Samba Masuri (ISM) rice variety seeds in Andhra Pradesh, Telangana, Tamil Nadu & Uttar Pradesh to aid farmers grow improved rice and keep seed for next season without depending on seed companies.
- CSIR-CDRI continued to contribute towards Sashakt Bharat by providing highest quality research training with cross- disciplinary knowledge, to provide skillful human resource for Health & Pharmaceutical Research in Industries as well as for Institutions & Academic centres. During the year, 82 Scholars completed Ph.D. program. Imparted advanced training in the field of biomedical sciences to 143 post graduate students & mentored 30 M.S. (Pharm) students of NIPER, Raebareli.
- CSIR-IITR's research activities are in five major areas that may lead to development of interventional strategies against chemical induced adverse effects on environment & health. Young Research Fellows and Post Graduate students are being trained in these niche areas of Toxicology and their skills shall contribute towards building Samarth Bharat.
- CSIR-NBRI's in depth taxonomic analyses brought to light several novelties in terms of discovery of new taxa as well as new national and regional geographic records of several plant and lichen taxa to India. The revisionary study on Teloschistacean lichens resulted in the discovery of a new genus and a new species, *Gallowayella awasthiana*. *Hoya pandurata*, a globally threatened flowering plant species, was recorded from India for the first time from Kamjong district of Manipur, bordering Myanmar. The additional geographic records of Bryophytes included the new report of six species to India, 58 species to Eastern Ghats, 12 species to southern peninsular India, 53 species to Nagaland, and 34 species to Manipur.
- CSIR-CIMAP conducted awareness/training programmes in different parts of the country to educate farmers and entrepreneurs for production and primary processing technology of economically important aromatic plants for income enhancement by utilization of underutilized and marginal lands. More than 1158 participants from different parts of the country got benefitted from these programmes.

- In addition, more than 3043 Mentha growers were benefitted in 41 awareness/ training programmes organized by CSIR-CIMAP on 'Efficient Price Discovery and Improved Cultivation Practices in 'Mentha Oil' during 2017-18 in different Mentha cultivation areas to improve its production and oil yield.
- CSIR-CIMAP organized its annual Kisan Mela on 31st January, 2018 in Lucknow campus. More than 6000 farmers, entrepreneurs, representatives of industries, buyers of essential oil and herbs belonging to various states like Odisha, Bihar, West Bengal, Andhra Pradesh, Uttar Pradesh, Uttrakhand, Chhattisgarh, Rajasthan and Assam participated in this fair. A special CSIR pavilion was also arranged on this occasion in which several laboratories displayed their rural technologies, products and services beneficial to the farmers. Representatives from different industries as MCX, Jindal Drugs, Herbochem, Arshi menthol, Kelker Group along with President, Essential oil Association of India also participated in this event. Improved variety named 'CIM-Pusti' of Ashwagandha and CIM-Sfurti of Kevanch developed by CSIR-CIMAP were released by the chief guest during this occasion.

Fig. 6.8 Kisan Mela at CSIR-CIMAP, Lucknow

- CSIR-IICT is conducting three months long orientation-cum-training programme every year for the students from North Eastern states of India. Training Course was specially designed to impart training to the students of Chemistry who have just passed their M. Sc. Examinations from the eight north-eastern states of India, namely Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura.
- To support the small entrepreneur CSIR-CSMCRI trained approx. 100 marginal salt manufacturers of Gujarat (LRK) and Rajasthan (Didwana, Nava, Falaudi) for high purity solar salt production and value addition of bittern
- To empower the society, CSIR-CSMCRI trained around 150 fisher women for cultivation of *Gracilaria edulis, Gracilaria salicornia, Gelidiella acerosa* and

Kappaphycus alvarezii seaweed for their livelihood generation in Tamil Nadu and Andhra Pradesh States.

- CSIR-NISCAIR journals and magazines brought out research papers and articles/reports on areas conforming to Govt. of India's Mission programmes. The artilcle "Unsung Heroes: Women Pioneers of Space" was published in Science Reporter in March 2018.

- **DRISHTI:** DRISHTI, an airport runway visibility assessor system developed by CSIR-NAL has completed the land mark supply of 101 systems (47 systems to Civilian and 54 systems to Defence Airports). It was a notable achievement that Kempegowda International Airport, Bangalore under the Prime Minister's Make in India with NAL's Drishti during the year. Following this success, the Airport Weather Monitoring System (AWMS) developed by the CSIR-NAL has been installed at Mangalore International Airport in June 2017. This airport is the first airport in the country to have indigenously developed AWMS. The system measures Wind Speed, Wind Direction, Humidity, Pressure, Temperature and Dew Point along with Visibility.

Fig. 6.9. Drishti at Kempegowda International Airport, Bangalore

- **SUCHAN UAV:** CSIR-NAL is one of the lead agencies for Unmanned Aerial Vehicle (UAV) development in the country. NAL's autopilot and Ground Control Station were integrated using NAL-UAV communication protocol. Currently, NAL mini UAV-SUCHAN flies with NAL autopilot and NAL Ground Control Station. SUCHAN UAVs endurance is increased to 90 minutes from 60 minutes by modifying wing span and incidence angle. The UAV is configured for two major applications. While surveillance is the primary objective of the project, however based on request from the users, the UAV is also configured for geo-spatial mapping applications. In collaboration with CSIR-CIMFR, one case study of geo-spatial mapping of coal mining fields (opencast coal mine in Sonepur BAZAR Area

in Budwan District, West Bengal) during 19-20 December 2017 was carried out with SUCHAN. The geo-tagged images taken from UAV were further processed offline to create orthomosaic and Digital Elevation Model (DEM) models of the coal mining area.

Fig. 6.10 Real Time object tracking using SUCHAN UAV (b) Google of map of coal mining areas (test site)

6.4 Make in India

To support the mission, CSIR Laboratories across various domains, have significantly contributed by developing processes, technologies and establishing facilities. CSIR has supported the Indian industry by transferring the know-how, providing incubation facilities and requisite trainings. A brief about the tools/technologies:

- **Handheld devices**: CSIR-CEERI has developed devices like (i) Ammonia Sensing System which is customizable, battery operated with Low power consumption;(ii) Handheld Milk Adulteration Tester- Prototypes of Handheld Milk Fat Tester Ver-2 has been successfully developed, tested and demonstrated and the Ksheer-Tester has been unveiled by the President of India on 26thSeptember, 2017 (Foundation Day of CSIR);(iii) Rapid Milk Analyser for Milk Collection Centres, Sweet makers and Enforcement Agencies. This device helps in measuring % fat, % of SNF, % water in milk. The technology has been transferred to M/s Rajasthan Electronics Instruments Limited, Jaipur; and Handheld Milk Fat Tester: CSIR-CEERI has developed a Handheld Milk Fat Tester for domestic Useas and Limited milk sample testing. They measure fat content from 0-7%. The technology has been transferred to M/s Rajasthan Electronics Instruments Limited, Jaipur
- **Textile Reinforced Concrete panels developed:** CSIR-SERC has developed a technology for manufacturing Textile Reinforced Concrete (TRC) panels for construction of rapid-built, affordable, light weight and durable toilets. The panels

are also non-corrosive and durable. Textile Reinforced Concrete (TRC) is a building material that consists of fine grained cementitious binder and non-metallic textile as reinforcement. Compared to conventional method of toilet construction, TRC toilet construction is cost effective and time saving.

Fig.6.11.Textile Reinforced Concrete panels

- **Cost effective toilet fabricated:** Cost effective toilet has been developed at CSIR-SERC using thin precast concrete segmental panels. Toilet is designed using locally/ traditionally available materials and handled by two persons while assembling the panels for toilet construction. Further, there is scope to develop light weight panels of durable toilet construction using modern materials at the same time at affordable cost

Fig. 6.12. Cost effective toilet fabricated

- **Low Cost Water Tanks using Flowable Cement Mortar**

Fig. 6.13 Cost effective water tank

Cost effective ferrocement water storage tanks have been developed using ferrocement plates of 25 mm – 30 mm thickness by CSIR-SERC. The structures are as strong as steel plates and are completely waterproof. This water tank is prepared by a simplified process in modifying the cement mortar as flowable in nature without compromising on its strength properties so that the process will eliminate the requirement of highly skilled person of artisan type and also would be highly cost effective compared to all other water tanks commercially available. Tanks can be made in various sizes (capacity ranging from 1000 to 10,000 litres) with the regular construction tools and its environmental friendly. The water tank can be constructed using this precast concrete panels and assembled in 30 minutes. Further, no machinery is required for lifting the tank. The technology has been transferred to M/s Laxmi Srinivas Engineers, Hyderabad for commercialization.

- **Production of furfural from raw biomass:** A one pot method for the conversion of raw biomass to C5 sugars and then to furfural using a series of BAILs was demonstrated by CSIR-NCL. It showed the best results compared to all other Ionic Liquids due to its acidic nature and planar structure of imidazolium cation. The maximum yield of C5 sugar was 88% under the conditions of 160°C within an hour; higher than those catalyzed by conventional catalysts.

- **High Strength Aluminium alloy Piston:** CSIR-NIIST has developed High Strength Aluminium alloy Piston for High Power IC engine and Hub component for Automotive Petrol Vehicle which is wear and fatigue resistant.

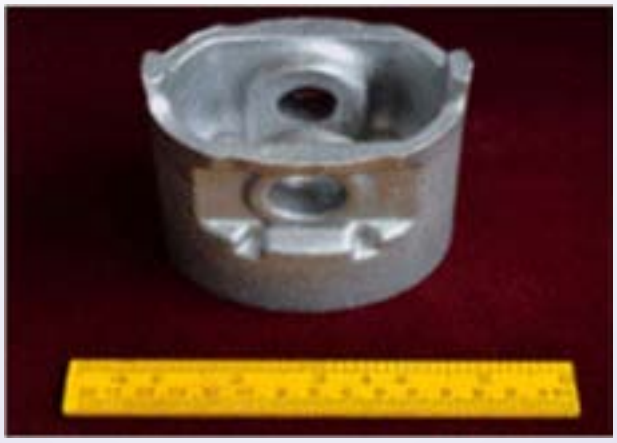


Fig.6.14. Strength Aluminium alloy Piston

- **Advanced Electrostatic sprayer:** The sprayer developed by CSIR-CSIO is one among the possible technological solutions which reduces the pesticides usage significantly with higher efficiency and bio-efficacy. This innovative spraying system is Indigenously designed and developed essentially for the small scale farms and rural economies.The technology has a great socioeconomic impact along with widespread possible applications in numerous other sectors. It also contributes to 'Make in India' campaign and the dream of doubling the income of farmers through technological interventions.

Fig. 6.15. Electrostatic sprayer

This is light weight and friendly to the environment with reduced human health risks. The technology has been transferred to two industries and the product is available in the market with brand name as 'eSPRAY'.

- **High-Volume PM2.5 Impactor Sampler**: CSIR-NPL has successfully developed, patented and transferred a technology, "High-Volume PM2.5 Impactor Sampler" to an industry. This technology involves a novel design of PM2.5 impactor sampler, which segregates particulate matter (PM) > 2.5 µm size (aerodynamic diameter) and facilitate to collect ≤ 2.5 µm size particles suspended in ambient air on filter size 8 inch × 10 inch with a high-flow rate (1.13 m3/min, i.e. 40 cfm).

- **Multi Zone Hot Bonder for Composite Repairs:** CSIR-NAL has signed two Non-Exclusive License Agreements for production, marketing and commercialization Multi Zone Hot Bonder with MSME industries M/s SAN Process Automation, Bangalore and M/s Ajay Sensors, Bangalore during the year. Both are targeting the Maintenance, Repair & overhaul (MRO) of airline industries, base repair depots of IAF and wind farms. CSIR-NAL will provide the hand holding assistance for absorption of technology, dissemination, demonstration, manufacturing of product and associated prove outs for a period of one year in order to ensure smooth technology transfer to the MSME industries.

Fig. 6.16. Multi zone hot bonder with 12 heater control

- **Moisture sensor meter:** CSIR-CGCRI has indigenously developed trace moisture sensor meter which is portable, affordable and user friendly when compared to other similar units available in the market. The moisture sensitivity ranges from 5-100 ppm and has fast response and recovery time. The developed moisture sensor meter can of utmost importance in use is transformer oil industry, food processing, gas sensing and edible oil manufacturing.

Fig. 6.17. Moisture sensor meter

- **Multi-Fab Micro Fabrication Machine:** this machine developed by CSIR-CGCRI is totally indigenous in terms of its controller and graphical user interfaces and can conduct operations such as micro turning, micro milling, micro drilling and micro patterning with a maximum machining resolution of 10 microns. The machine is reconfigurable for various machining operations.

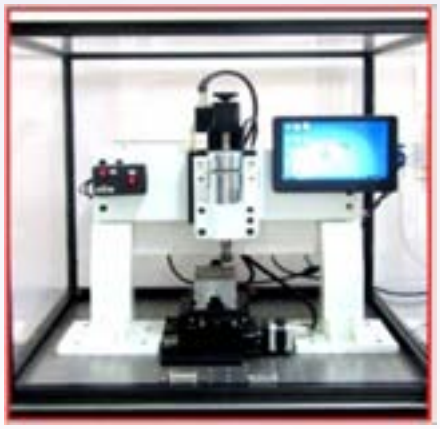


Fig. 6.18. Multi-Fab Micro Fabrication Machine

- **HERBAS Pro: A Computer-aided Machine Vision System for Authentication of Herbal Plants used in Ayurvedic Medicine:** A computer-aided machine vision system for authentication of herbal plants used in Ayurvedic medicines (HERBAS Pro) has been developed at CSIR-CEERI Chennai Centre. The system captures images of the herbs from the affixed microscope, collects data, creates reference for new herbs, and authenticates the herbal test specimen.The system also enables the user to generate Quality Check Reports (QCR) for the analysis performed over the herb specimen.

  HERBAS Pro system is designed to facilitate botanists in the authentication and grading process of the herbs used in Ayurvedic medicines at the microscopic level and to generate an herb reference collection of the herbs that are being provided by various suppliers. The system development will enormously help in improving the marketability of the company's product.

Fig. 6.19. HERBAS Pro: Herbal Authentication System

6.5 Namami Gange

- **Water quality testing:** CSIR-IITR is participating in National Mission for Clean Ganga (NMCG project with CSIR-NEERI). CSIR-IITR's role is to monitor Ganga river water quality in terms of physicochemical parameters, poly aromatic hydrocarbons, pesticides, and metals at 7 locations from Bijnor to Mirzapur of Uttar Pradesh, India.
- **Establishment of herbal gardens in Ganga grams:** The River Ganga is the fifth largest in world and third largest in Asia. Ganga basin, the largest river basin in India, has cultural, heritage and religious values. Four Ganga Grams: Bithoor Khurd, Bithoor Kalan, Katari Dodhi and Katari Bidhara of Kanpur Nagar district, Uttar Pradesh which have historical, religious and tourist importance were selected by CSIR-CIMAP for *in-situ*/*ex-situ* conservation of medicinal and medicinally important aromatic plants under National Mission for Clean Ganga (NMCG).
- During 2017-18, government primary schools, scholar mission school and about one-acre land of Bithoor Nagar Panchayat was selected, and plantation of M&MIAPs *viz. Acorus calamus, Andrographis paniculata, Aloe vera, Asparagus racemosus, Bacopa moneirii, Centella asiatica, Cassia senna, Phyllanthus niruri, Rauwolfia serpentina, Stevia rebaudiana, Withania somnifera,* etc. were done on large scale by CSIR-CIMAP.
- **Dissemination of Vetiver (*Chrysopogon zizanioides*) agro-technology:** National Mission for Clean Ganga (NMCG) project (Ministry of Ayush) was initiated by CSIR-CIMAP with the aim to save the Ganga river basin from soil erosion, clean Ganga water, decontaminate the river basin soil, enhance the greenery and doubling the income as well as to improve the livelihood of the farmers living in these areas. In this ongoing project, agro-technology for flood prone areas were developed and about 5.0 lakh vetiver slips were transplanted in Ganga river banks of Varanasi, Mirzapur and Kanpur.

Fig. 6.20. Plantation of vetiver slips at Ganga River banks in Varanasi

The awareness-cum-training programme related to decontamination, control soil runoff and enhancing income in flood prone/low productive lands located in near Ganga were organized.

- **Zero wastewater discharge technology:** Waterless Chrome tanning technology of CSIR-CLRI has been implemented in about 12 tanneries in Kanpur during 2016-18 and Zero wastewater discharge technology has been implemented in about 3 tanneries in Kanpur towards clean ganga.

Fig. 6.21. Zero wastewater discharge technology

6.6 Startup India

Support to Start-ups:

CSIR-CCMB is incubating various start up pharma companies in its Atal Incubating Centre at Hyderabad. These companies are: Bioartis Life Sciences Pvt. Ltd., Theranosis Life Sciences Pvt. Ltd., Virupaksha Life Sciences Pvt. Ltd., Kommareddy Biopharma Pvt. Ltd., Oncosimis Biotech Pvt Limited, Helixworks Technologies Pvt. Ltd., Magellan Life Sciences Pvt. Ltd., Tardigrade Private Ltd., RR Animal Health Care Ltd., Srikara Biologicals Private Ltd.

CSIR-CIMAP is supporting 'Make in India' program through its incubation centre in Lucknow campus. The production work of following start-ups/Entrepreneurs has been taken up to promote the technologies of CSIR-CIMAP during 2017-18.

S. No.	Name of the Company	Name of the product
i.	Deltas Pharma, Haridwar	Anti-inflammatory Pain Relieving Oil
ii.	Divine Herbals, Lucknow	Herbal Shampoo
iii.	Next Era Pharma, Bilaspur	Anti-dandruff Shampoo
iv.	Medas Consultancy Services, Bhopal	Herbal Shampoo

v.	Medas Consultancy Services, Bhopal	Anti-dandruff Shampoo
vi.	Medas Consultancy Services, Bhopal	Anti-inflammatory Pain Relieving Oil
vii.	Medas Consultancy Services, Bhopal	Poly herbal Toothpaste
viii.	Next Era Pharma, Bilaspur	Anti-dandruff Shampoo
ix.	Shri Ghanshyam Triveni Centre, Bulandshahar	Anti-dandruff Shampoo
x.	Ritu Sales & Activations, Lucknow	Lip Balm
xi.	Saksham Herbals & Orgnics Pvt.Ltd., New Delhi	Mosquito repellent spray
xii.	Saksham Herbals & Orgnics Pvt. Ltd., New Delhi	Mosquito repellent cream
xiii.	Aparnaa Kadam, Mumbai	CIM-Paushak

During the year, CSIR-CIMAP designed 24 improved distillation units of varying capacities for extraction of essential oils from different aromatic crops and got them installed at various locations across the country.

- **CSIR-IHBT has been incubating entrepreneurs in the major area like:** herbal beverages, tea based variants, honey vinegar, juices, turmeric processing, fruit barfi, natural juices, e- tradining platform for MAPs, floriculture, tissue culture potato, curcumin, green coffee and floriculture.
- CSIR-IIIM-TBI provides support to Startups, young Entrepreneurs, Small and Medium scale enterprises; scientists, student, research institutes /universities, new or established companies who plan to incubate their ideas or technologies to a successful commercial scale.
- Centre for Innovation and Translational Research (CITAR) has been set-up at CSIR-IITR. CITAR is an ecosystem providing researchers, innovators and entrepreneurs from academia and industry access to state of the art platform technologies and mentorship in a multidisciplinary collaborative environment.
- **CSIR-CLRI has licensed the technology to stat up:** CSIR-CLRI has transferred technology a start-up company, M/s Anipro Manufacturing Company for preparation of high grade gelatine and protein hydrolysate from trimmings waste of leather manufacturing industry.

Fig. 6.22. Technology transfer on high grade Gelatine

- CSIR-CFTRI has established Nutra-Phyto Incubation Centre and Common Instrumentation Facility (NPIC-CIF) with the support of Govt. of Karnataka. The Incubation Centre is functional which has 10 suites for incubatees covering an area of 8536 Sq.
- An online platform `SME Corner' that connects SMEs with experts at CSIR-CFTRI was launched in the institute. The platform is aimed to help Small and Medium Entrepreneurs (SMEs) to support the entrepreneurship. So far, 648 companies/ entrepreneurs have registered for availing the services. A total of 24 experts are providing required guidance on 15 broad topics on a day-to-day basis.
- **Spent wash management technology for molasses based distilleries:** CSIR-CSMCRI, in collaboration with engineering partner M/s Chem Process Systems Private Limited, have developed complete technology solution for valorisation of spent wash generated in sugarcane molasses based alcohol distillery . The process allows utilisation of spent wash for production of value-added by products, viz., potash fertiliser, animal feed ingredient etc., while achieving statutory compliance with 'zero liquid discharge' norms. The technology has been licensed to M/s Aurangabad Distillery Limited, Valchandnagar, Maharashtra for its application.
- **Ceramic membrane technology:** CSIR-CGCRI has licensed the Ceramic membrane technology to five companies, Installed 48 out of 94 Units 5000LPD for BSF (Rs. 5.6 Cr), Demonstration of High capacity ceramic membrane (8m3/hr) plant for Arsenic and Iron removal at Ramchandrapur village, Dist Malda, West Bengal completed in July 2017 and handed over to PHED, Govt. of West Bengal. Initiatives taken for supplying, installing and commissioning of Arsenic and Iron removal in Assam, Jharkhand and Bihar states.

Fig. 6.23. Plasma sprayable Hap granules

6.7 Skill India

- **CSIR Integrated Skill Initiative**

Several CSIR labs are engaged in conducting industry oriented training/ skilling programmes that have been well accepted by users. In tune with the Government Policy on Skill Mission, CSIR in its Platinum Jubilee Year mounted a major programme on "CSIR Integrated Skill Initiative". Dr. Harsh Vardhan, Hon'ble Minister of (S&T and ES) and Vice President, CSIR had launched 'CSIR Integrated Skill Initiative' on September 23, 2016 across various CSIR labs.

Fig. 6.24. Launching of CSIR Integrated Skill Initiative

Some major highlights of CSIR Integrated Skill Initiative are:

- Nearly 24,000 candidates skilled/trained at CSIR laboratories in various S&T domains.
- CSIR-IICT bagged a contract for Andhra Pradesh Skill Development Council for Biotech program for 250 candidates;
- CSIR-CSIO has received a work order in collaboration with Punjab Skill Development Mission to train 500 candidates under DAY-NULM scheme;

- CSIR-CLRI has imparted skill training of 2071 artisans in different leather trades pan India with financial support from institutions like National Scheduled Castes Finance and Development Corporation (NSFDC);
- CSIR-NEIST Integrated Skill Initiative Program has been selected under NABARD's Joint Liability Group (JLG) Promotion scheme for bank loans;

CSIR-NEIST is actively involved in different societal activities for decades where S&T interventions are involved and continued weaving training program in 2017-18 under the National Skill Development Mission & CSIR Integrated Skill Initiative in association with a local NGO. The course on "Basic Jacquard Weaving Practices" which is a 3-months course was carried on for three batches in a year. Till date three batches comprising a total of 100 women weavers have successfully completed the training. Furthermore, 109 trained weavers have been provided loan by NABARD under Joint Liability Group scheme to start the commercial production on cluster mode. The net income of the weavers is in the range of Rs. 6,000/- to Rs. 15,000/- per month.

Fig. 6.25.Training program on Weaving and products in display

CSIR labs established connect with various Sectoral Skill Councils (SSC): Leather Sector Skill Council (CSIR-CLRI); Life Sciences Sector Skill Council (CSIR-IICT); Capital Goods Sector Skill Council (CSIR-CSIO); Automotive Sector Skill (CSIR-CSIO); Aerospace & Aviation Sector Skill Council (CSIR-NAL); Agriculture Sector Skill Council (CSIR-NIO/ CSIR-NBRI/CSIR-IITR); Skill Council for Mining Sector (CSIR-CIMFR); Health Care Skill Council (CSIR-IICB) and Paint & Coating Skill Council (CSIR-CECRI).

- CSIR-NAL, in collaboration with Aviation Sector Skill Council (AASSC) has worked towards development of various Qualification Packs (QP) and National Occupation Standards (NOS) for Aviation sector.
- Under CSIR-Intregrated Skill Initiative, CSIR-CDRI has started offering following certificate course on Skill development under skill India:

i. Certificate course in care, Management of Laboratory Animals & Experimental Techniques.

ii. Certificate course in Advanced Spectroscopic Techniques.

iii. Certificate course in Computational Approaches to Drug Design and Development Certificate.

iv. Certificate course in Microscopy and Flow Cytometry.

v. Currently 30 candidates have been skilled from this Lab.

- CSIR-IIIM Technology Business Incubator (TBI) at Jammu has started Skill development Manpower training programme. TBI is running professional training programme in the areas such as cGMP Herbal Drug Formulation, packaging and manufacturing Microbial Biotechnology, Fermentation Technology, Herbal Drug manufacturing.
- CSIR-NBRI Institute conducted a number of trainings, workshops and outreach programs. During the year under report 92 persons attended seven skill development programmes, viz. garden maintenance, soil and water testing, plant tissue culture techniques and quality analysis of herbal drugs. Most of these programmes were either fully supported or semi sponsored by industry and government organizations and recognized by Agricultural Skill Council of India (ASCI).
- CSIR-IICB offered five skill development training programs on: 1. Clinical Biochemistry, microbiology, and pathology Techniques for biomedical applications, (2) Advanced Bioinformatics including NGS data analysis and interpretation, (3) Phytochemical analysis of Medicinal Plants using advanced analytical techniques, (4) high end equipment's for clinical applications, (5) Plant Tissue culture techniques. Eight students received the training in 2017-18.
- CSIR-CIMAP organized MCX- and NABARD-sponsored training programmes at Barabanki, Uttar Pradesh. A Total of 120 farmers were able to gain knowledge about nursery preparation, cultivation, processing and marketing of menthol mint oil by participating in this programme. Training programmes on essential oil and *Aloe vera* processing were organised to support the new start-up/entrepreneur in the area of medicinal and aromatic plants.
- CSIR-CECRI organized 5 (one month) and 2 (two weeks) certificate training programme under Integrated Skill Initiative for the benefit of 233 youth with the educational qualification of 10^{th}, HSc., ITI, Diploma / Degree etc., in Lead Acid battery, Electroplating, Paints and coatings, and waste water treatment and analytical instruments for the degree / diploma candidates. Through 5 skill up

gradation & 3 tailor made training respectively 125 and 66 candidates from various organization were trained.

Fig. 6.26. Training programme under skill intiative

- Two skill development programmes on IoT and MEMS processing were organised by CSIR-CEERI to train the student and professionals on (February 27-April 07, 2017 and May 15-June 23, 2017). SERB school on Plasma Devices: Science and Technology was organised during 4-22 December, 2017 or Research Scholars, Post Doctoral Fellows and Young Faculty Members from Institutions, Universities, Colleges and young researchers from R&D Centres.
- CSIR-NIO conducted a two-day interactive skill training workshop on skill development in fisheries and aquaculture. Participants of the Skill Training Workshop included the stakeholders (mostly women), fishermen and entrepreneurs. The overall objective of the Skill Training Workshop was to create an awareness on the various skill development activities undertaken by the Institute as a part of ongoing activity of the CSIR's Integrated Skill Initiatives and Government of India's Skill India Mission.
- CSIR-NPL has funded the One Year Certificate Course in "Precision Measurements and Quality Control" (PMQC) for 13 students, conducted training programmes to Legal Metrology Officers, various training programmes in Physico-mechanical parameters to Calibration and R&D Users.
- CSIR- AMPRI has started with 10 skill programs to make the youth friendly with processing industries and techniques involved
- A two days “Skill development Programme on Iron Ore Pellet Processing” was organised by CSIR-IMMT, Bhubaneswar in association with Pellet Manufacturers Association of India, New Delhi, and Indian Institute of Mineral Engineers, Bhubaneswar Chapter during 3-4th June 2017 at CSIR-IMMT. Fifty-two numbers of trainees from different pellet manufacturing companies throughout India and R&D institutions had participated in the above mentioned training program.

Fig. 6.27. Skill development Programme on Iron Ore Pellet Processing

- CSIR-CBRI, Roorkee conducted Training Programme on Housing for All - Innovative Technologies for Rural Housing, which was attended by engineers and Assistant Project Directors of PR Dept., Odisha Govt and 38 engineers of Uttarakhand Govt. It was aimed at enhancing knowledge & skills of implementing archives to incorporate innovative & disaster resistant building techniques in rural house design lectures, demonstrations & hands-on exercises & to build durable, disaster resilient low cost houses acceptable to local community.

Fig. 6.28. Training Programme on Housing for All - Innovative Technologies

7.0 IMPORTANT TECHNOLOGICAL CONTRIBUTIONS AGAINST SUSTAINABLE DEVELOPMENT GOALS

GOAL 2: Zero Hunger

- CSIR-CCMB in collaboration with ICAR-Indian Institute of Rice Research (ICAR-IIRR) has developed Improved Samba Mahsuri (ISM), a BB resistant derivative of Samba Mahsuri that retains the quality and yield characteristics of the parent. This variety has been distributed in AP, Telangana, TN and Uttar Pradesh to have better yield and mitigate hunger.

GOAL 3: Good Health and Well-being

- **CDR2492/C003–A standardized formulation for the management of osteoarthritis developed by CSIR-CDRI:** Standardized Nano formulation from *Spinacea oleracea* commonly known as 'Palak' for treatment of osteoarthritis. Product not only has the ability to form bone but it also possesses an intrinsic ability to bed more of cartilage cells at affected site. It has been observed that in the osteoarthritis model of rodents, *Spinacea oleracea* repaired and cured the degenerated cartilage. The product is available in market with brand name “Joint Fresh”.
- **Standardized fraction 219 C002 for the treatment of glucocorticoid-induced Osteoporosis has been developed by CSIR-CDRI:** Globally glucocorticoid is the third biggest cause of osteoporosis. Therefore, an osteogenic (bone forming) therapy such as standardized extract 219C002 will benefit a vast population across all ages in reducing the risk of fracture caused by the use of synthetic glucocorticoids. Moreover, long-term use of glucocorticoid is also detrimental to muscle and the standardized extract 219C002 protects against such insult.
- **Mit-o-Matic:** Comprehensive pipeline for diagnosis of mitochondrial diseases using next-generation sequencing technology (Mit-o-Matic) has been developed by CSIR-IGIB. Dysfunction of the mitochondrial genome, through genetic variations are well known to cause mitochondrial diseases. Mitochondrial diseases are one of the most common genetic diseases, with an incidence of approximately 1 in every 5000 births. This methodology has application in fast diagnosis of mitochondrial genomic variations and diseases associated with the variations., with additional advantage of detecting heteroplasmy in the mitochondria. It enables clinical diagnosis, prenatal testing and carrier screening. This technology has been licensed to a M/S Eurofins Clinical Genetics India Pvt. Ltd. for enabling Clinical diagnosis, Prenatal testing and Carrier screening.

- **Genomics and other omics technologies for Enabling Medical Decision (GOMED):** CSIR-IGIB has pioneered in the area of genomic medicine in the country and also been closely worked with clinicians from a large number of hospitals and tertiary healthcare centres across India and addressing their long-felt and unmet need. The institute has set up a pilot platform entitled "Genomics and other omics technologies for Enabling Medical Decision (GOMED)". Through this initiative CSIR-IGIB makes available in-house expertise to a larger community of clinicians, through the development and availability of low-cost molecular genetic diagnostic tests for common genetic disorders specific to India.

  Through the GOMED initiative, CSIR-IGIB's in-house expertise is made available to a larger community of clinicians to enable precise diagnosis and prognostication. Assays for 27 diseases, developed at CSIR-IGIB were licensed to M/S Dr. Lal Path Lab Pvt. Ltd. for commercial application

- **Development of Improved variety of Stevia by CSIR-IHBT:** Leaves of stevia produce diterpene glycosides, non-nutritive, non-toxic, high-potency sweeteners and may substitute sucrose as well as other synthetic sweeteners, being 300 times sweeter than sucrose. Rebaudioside-A has desirable taste profile, while stevioside is responsible for aftertaste bitterness. Development of new cultivar of stevia with higher content of rebaudioside-A and reduced content of stevioside is of prime importance for the improvement and utilization of this source as low calorie sweetener. CSIR-IHBT through conventional breeding technique has developed superior variety of Stevia, HIMSTEVIA with higher Reb A content. The cultivar has excellent nursery performance with respect to rooting and early establishment. It is vigorous in growth and has good adaptability. Tissue culture protocol has been standardized for its large scale multiplication so that the improved trait is retained. The technology has been transferred to M/s Madan Tissue Culture Lab, Alampur, Dist. Kangra (H.P.) for commercialization.

- **Protein beverage mixes:** For better health management CSIR-IHBT has developed Multigrain high protein beverage mixes. It is 100% Natural high energy drink, non-hygroscopic for ease of storage. Devoid of malt extract or processed sugar like fructose syrup, corn syrup. It is a ready to mix formulation. The technology is simple. The raw materials are widely available. It meets the following requirement:

  - g to 5g raw protein from pulses cereals and pulses meeting 20% of RDA;
  - 3g dietary fiber from millets and whole grains meeting 20% of RDA;
  - Natural calcium from cereals meeting 30% of RDA;

- Elemental Iron from nuts meeting 15% of RDA;
- Low fat drink - Zero Cholesterol & Trans-Fat free; and
- Essential amino acids from milk solids.

- **MO Check Strip (Color Detection Strip):**

  To check the adulteration of Butter Yellow in mustard oil, a handy, quick and easy spot test using a paper strip has been developed by CSIR-IITR. The strip is coated with chemicals to facilitate the monitoring of mustard oil to safeguard the health of consumers.

Fig.7.1.Color Detection Strip

- **Argemone Oil Detection Kit (AO Kit):** Mustard oil constitutes a prime dietary component of various households. Consumption of mustard oil adulterated with Argemone Mexicana oil is known to cause an epidemic popularly referred to as Dropsy. AO-kit is used to detect Argemone oil adulteration in Mustard oil developed by CSIR-IITR. The kit consists of a paper strip and a small instrument for the visualization of fluorescence. The test is easy to perform and takes about 20 minutes. The test is very sensitive with a minimum detection limit of 0.01% (100ppm).
- CSIR-NBRI has developed herbal formulation to alleviate urolithiasis. This product is efficacious and cost effective than existing herbal brands against urolithiasis and nephrolithiasis.
- **Herbal Acaricides:** To overcome the issues related to health hazards in cattle, CSIR-NBRI has developed two novel herbal acaricides were developed to control cattle ticks, jointly with ICAR-Indian Veterinary Research Institute, Izatnagar - Bareilly (UP) under NAIP scheme of ICAR.
- **Process for packaging of minimally processed vegetables developed by CSIR-CFTRI:** Fresh vegetables can be minimally processed using the package of technology protocols standardized. The minimally processed vegetables are hygienically packed in flexible pouches and stored, handled and traded under low temperature conditions.
- **Process for bottling of sugarcane juice developed by CSIR-CFTRI:** The process consists of washing freshly harvested sugarcanes thoroughly with water, trimming both the ends to remove roots and shoots, scraping the rind

with SS kinves, soaking the cleaned canes in a solution containing potassium meta bisulphite and citric acid, again washing in water, crushing the canes to obtain the juice, adjusting the pH of the juice after suitable dilution, blending with certain additives followed by filling in glass bottles, sealing with crowns and pasteurization.

Fig.7.2.Bottled sugar cane juice

- **Process technology for Crospovidone (Type A) Polypasdone XL (Polymeric excipients for pharmaceutical applications):** Laboratory scale processes for high value excepients used by Indian pharma industry has been developed and technology transferred to industry (400g/batch) by CSIR-IICT. The special features of the excipients are solvent like polymer behaviour with multiple mechanisam for disintegration and swelling without gelling. It has high compressibility and smooth mouth feel. The know how has been transferred to M/s Lucas Technologies, Hyderabad.
- **Herboprint:** Development of the invention of Herboprint by CSIR-IICT has facilitated to provide scientific basis of the wholistic/ traditional medicines. This has been accepted as a national method by FADC, India and will be submitted to ISO for international standard. This will facilitate to implement One Standard for the wholistic/ traditional medicines under the concept of Unified Systems of knowledge in healthcare systems.
- **Handheld Milk Fat Tester**
  CSIR-CEERI has developed a handheld milk fat tester with the following specification:

Type	Specifications
Milk composition (%)	Fat; Range: 0-9%; accuracy:±0.3%;
Communication	RS232 for computer
Measuring time	< 20 seconds

Sample volume	5-10 ml
Usage	Domestic
Principle	Electrochemical
Sample test charge	Nil

The technology has been transferred to M/s Rajasthan Electronics & Instruments Ltd., Kanakpua Industrial Area, Sirsi Road, Jaipur (Rajasthan).

Fig.7.3. Handheld milk fat tester

Salivary Fluoride Detection Kit: CSIR-CMERI has developed the indigenous salivary fluoride for diagnosis of salivary fluoride level for the welfare and betterment of the society. The salivary fluoride detection kit has mainly two components: Solution Kit & Sensor Station. It is user friendly, light weight, portable & affordable low cost. Technology package contains Synthetic Protocol of the Chemosensor material for salivary fluoride level detection along with all technical details & specifications of solution kit prototype fabrication. It can be implemented in dental hospital or clinic an affordable one-time investment (~Rs. 2,500/-).

GOAL 6: Clean Water and Sanitation

Number of CSIR laboratories are involved in developing new technologies in cleaning water fit for safe drinking.

Oneer- a novel solution for safe drinking water for domestic and community purpose: The device is based on the principle of anodic oxidation. The device is particularly useful for the treatment of drinking water supplies that have microbial contamination to disinfect pathogenic microorganisms and to provide safe drinking water to communities as per National and International standards [World Health Organization (WHO) and Environmental Protection Agency (EPA) USA] prescribed for potable water. This has high disinfection efficiency of >8 Log reduction of bacteria (E coli) and is maintenance-free. It is a low-cost water disinfection device that can even treat brackish or turbid water unlike UV technology. Cost of treated water is less than 1 paisa per litre. Domestic device can supply 10 litres of water for domestic use and small establishments while the online version can supply 450 litres of safe water for communities.

Fig.7.4. Oneer System

Anaerobic digester for household organic waste: CSIR-NIIST has carried out design improvement and performance evaluation of the scale-up version of the digester for treating large quantity of organic waste was one of the major activities of the laboratory. A demonstration scale modified unit was established in CSIR-NIIST and it was continuously operated for nearly 8 months. Compared with the previous model, the revised design was more mechanical with automatic control system for more efficient biogas production and its utilization. The 40 Kg food waste/day unit was generating around 7 M3 biogas daily (average biogas was 160-180 L/Kg food waste, methane content >60%). The total solid loading into the digester was around 4.6 Kg/M3.day. CSIR-NIIST food waste digester cum biogas plant is installed in schools, Regional cancer center, Marthoma orphanage in Thiruvananthapuram, CPCRI, Kayamkulam , Kavaratti island in Lakshadweep and few households. Ensures a cleaner and greener environment in line with Swatch Bharat Program. The patented domestic organic waste converted to biogas with zero discharge, generates excellent manure as by product.

Fig.7.5. Anaerobic Digester

Colour removal treatment of rice mill effluent: CSIR-NIIST using lime has developed a process for color precipitation followed by neutralization with carbon dioxide absorption from biogas. This is the first known commercially applied colour removal process for parboil rice mills in India /rest of world.

Simple user friendly bacterial contamination detection kit for municipal, aquaculture and swimming pool water: CSIR-CSMCRI has developed an easy detection system for bacteria, without the need of expensive or heavy instruments, containing PVDF based composite membrane with the property of attaching bacteria. The method includes preparing a cost effective membrane comprising glucose as a carbon source and triphenyl tetrazolium chloride as an indicator. Graphene oxide is used to enhance the bacterial growth in surrounding water. The membrane can be deployed at field for real time application to detect bacteria in contaminated water samples. The membrane attached bacteria from the water sample utilize the carbon source and change the color of dye to pink/red. The time taken for changing the colour of water depends on the bacterial load in the surrounding water. The device can be operated onsite the water source to detect the bacterial contamination and circumvents the transportation of water sample to the laboratory. Further, this method is simple and can be used by any one even in remote location like small villages, without requirement of any microbiology laboratory or trained personnel.

Thin film composite membrane reverse osmosis based water desalination-cum-purification: CSIR-CSMCRI has developed reinforced ultrafiltration membrane for TFC RO and water purification and licensed to OM Tech, Rajkot, Gujarat. The salt rejection in these membranes is 95-97% with water flux 60+- 5 l/m2h when tested at 250 psi operating pressure. The leak proof spiral membrane modules of 4" diaX 1m length and 8" dia X1 m length have been fabricated. CSIR-CSMCRI has provided all machine drawings for establishing the facilities at the client site.

Domestic Filter for the Purification of Fluoride and Arsenic Contaminated Water: CSIR-AMPRI has developed low cost (~600 Rs/kg) process of synthesis of nanoalumina particles as adsorbent material for removal of fluoride and arsenic of water. It is very cost effective with high removal efficiency of fluoride and arsenic contaminant of water. It has the potential to be used in the domestic as well as small community level (80-100 people). The developed filter requires no electricity in filtration and very userl friendly, as simply put contaminated water via inlet of the filter and get treated water from the outlet of the filter through 3-5 lit/hour flow rate . To certain extent it removes bacteria and viruses too. The filter retains all essential mineral of water and does not result in any wastage of water. The adsorbent used in the filter has 3-4 times regeneration quality and susceptibility of leaching of aluminium in treated water is completely nil.

CSIR-AMPRI developed filter modem was installed in Molukheri village of Aasta tahsil in Sehore district of M.P. state where fluoride level in ground water occurs 5-8 mg/l.

After installation, developed filter was able to reduce fluoride level more than 75% in the treated water.

Arsenic and iron contaminated purification by ceramic membrane: One notable achievements of CSIR-CGCRI is Ceramic membrane based technology for production of quality drinking water from contaminated arsenic and iron contaminated turbid ground water. This technology pertaining to Iron, Arsenic and particulate removal from groundwater have been developed and are being propagated through technology transfer to six licensees. Notable success has been achieved in propagating these application technologies through installations of more than 150 water purification plants of various capacities mainly thorough financial assistance from DST, Govt. of India, work contracts from PHED, Govt. of West Bengal and PHED, Govt. of Bihar and also through private individual funding.

Fig.7.6. Ceramic Membrane based purification system

Iron Removal Plant: To render water safe for human consumption, CSIR-CMERI has developed a water purification technology that reduces excess iron in potable water to a safe limit. Based on this technology, community level iron removal plants have been set up which are durable, chemical free, and as well as user friendly. Groundwater contaminated with iron is manually pumped to aeration chamber of the iron removal plant attached with the usual Mark-II hand pump.

The novelty of the present invention lies in the ability of the device to deliver instantly iron free safe drinking water without affecting water quality parameters and that too without electricity. 52 Nos. of improved iron removal plants (IIRP) have been implemented in various district of West Bengal thus serving the needs of about 30,00 rural population.

Fig.7.7. Installation of iron removal plant from drinking water

Domestic type filtration unit: CSIR-CMERI has developed a completely green technology, addressing the removal of iron from groundwater is very much in demand in areas depending solely on groundwater for their livelihood.

Domestic type filtration unit removes iron to the desired permissible limit (0.3ppm) of drinking water. No electricity, chemicals required. It can also remove foul odor, bad taste of iron water.

Fig.7.8. Domestic Filter for iron removal

Comprehensive study of technologies available for these contaminants removal from drinking water all together, worldwide: A Scientometric approach was undertaken by CSIR-NISTADS to study Arsenic, Fluoride, Nitrate and other heavily metal in drinking water during the 1995-2015 period, as an outlook to treatment alternatives for removal of contamination. To understand knowledge structures both quantitatively and visually by integrating keyword analysis and social network analysis of scientific papers.

GOAL 7: Affordable and Clean Energy

Thermoelectric refrigerator developed by CSIR-NPL: The Peltier Based solid state cooling is an environment friendly alternative to the cooling options. This technology has been employed to provide a solution for food and drug storage at temperatures below 10^0C. This is a green cooling concept where it does not require any refrigerant gas for cooling thus, it operates without compressor and completely on a 12 or 24 VDC

voltage. The technology of low-cost and maintenance-free thermoelectric refrigerator has been transferred to M/s JTC, New Delhi.

GOAL 8: Decent Work and Economic Growth

Improved Varieties of Citronella and Lemongrass: CSIR-NEIST has been working and contributing immensely in improving the socio-economic conditions of the people in rural areas through various S&T interventions. So far, the Institute has brought several thousand hectares of shallow and waste lands in NE India under the cultivation of aromatic plants such as Citronella, Lemongrass, Patchouli, etc. The efforts have provided avenues for income & employment generation to many beneficiaries. The Institute also developed improved varieties of Citronella and Lemongrass named as 'Jor Lab C-5' and 'Jor Lab L-8'. The variety Jar Lab C-5 has 78% Citral content, which is superior by 22% when compared with the existing varieties. Lemongrass oil works as an air freshener & deodorizer especially when blended with other essential oils and also known for its ability to repel insects.

Fig.7.9. ToT in Citronella and Lemongrass varieties

Apart from short-term programmes, CSIR-CLRI in association with NSFDC has also conducted 6-months Diploma/Certificate course pan India in different leather trades including Leather Processing, Leather Goods and Garments and Leather Footwear. A total of 200 trainees were equipped with technical as well as professional skills.

Fig.7.10. Training program in leather

GOAL 9: Industry, Innovation and Infrastructure

- **Corrosion resistant inhibitive admixture for portland pozzolana cement:** CSIR-CECRI has developed a process to get corrosion resistant inhibitive admixed Portland pozzolana cement concrete. The process involves a simple step of adding inhibitors during manufacturing of cement or while making concrete at site. The added chemicals are in powder form and can be mixed at the factory itself, while producing cement or during making concrete. This product can be used for constructions in aggressive marine environments, since it is more corrosion resistant than normal cement due to the inhibitive nature of the added compounds. The technology has been transferred to Cleanflo India Pvt Ltd., Delhi
- **Cement Polymer Composite Coating System for Corrosion Protection of Reinforcing and Prestressing Steels**: Versatile corrosion protecting coatings have been developed by CSIR-CECRI with high market value. The coating protect the steel rebar embedded in concrete structures exposed to marine environment through on situ process which Improves bond strength and is cost effective. The technology has been transferred to Protektol Anticorrosives, Chennai.

- **Road Dust Collecting and Briquetting System:** CSIR-CIMFR has developed a system that collects coal dust from road surface and transforms it into coal briquettes. The process consists of four major parts: (i) coal dust collecting mechanism, (ii) dust separating and storage arrangement, (iii) water spraying and mixing process, and (iv) briquettes manufacturing.The system utilizes waste coal dust as domestic fuel, which is abundantly available on mine road surfaces. It cleans road surface and controls air pollution in mining, industrial and urban areas. The technology has been patented.

  The specialties of the system are that it can: (i) operate on uneven mine roads, (ii) collect heavy amount of dust accumulated on mine roads, (iii) collect lump size upto 10 cm, and (iv) operateas dust extractor in the confined industrial working areas.

  The technology has been licensed to M/s TATA Motors Limited, Mumbai for commercialization.

- **Spent wash management technology: potash, organics & ZLD:** CSIR-CSMCRI, in collaboration with engineering partner M/s. Chem Process Systems Private Limited, have developed complete technology solution for valorisation of spent wash generated in sugarcane molasses based alcohol distillery . The process allows utilisation of spent wash for production of value-added by products, viz., potash fertiliser, animal feed ingredient etc., while achieving statutory compliance with 'zero liquid discharge' norms. Preliminary economic analysis for implementation of the technology in a 100 klpd distillery suggest a CAPEX payback period of about 3.5 years. The plant is expected to be operational in 2018-19.

- **Design and development of compact cascaded reverse osmosis membrane based system for demineralized water production:** Cascaded compact reverse system of 40–60 L/h capacity is a low cost import substitute that costs Rs. 35,000/- only as compared to Rs 5-10 lakhs charged by multinational companies. The membrane is made up of novel polyether urea that provides high TDS rejection with permeate TDS ranging from 2-5 ppm. Studies on process scale up are underway. The system is maintenance free compared to multinational companies that charge Rs 1 lakh per annum and can produce DM water at an operating cost of 5 Paise per liter. The water can be useful hospitals, biotech industry, caustic soda and power plants and automobile industry.

Fig. 7.11. Compact reverse osmosis membrane system

- **Herbal Mosquito Repellent Vaporizer:** Mosquito infestation is a major problem in tropical and subtropical countries like India. The demand for Mosquito repellent products has been increasing with time palpable with the introduction of wide variety of products in the market such as coils, sprays, ointments, liquid vaporizers, incense sticks, etc. to prevent mosquito borne diseases. Herbal mosquito repellent liquid vaporizer developed by CSIR-NEIST is effective to ward off mosquitoes and completely safe to humans. The product is eco-friendly and non-toxic to humans.

Fig. 7.12. Herbal Mosquito Repellent Vaporizer

- **OP-12 Biofertilizer:** CSIR-NEIST has developed OP-12 Biofertilizer, having the ability to work in normal as well as in water deficit condition. Based on a unique Rhizobacterial strain, OP-12 Biofertilizer has plant growth-promoting traits like N fixation, phosphate solubilization, production of indole-3-acetic acid (IAA) like molecules, ammonia, hydrogen cyanide, etc. CSIR-NEIST licensed the technology to M/s Amrit Organic, Duliajan, Assam, after working closely with local farmers. Around 150 farmers are using the product based on this technology. The technology also provided a source of income generation for the party who has net earnings of Rs.9000.00/month today providing direct/indirect employment to 10 people.

Fig. 7.13.Field application of OP-12 biofertilizer

- **Air-Assisted Electrostatic Spraying Technology:** There has been a very serious concern over excessive pesticides use and their adverse effects on human health, soil, water contamination and environment. India uses very less pesticides per hectare (Kg/ha) than other countries however, still facing adverse consequences because we are still using older technologies which are less effective and efficient. Electrostatic spraying developed by CSIR-CSIO is one among the possible technological solutions which reduces the pesticides usage significantly with higher efficiency and bio-efficacy.

An air-assisted nozzle is a combination of an air-assisted nozzle, electrostatic charging mechanism and automated ON/OFF power supply system. Electrostatic pesticide spraying technique reduces the off-target drift, environmental pollution and human health risks hazardous and increases the bio-efficacy and mass transfer efficiency onto the surfaces of crops, orchards and tress with uniform back deposition. It has a great socio-economic impact which is directly linked to the farmers.

The technology has a great socioeconomic impact which is directly linked to our farmers and its widespread applications to various sectors would contribute largely to 'Make in India' campaign and the dream of doubling the income of farmers through technological interventions. The technology has been transferred to M/s. Dashmesh Industries, Alwar, Rajasthan.

Fig. 7.14. Air assisted electro static spraying

- **Development of High Volume PM 2.5 sampler:** Reliable measurement of air quality parameters is an important task in Indian cities. Also, for making an effective control policy, it is very important that the air quality measurements should be reliable. PM 2.5 is a governing factor of air quality, and is a key parameter to define the degree of pollution level. In this direction, CSIR-NPL has developed a sharp cut-off point high-volume PM 2.5 sampler. The developed sampler can be used to measure PM 2.5 concentration in ambient air better than equal to 5% of total uncertainty under Indian conditions. At international market few high-volume PM 2.5 samplers are available. However, the CSIR-NPL's sampler is first in India which has been indigenously developed according to our need and conditions. Also, this development is not limited to the growing need and reliable measurement of PM 2.5 but will further save a huge amount of foreign currency, which is being invested in purchase of imported samplers every year. The technology has been transferred to M/s Environmental Solutions, Noida, Uttar Pradesh.

- **Development and evaluation of "Soil Nailing Technique" for stabilisation of soil slope for the construction of underpass intersection below Road traffic:** The rapid growth in population, industries and infrastructure development in country has led to shortage of land space in the metropolitan cities and also resulted in the tremendous increase in traffic volume and congestion on roads. Many a time, the scope of further widening and flyovers are not feasible in city due to many constraints Construction of an underpass involves in addition to huge money, man power and time, a special construction skill. But, underpass becomes unfeasible due to instability of soil and other site constraints; therefore, idea of construction of underpass below the existing road in live loading condition is generally dropped. Now there is a need of advance technology using which, the safe and economical underpass can be constructed by any means without any interruption to the live traffic. CSIR- CRRI has developed a new methodology for box pushing with the help of "Soil Nailing Technique" which was used for stabilizing the sandy soils during box pushing operation. The methodology has been established for construction of the intersection without disturbing the traffic.

- **NiTi Shape Memory Alloys (SMAs):** CSIR-NAL has signed an agreement with M/s Mishra Dhatu Nigam (MIDHANI) Limited, Hyderabad on transfer of technology (ToT) for commercial production of engineering and biomedical grades of SMAs. The ToT to MIDHANI for production of engineering products such as rods, plates, wires and strips has been completed and the products are now commercially sold by MIDHANI. CSIR-NAL is working with MIDHANI in drawing the specifications and costing for effective marketing of the products in the country as well as abroad. During the last one year, CSIR-NAL and Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum. SCTIMST have worked together in unison and finalized the design and fabrication scheme for NiTi SMA stent grafts. The first prototype stent graft has already been fabricated and the same is being subjected to functional and biological tests at SCTIMST..

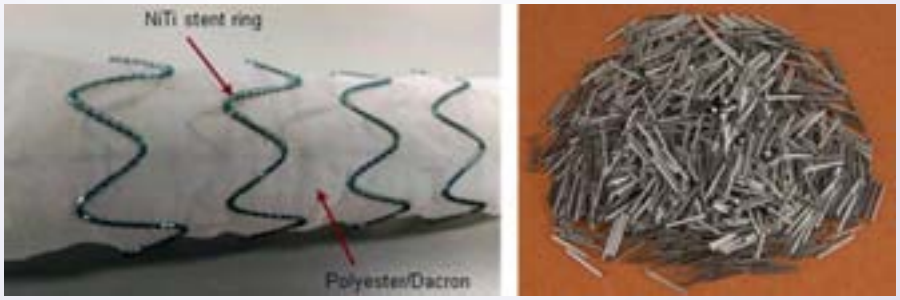


Fig.7.15 (a) A prototype stent-graft made by stitching NiTi stent rings on to polyester/dacron cloth; superelastic NiTi stent rings were fabricated at CSIR-NAL, (b) electropolished SE NiTi SMA samples prepared at CSIR-NAL and provided to SCTIMST for biocompatibility and toxicology studies.

GOAL 11: Sustainable Cities and Communities

- **Development of a Boring Machine Based on Trenchless Technology:** A small-capacity boring machine capable of making horizontal bores under the ground at required depth economically and effectively has been developed at CSIR-CBRI. The machine is suitable to make bores for installation of sewer pipelines, conduits, electrical cables, water lines, other transmission products under the buildings, roads and allied constructions. The salient features of the developed boring machine are as follows:

  - Boring diameter : Up to 160 mm
  - Boring length : Up to 14.0 m
  - Depth of Boring : Up to 1.0 m (under surface)
  - Required Pit Size : 1m X 0.75m
  - Power requirement : 3 HP

The technology has been transferred to M/s. Techno Industrial Marketing, Kashipur (UK)

Fig. 7.16. Trenchless Boring Machine

- **Safe Disposal of Municipal Solid Waste utilising high temperature plasma:** The generation and efficient management of solid waste is unambiguously a prime concern. This waste is a potential health hazard to the workers who are associated with this job, public and flora and fauna of the area. The technology has been developed by CSIR-CMERI for effective & eco-friendly disposal of municipal solid waste material generated on daily basis and generation of fuel gas containing predominantly CO and H_2 utilizating high temperature (>3000^o C) Plasma arc. Mechanized handling of waste would be useful to avoid health hazard to the associated workers. The salient features are:

(a) Eco-friendly disposal of municipal solid waste through utilizing high temperature ionized gas /electric arc with significantly low level of toxin generation

(b) Large volume reduction, slag is 1/250th of the volume of processed solid waste

(c) Generation of fuel gas containing predominantly CO & H2

(d) Unique gas cleaning system to minimize the dust accumulation in the generated fuel gas

(e) Special design consideration to prevent leakage of gas from the system during regular operation

(f) Storing facility of generated fuel gas

(g) Energy harvesting from generated gases through generation of electricity

(h) Utility of slag as construction material

Fig. 7.17. Plasma technology for mechanized disposal of soiled wastes

- **Technology Empowerment of North East with Water, Energy and Communication Solutions and Other Critical Areas (TENE WECS):** The TENE WECS study by CSIR-NISTADS was designed to provide technology solutions in critical sectors such as water, energy and communication to the 88 technical institutions in North East identified by AICTE by developing and implementing projects through training and active participation of these institutions.

GOAL 12: Responsible Consumption and Production

- **A technology to enhance the shelf life of fruits and vegetables by converting them into crispy form:** As per FAO estimate about 45% post-harvest losses are incurred in fruits and vegetables. It is the highest wastage rate among all the food products. CSIR-IHBT has developed a technology to enhance the shelf life of fruits and vegetables by converting them into crispy from. It is a simple and convenient technology and can be set up at farm level. Crispy fruits in addition to prolonged

shelf-life also retain near original colour, texture, taste and aroma. It can regain their original texture, taste, colour and aroma on reconstitution in water. The nutritional properties are retained. Remains stable at room temperature for easy storage and easy to transport due to 80% weight reduction during processing.

- **A technology to preserve traditional pulse based recipes of Himachal Pradesh in Ready to Eat form:** Post-harvest losses in India amount to 12 to 16 million metric tons of food grains each year. Processing of pluses can significantly reduce this loss. CSIR-IHBT has developed a technology to preserve traditional pulse based recipes of Himachal Pradesh in Ready to Eat form. CSIR-IHBT has developed an indigenous technology for commercial production of ready-to-eat food without adding any preservative. These products remain fresh for over seven months. Regulatory studies of these products have shown prebiotic health benefits. With this, raw material could be sourced from local farmers owing to geographical attributes of the specific pulses. This in turn will improve the returns of the farmers. The technology has been transferred to M/s Dexter Retail and Distribution Pvt. Ltd., New Delhi for commercialization.

  Bed Waterless Chrome tanning technology (WCTT) and Zero wastewater discharge technology (ZWD). Current and Envisaged with WCTT of CSIR-CLRI savings per year are:

  - Savings of 75 million liters and 2 billion liters of water (low wastewater)
  - Savings of 1000 and 24000 tonnes of BCS (Zero Cr discharge)
  - Savings of 3800 and 100000 tonnes of salt (20% low TDS)
  - Handling of 380 and 10000 tonnes of dangerous sulfuric acid is averted ZWD
  - Present discharge of about 24 billion liters of wastewater per annum is averted - zero discharge.

  The possible reduction of cost of waste water treatment will be about Rs. 96 million per annum. About 160 tons of sludge generation per annum is averted. As there is no discharge of wastewater including sulfide bearing stream, the average annual fatalities due to release of H_2S of about 10 per annum in India.

- **Innovative drying model, Refrigeration Adsorption Dehumidified Drier (RADD):** CSIR-NIIST designed and developed an innovative drying model, Refrigeration Adsorption Dehumidified Drier (RADD), for the low temperature drying of indigenous fruits and vegetables for further value addition for post harvest processing.

Fig. 7.18. An innovative 'Refrigeration Adsorption Dehumidified Drier' for the low temperature drying of indigenous fruits and vegetables

GOAL 13: Climate Action

- **Plant species as potential mitigants of ozone pollution:** During experimental trial on nine tree species, CSIR-NBRI identified four species, *Nerium indicum*, *Plumeria rubra*, *Polyalthia longifolia*, and *Ficus benghalensis* as potential mitigants of ozone pollution. In another experimental study on two wheat varieties revealed the potential of an aromatic compound, Ethylendiurea (EDU), as a good research tool to assess ozone toxicity in field –grown crops.
- **Simulating CH_4 and CO_2 over South and East Asia using the zoomed chemistry transport model LMDzINCA:** The increasing availability of atmospheric measurements of greenhouse gases (GHGs) from surface stations can improve the retrieval of their fluxes at higher spatial and temporal resolutions by inversions, provided that chemistry transport models are able to properly represent the variability of concentrations observed at different stations. South and East Asia (SEA) is a region with large and very uncertain emissions of carbon dioxide (CO_2) and methane (CH_4), the most potent anthropogenic greenhouse gases. Monitoring networks have expanded greatly during the past decade in this region, which should contribute to reducing uncertainties in estimates of regional GHG budgets. In this study, CSIR-4PI simulated concentrations of CH_4 and CO_2 using a zoomed version of the global chemistry transport model LMDzINCA during the period 2006–2013. The zoomed version has a fine horizontal resolution of ~0.66° in longitude and ~0.51° in latitude over SEA and a coarser resolution elsewhere. The concentrations of CH_4 and CO_2 simulated from the zoomed model (abbreviated as 'ZASIA') are compared to those from the same model but with a uniform regular grid of 2.50° in longitude and 1.27° in latitude (abbreviated as 'REG'), both having the same vertical 19 sigma pressure levels and prescribed with the same biogenic and anthropogenic fluxes. Model performance was evaluated for annual gradients between sites, seasonal, synoptic and diurnal variations, against a new dataset including 30 surface stations (of which Hanle, Pondicherry

and Port Blair are run by CSIR-4PI), over SEA and adjacent regions. The results show that, when prescribed with identical surface fluxes, compared to REG, the ZASIA version moderately improves the representation of CH_4 mean annual gradients between stations as well as the seasonal and synoptic variations of this trace gas within the zoomed region. This moderate improvement probably results from reduction of representation errors and a better description of the CH_4 concentration gradients related to the skewed spatial distribution of surface CH_4 emissions, suggesting that the zoom transport model will be better suited for inversions of CH_4 fluxes in SEA.

- **Reduction of atmospheric CO_2 over Delhi through non-disruptive and sustainable Carbon Sequestration:** CSIR-NISTADS system designed and optimal growth conditions under representative urban (Delhi) soil conditions under open environment. Implementability is established by developing and maintaining field plots through inter-institutional arrangements among CSIR-NISTADS, CSIR-NPL and CSIR-IGIB, functional for past about one year. In terms of effectiveness, measurements show that the percent of carbon sequestered in the field plots in Delhi is comparable to that in farm environment in Bangalore.

  The first outlook of high resolution long-range forecast of the Monsoon 2017 was made available in April, 2017.These forecasts are based on an ensemble consisting of initial conditions from 15th March to 15th April 2017. The CSIR-4PI forecast of the date of Onset of Monsoon was May 31, and the actual DOM was on May 30, 2018. The post season validation of distribution of monthly and seasonal rainfall anomalies show good agreement of forecast with observation over many regions of the country.

GOAL 14: Life Below Water

- **Modelling and Simulation of subsurface oxygen distribution in the north Indian Ocean:** Numerical Simulations of the contemporary three-dimensional prognostic marine biogeochemical model (TOPAZ having more than 25 tracers) were carried out at CSIR-4PI in the global domain for climatological and interannual variability. Model is able to capture all the Oxygen Minimum zones (OMZ) in the global ocean and OMZ extends between 150 to 1200m depth in the Arabian Sea (AS) north of 12° N. Spatial extent of suboxic zone (Oxygen < 6 m Mol/m3) shows significant interannual variability. Denitrification flux in the Arabian Sea from the model simulation results (i) indicated variation between 20 and 40 TgN/year which is comparable with the estimates based on calculations of nitrate deficit (ii) depends on the Primary Productivity and the volume of Oxygen Minimum Zone.

- **Effect of Iron limitation on Primary Productivity and Carbon Flux in the Arabian Sea:** There have been many studies on Iron as a limiting factor for

productivity in the World ocean but only a few studies have been done in the Arabian Sea (AS) on Iron limitation. Detailed analysis of the two numerical simulation results on Primary Productivity (PP), Chlorophyll (Chl) and Nutrients were carried out by CSIR-4PI for different regions in AS to understand the sensitivity of one of the parameters related to Fe limitation. Model results show that the trace element iron plays a critical role in nutrient utilization, phytoplankton growth and therefore the uptake of carbon dioxide from the surface waters of the global ocean.

GOAL 15: Life on Land

- Laboratory for Conservation of Endangered Species (LaCONES) of CSIR-CCMB provides DNA-based identification of species, services for wild animal rehabilitation and wildlife crime investigation. This activity enables the law enforcing authorities to main the biodiversity and conservation of endangered species. Assisted reproductive and patented Universal Primer technologies are being employed to screen and analyse the wildlife samples.

- **Microfarming is a technique to grow tiny plants:** Tiny plants are very essential for soldiers posted in the regions of extremely low temperature and high altitude. These tiny plants are source for providing required nutrients and water content to the Jawans of Indian Army. The germination and growth of these tiny plants does not happen in the extreme cold climatic conditions. In order to germinate and grow these tiny plants on a regular basis in these regions, hotplates play an important role for maintaining the required temperature inside the microfarming unit. The microfarming units developed by DRDO-DIHAR have been integrated with CSIR-CEERI developed hotplates. Hotplate integrated microfarming units have been installed and tested successfully for maintaining the temperature inside the unit in the range of 15-20°C at DRDO-DIHAR, Leh and DRDO-DIHAR, Chang La centre as per the user requirement. The unit installed at Chang La centre (17,600 ft above sea level) has maintained a temperature of 18-20°C inside the unit while the temperature outside was below -5°C. The germination of seeds (radish) has been successfully demonstrated in both the units.

8.0 IMPORTANT SCIENTIFIC AND TECHNOLOGICAL CONTRIBUTIONS - CLUSTERWISE

8.1. BIOLOGICAL SCIENCES

A chiral selectivity paralog of DTD for proofreading tRNA mischarging in Animalia

CSIR-CCMB identified emergence of totally new proofreading capabilities in the context of genome evolution and shown its implications for the evolution of Animalia. A new enzyme has been identified and characterized, which is present only in the context of Animalia, called Animalia-specific tRNA deacylase (ATD). While all the known proofreading during protein biosynthesis, apart from ribosomal proofreading, are associated with amino acid ambiguity, it has been shown for the first time that ATD corrects an error arisen from tRNA mis-selection. The proofreading activity of ATD is conserved across diverse classes of phylum Chordata. The study highlights the emergence of ATD during genome expansion as a key event associated with the evolution of Animalia.

DRB4 dsRBD1 drives dsRNA recognition in *Arabidopsis thaliana* tasi/siRNA pathway

The study by CSIR-CCMB highlights that the preferred orientation of tandem dsRNA binding domains in DRB4 allows the process of siRNA pathway initiation in plants. Further, domain selectivity and specificity leads to DRB4's multifarious activity in the post-transcriptional gene regulation mediated by tasiRNA & siRNA and antiviral response. The study exemplifies that the process of RNAi initiation is unique for each organism and is heavily dependent on multiprotein assembly consisting of Dicer, its partner dsRNA binding protein and the trigger RNA. This work provides key mechanistic inputs for future design of gene silencing tools in plants.

The [Fe-S] biogenesis SUF pathway as a validated target in malaria parasites

CSIR-CDRI has provided the first experimental evidence for a functional SUF pathway for [Fe-S] biogenesis in the *Plasmodium falciparum* apicoplast (a relict plastid). Delineation of major steps and proteins of the pathway has since been completed and conditional knockout of sufS has demonstrated that the SUF machinery is essential for parasite growth in the mosquito vector. Essentiality of SufC in human blood stages *of P. falciparum* has been shown earlier. There are no known inhibitors of SUF proteins, necessitating a de novo approach to search for putative inhibitors for critical interactions such as those between desulfurase SufS and SufE, and scaffold components SufC and SufD. Molecular structure models for SUFs have been developed. It is being deployed in the drug discovery program at CSIR-CDRI.

Design of novel antimicrobial and anti-endotoxin peptides for the development of new anti-infectives

CSIR-CDRI has designed and developed a 15-residue novel peptide, S-016-1271, which is appreciably non-cytotoxic to human RBCs and murine 3T3 cells and possesses significant antimicrobial and anti-endotoxin activities. The peptide retains its antibacterial property in serum and physiological salts. The peptide is highly active against both Gram-positive and Gram-negative bacteria, fungi (*Candida albicans, Cryptococcus neoformans, Candida parapsilosis*) and Methicillin, gentamicin and multidrug resistant strains of *S. aureus.* Treatment of this peptide (single dose of 7 mg/kg) to mice administered with *P. aeruginosa* (ATCC BAA-427) showed 60% survival indicating appreciable efficacy of this peptide in rescuing mice against this bacterial infection.

Artificial Small Intestine Helps Study Nutrient Absorption from food

CSIR-CFTRI and the Indian Institute of Food Processing Technology (IIFPT), Thanjavur, have developed an artificial small intestine system to test the level of absorption of micronutrients and other bioactive compounds from food. The artificial system consists of a perfusion chamber fitted with rat intestine and requires just two hours to analyse the intestinal absorption. Methods currently in use are time consuming and not suitable for studying large number of compounds.

Fig. 8.1.1. Small intestine system simulation test setup

The artificial intestine system, simulates the exact physiological conditions and helps to evaluate both bioaccessibility and bioavailability of nanoformulated bioactive compounds. The system has reduced the number of rats required for animal trials from 6-10 rats to just 2-3 thus taking care of the ethical issues that researchers face in carrying out *in vivo* studies. The permeability of both fat-soluble (vitamin E) and water-soluble (gallic acid) compounds was checked using the new setup. While in the case

of the fat-soluble compound, the permeability was higher in rats than the new system, the artificial system performed better for the water soluble compound.

A transcription factor from *Withania somnifera* regulates withanolide content and confers biotic stress tolerance through modulation of defense pathways

CSIR-CIMAP identified a transcription factor (*WsWRKY1*) from *W. somnifera* which regulates triterpenoids (phytosterols and withanolides) biosynthesis. Its knock-down causes stunted plant growth and reduced levels of triterpenoids while over-expression elevates the biosynthesis of triterpenoids. This factor interacts with W-box sequences that are present in the promoters of squalene synthase and squalene epoxidase genes of sterol pathway for modulating their expression. Apart from enhancement of triterpenoids, this transcription factor also improves the tolerance to biotic stress in *W. somnifera,* highlighting its importance as a metabolic engineering tool for simultaneous improvement of triterpenoid biosynthesis and plant defense.

Terpene synthases of terpenoid and carbazole alkaloid biosynthesis pathways identified in curry tree (*Murraya koenigii*) through transcriptomic approach

Curry leaf (*Murraya koenigii L.)* is a rich source of aromatic terpenes and pharmacologically important carbazole alkaloids. CSIR-CIMAP carried out the transcriptome sequence of *M. koenigii* leaf and identified two terpene synthase genes (*MkTPS1* and *MkTPS2*) with highest *in silico* transcript abundance. Their enzymatic characterization revealed that MkTPS1 produces primarily (-)-sabinene from geranyl diphosphate (GPP), while, MkTPS2 exhibits sesquiterpene synthase activity and produce (E,E)-*α*-farnesene from farnesyl diphosphate (FPP). Overall, the transcriptome data generated in this study will be a great resource and the start point for characterizing genes involved in the biosynthetic pathway of medicinally important carbazole alkaloids.

DNA barcoding for authentication and conservation of threatened species of genus *Decalepis* (Apocynaceae)

The endemic species of genus *Decalepis* are highly threatened by destructive wild harvesting. Medicinally important fleshy tuberous roots of *Decalepis hamiltonii* are traded as substitute to meet the international market demand of *Hemidesmus indicus*. The tuberous roots of all three species of *Decalepis* possess similar exudates and texture, and cannot be distinguished and authenticated based on conventional techniques. For accurate identification and authentication, CSIR-CIMAP developed DNA barcode reference library and a species-specific SNP position (230 bp) in the *matK* region, which is characteristic of *D. hamiltonii*, could be successfully used for specific assays enhancing its applicability for direct use in CITES enforcement for distinguishing it from *H. indicus*.

Plant Varieties developed and released

CSIR-CIMAP released the new varieties of **Ashwagandha** (***Withania somnifera***) **and *Mucuna Pruriens***:

- CIM-Pushti (*Withania somnifera*): It is a Withanolide A-rich, high-yielding advance breeding line of Ashwagandha (*Withania somnifera*) with commercially accepted root quality.
- CIM-Sfurti (*Mucuna Pruriens)*: This variety is developed through mutation breeding and has improved seed (21.5 ql/ha) and L-DOPA (98.90kg/ha) yield

Development of Herbal Toothpaste

CSIR-CIMAP and CSIR-NBRI have developed jointly a 100% herbal toothpaste that could be a complete solution for oral problems. The CSIR herbal product, made by using six herbs and five essential oils, is chemicalfree and will help to fight problems like cavity, tooth sensitivity, bad odour and will also cure and tighten bleeding gums. Herbs such as majuphal known as gall oak and magic nut have been used. The herb is known for being very effective in curing bleeding disorders ranging from bleeding gums to excessive bleeding during the menstrual cycle. Other herbs like vajradanti and akarkara – known for the treatment of halitosis and tooth and gum problems have been used.

Establishment of herbal gardens in Ganga grams

The River Ganga is the fifth largest in world and third largest in Asia. Ganga basin, the largest river basin in India, has cultural, heritage and religious values. Four Ganga Grams: Bithoor Khurd, Bithoor Kalan, Katari Dodhi and Katari Bidhara of Kanpur Nagar district, Uttar Pradesh which have historical, religious and tourist importance were selected by CSIR-CIMAP for *in-situ*/*ex-situ* conservation of medicinal and medicinally important aromatic plants under National Mission for Clean Ganga (NMCG). During 2017-18, government primary schools, scholar mission school and about one-acre land of Bithoor Nagar Panchayat was selected, and plantation of M&MIAPs *viz. Acorus calamus, Andrographis paniculata, Aloe vera, Asparagus racemosus, Bacopa moneirii, Centella asiatica, Cassia senna, Phyllanthus niruri, Rauwolfia serpentina, Stevia rebaudiana, Withania somnifera,* etc. were done on large scale by CSIR-CIMAP.

Dissemination of Vetiver (*Chrysopogon zizanioides*) agro-technology

National Mission for Clean Ganga (NMCG) project (Ministry of Ayush) was initiated by CSIR-CIMAP with the aim to save the Ganga river basin from soil erosion, clean Ganga water, decontaminate the river basin soil, enhance the greenery and doubling the income as well as to improve the livelihood of the farmers living in these areas. In this ongoing project, agro-technology for flood prone areas were developed and about

5.0 lakh vetiver slips were transplanted in Ganga river banks of Varanasi, Mirzapur and Kanpur. The awareness-cum-training programme related to decontamination, control soil runoff and enhancing income in flood prone/low productive lands located in near Ganga were organized by CSIR-CIMAP.

Fig. 8.1.2. Plantation of Vetiver slips at Ganga River banks in Varanasi

eSkIN for Cosmetic Testing

CSIR-IGIB in collaboration with Pune-based firm Persistent System, has developed a software "eSkIN", a first-of its-kind computational platform for skin research that can ascertain the efficacy and adverse effects of cosmetic formulations.The computational platform could be a boon for cosmetic and pharma firms. Testing in animals to ascertain the efficacy and adverse effects of so far formed an integral and significant part of the process of discovery of new pharmaceutical and cosmetic products.The skin data analysis tool eSkIN, however, is a software with a collection of the large data available in the open domain offering an intuitive solution. Without torturing any animal and with just a few clicks, it will tell what will be the likely result of that data.eSkIN also converts large-scale high-throughput Omics data into biomedical knowledge. It is a repository of over 2600-plus skin-specific genes obtained by manual curation of biomedical literature.

Discovery of Skin Bacterium with Antimicrobial Activity

CSIR-IGIB has identified a new bacterial strain of *Staphylococcus capitis* which has a strong antibacterial activity against Gram-positive bacteria, including *Staphylococcus aureus*. CSIR-IGIB isolated the bacteria from the skin surface of a healthy human foot– specifically near the toes. Different bacteria are found in different niches of the skin. For instance, bacteria found in the arm pit are different from those found on the feet. The antimicrobial activity helps the bacteria to secure their niche environment by preventing other bacteria, including pathogenic bacteria, from colonizing. CSIR-IGIB also sequenced the genome of the bacteria and identified all the possible peptides that have antibacterial activity. And then, synthetic peptides with sequences identical to the

natural ones isolated from the bacteria were synthesised. The synthetic peptides were found to possess antibacterial activity, opening the window to developing new antimicrobial compounds.

Heterologous expression of key carbon (C) and nitrogen (N) metabolic enzymes improves re-assimilation of photorespired CO_2 and NH_3, and growth

CSIR-IHBT investigated the effect of the heterologous expression of *phosphoenolpyruvate carboxylase* (*ZmPepcase*), *aspartate aminotransferase* (*GmAspAT*), and *glutamine synthetase* (*NtGS*) on carbon (C) and nitrogen (N) metabolism in Arabidopsis (*Arabidopsis thaliana*). These transgenes were expressed either separately or in different combinations. Heterologous expression of phosphoenolpyruvate carboxylase (ZmPepcase), aspartate aminotransferase (GmAspAT), and glutamine synthetase (NtGS) reduced the photorespiratory loss of C and N with concomitant enhancements in shoot biomass and seed yield in Arabidopsis (Arabidopsis thaliana). Upon feeding the leaf discs with glycine-1-14C, transgenic lines evolved significantly lower $14CO_2$ levels than the WT, suggesting a higher re-assimilation of CO_2 evolved during photorespiration. This work demonstrates that the heterologous coexpression of *ZmPepcase*, *GmAspAT*, and *NtGS* reduced the photorespiratory loss of C and N with concomitant enhancements in shoot biomass and seed yield.

Melatonin protects against lipid-induced mitochondrial dysfunction in hepatocytes and inhibits stellate cell activation during hepatic fibrosis in mice

Non-Alcoholic Fatty Liver Disease (NAFLD) affects millions worldwide and increasing for many reasons, most common being obesity. If unaddressed, it often developed to Non-Alcoholic Steato-Hepatitis (NASH), which causes inflammation of liver. There is no single medicine to cure. CSIR-IICB presented the pharmacological interventions for the disease by studying that lipid generates reactive oxygen species (ROS) in consequence to mitochondrial fission followed by inflammation in propagating hepatic fibrosis. The interaction of SIRT1/Mitofusin2 is critical for maintaining mitochondrial integrity and functioning, which is disrupted upon excess lipid infiltration during the progression of steatohepatitis. High glycolytic flux generates metabolically unfavorable milieu in hepatocytes leading to inflammation, which is abrogated by melatonin. Subsequently, melatonin reduces hepatic fat deposition and inflammation in HFD-fed mice. Thus, melatonin disrupts the interaction between steatotic hepatocyte and stellate cells, leading to the activation of the latter to abrogate collagen deposition. Altogether, the results of the current study by CSIR-IICB have shown that excess lipid infiltration disrupts mitochondrial functioning that potentiates ROS production to initiate steato-hepatitis could be ameliorated by a potent anti-oxidant, Melatonin. It also prevents activating stellate cells and collagen formation, a crucial step to develop

NASH. Thus, Melatonin alone or in combination with lipid-lowering drug will be useful to treat NASH.

Biodegradable Neuro-Compatible Peptide Hydrogel Promotes Neurite Outgrowth, Shows Significant Neuroprotection, and Delivers Anti-Alzheimer Drug

Human brain is comprised of millions of neurons that interconnect and maintain its function. Due to the complexity of the brain, repairing the damage is a challenging task. Recently developed neuron transplantation-based approach often suffer from poor *in vivo* survival rates due to lack of biocompatible transplantable scaffold. To address this issue, CSIR-IICB has developed a novel peptide-based neuro-compatible hydrogel for transplantation of regenerated neurons into damaged area of brain. This work reveals that hydrogel is capable of auto release neuroprotective molecules, maintain healthy neurons (2D and 3D neuron culture), encapsulate and release neuro-drug. Results of the study revealed that this hydrogel is non-cytotoxic, promotes neurite outgrowth, stabilizes microtubule networks, and enhances the expression of some key neural markers in rat cortical primary neurons. Further, this hydrogel exhibits significant potential in neuro-regeneration and also promotes fast recovery of the sham injured mice brain. Moreover, CSIR-IICB has found significant enhancement of reactive astrocytes in the hippocampal DG region of the sham injured brain, indicating its excellent potential in neural repair of the damaged brain. Finally, above results clearly indicate that this neuro-regenerative hydrogel is highly capable of maintaining the cholinergic balance through local release of acetylcholine in the injured brain, which is crucial for brain repair.

Inhibition of Twist1-mediated invasion by Chk2 promotes premature senescence in p53-defective cancer cells

In this study, CSIR-IIIM demonstrated that ectopic Checkpoint kinase 2 (Chk2), as well as its induction by natural podophyllotoxin analog, 4'-demethyl-deoxypodophyllotoxin glucoside (4DPG), efficiently blocks cancer cell invasion, scattering and thereby highlighting its potential role in cancer prevention. CSIR-IIIM also validated that 4DPG treatment significantly abrogates tumor growth as well as metastatic

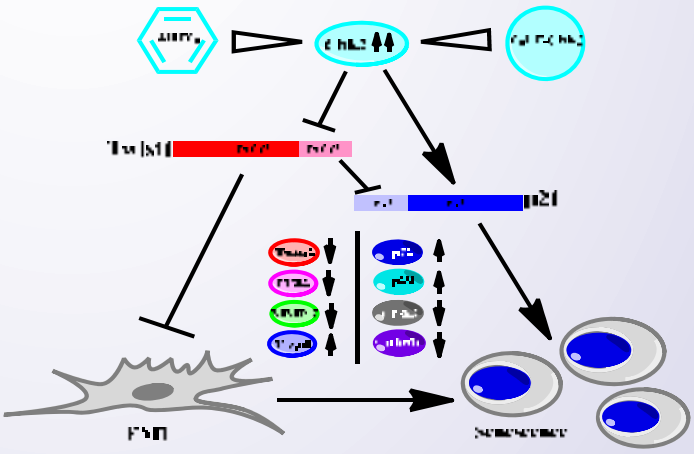


Fig. 8.1.3. Schematic representation of Epithelial-Mesenchymal Transition (EMT)

lung nodules formation in mouse mammary carcinoma model. Together these results validate the findings and unveil a novel strategy of Chk2-mediated Twist1 suppression that promotes premature senescence and prevents the metastatic dissemination of the p53-defective invasive cancer cells.

Discovery and Preclinical Development of IIIM-290, an Orally Active Potent Cyclin-dependent Kinase Inhibitor

Cancer is one of the deadliest disease of human mankind with high prevalence throughout the world. Particularly, for pancreatic cancer there is extreme scarcity of drugs. Thus, there is great need of newer and effective medicines for treating patients suffering from pancreatic cancer. CSIR-IIIM has been working in the area of natural product based drug discovery for cancer since last 6-7 years. From this oncology drug discovery program, the preclinical lead candidate IIIM-290 has been identified which has shown excellent efficacy and safety profile in cellular as well as in animal models of the cancer. This lead compound is a semi-synthetic derivative of the natural product "rohitukine", a major constituent of Indian medicinal plant *Dysoxylum binectariferum*. The drug candidate has excellent oral bioavailability. IIIM-290 potently inhibits the cyclin-dependent kinase-9 (with IC_{50} value of 1.9 nM), the enzyme which is responsible for proliferation of cancer cells. In cellular assay, it showed inhibition of the growth of pancreatic cancer cells with IC_{50} value of 1.0 µM and was found to be highly selective for cancer cells over normal fibroblast-cells. It showed excellent in-vivo efficacy in animal model (human xenograft model) of pancreatic cancer at 50 mg/kg dose, after oral administration. This lead compound does not show any liabilities of cytochrome 450 inhibition, or the substrate of efflux pumps and it does not cause cardiotoxicity, mutagenicity and any effect on male fertility in rats.

The preclinical studies as per Schedule Y of the Drugs and Cosmetics Act 1945 have been completed and IND application is being file to DCG(I) for seeking approval for conducting Phase I clinical trial.

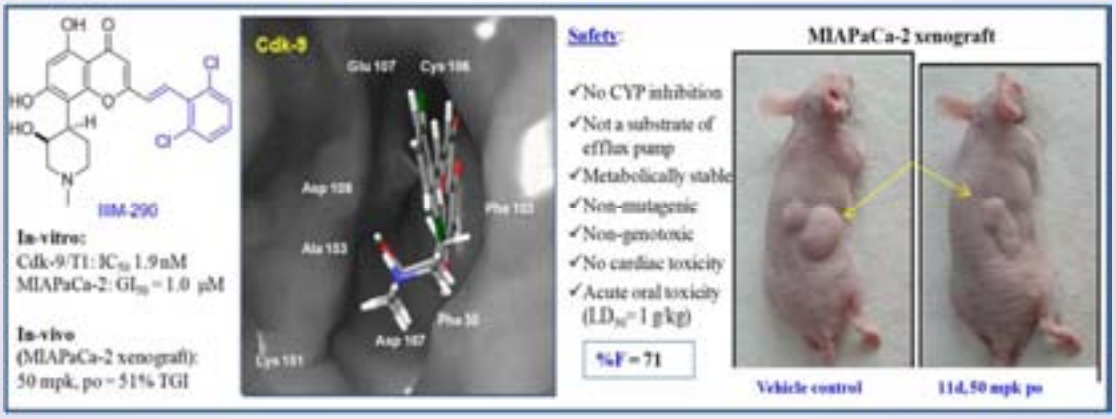


Fig. 8.1.4. Schematic representation of IIIM-290, an Orally Active Potent Cyclin-dependent Kinase Inhibitor

New Drug lead for Triple Negative Breast Cancers

Globally, Breast cancer remains largest cause of cancer associated deaths in women. Scientists have now established that Breast cancer is not a single disease and isn't the same for every woman and even not at the cellular level. Clinically breast cancer is categorized in three major subtypes based on the expressions of hormone receptors, Luminal (ER^+, PR^+), HER2 enriched ($HER2^+$) and Basal/Triple Negative (TNBC). TNBC subtype is negative for ER/PR and HER2 expression, which represents the most aggressive and lethal among all subtypes of breast cancer. There is no target based drug for TNBC, and chemotherapy is the only available treatment option. CSIR-IIIM, Jammu initiated work on target specific kinases termed as Cyclin Dependent Kinases (CDKs) that are involved in cell growth and proliferation. The primary aim of their study was to focus on natural products scaffold isolated from marine species.

CSIR-IIIM reported the discovery of new chemical entity for the treatment of Triple negative breast cancer (TNBCs). By extensive medicinal chemistry and screening efforts a lead compound “IIIM368” was discovered, which have good physic-chemical properties (Solubility, stability, ligand efficiency), Pharmacokinetics, plasma exposure) and promising activity in biochemical and cellular assays at nanomolar potency against CDKs. The lead compound (IIIM368) has also shown significant tumor growth inhibition (90% at 15mg/kg) in mice model of TNBCs without any mortality. IIIM368 has also shown excellent therapeutic index (selectivity, safety, activity) compared to natural product scaffolds.

Microbial F-type lectin domains with affinity for blood group antigens

CSIR-IMTECH has made a significant academic impact in the area of molecular glycobiology, particularly with respect to fucose-binding lectins. The Institute has biochemically characterized the glycan-binding specificity of F-type lectin domains from proteins of *Cyanobium sp*. PCC 7001, *Myxococcus hansupus* and *Leucothrix mucor*. Although all three F-type lectin domains recognized the blood group H antigen motif on fucosylated glycans, they differed in their fine oligosaccharide binding specificity. *Cyanobium* sp. PCC 7001 F-type lectin domain exclusively bound to extended H type-2 motif, *Myxococcus hansupus* F-type lectin domain bound to B, H type-1 and Lewisb motifs, and *Leucothrix mucor* F-type lectin domain bound to a wide range of fucosylated glycans, including A, B, H and Lewis antigens.

Lychee-associated acute hypoglycaemic encephalopathy outbreaks in Muzaffarpur, India

CSIR-IITR carried out study related to understanding the causation of acute encephalopathy syndrome (AES) and its correlation with Litchi consumption by children of Muzaffarpur, Bihar. CSIR-IITR studies on the causative factors of Litchi

revealed the association of AES with Litchi consumption in under nourished or starved children. It was found that, the disease is due to the presence of MCPG in Litchi pulp. Awareness was created in the area in this regard and as a result, there has been no mortality due to AES since 2015 in Muzaffarpur, Bihar.

Discovery of new taxa as well as new national and regional geographic records of several plant and lichen taxa

CSIR-NBRI's study on Teloschistacean lichens led to the discovery of a new genus Upretia and a new species, *Gallowayella awasthiana.* CSIR-NBRI also recorded a globally threatened flowering plant species, *Hoya pandurata*, from India for the first time from Kamjong district of Manipur, bordering Myanmar.

8.2. CHEMICAL SCIENCES

Graphene-based Super capacitors from Lithium-ion Batteries

Millions of rechargeable Li-ion batteries are disposed each year due to its short life span of 2-4 years. The use of these batteries in portable electronic devices and electronic vehicles would further contribute to the electronic waste problem. A new eco-friendly recycling process of these widely used Li-ion batteries has been developed by CSIR-CECRI and CSIR-CSMCRI. They have produced graphene from discarded lithium-ion batteries which could potentially be an ideal material for next generation high-performance supercapacitors. Graphene oxide collected from Li-ion batteries showed high specific capacity at low current, 112 farads per gram which is almost equal to commercially ones. The process involves conversion of graphite into graphene oxide by oxidation and subsequent exfoliation which is then further converted into reduced graphene oxide. The new electrodes made using the reduced graphene oxide showed high stability and high retention capacity. When exposed to 20,000 cycles of charging and discharging at a high current density, electrodes retained 70% of their efficiency even after 85 cycles. The efficiency slowly increased and reached 108% after 20,000 cycles. The process is faster and cheaper than the ones available in market today for generating reduced graphene oxide at lower temperatures.

Fig. 8.2.1. Graphene-based Super capacitors from Lithium-ion Batteries

Synthesis of Quantum dots from 2D Materials

CSIR-CECRI has reported a novel single step electrochemical route for the synthesis of tungsten-di-sulfide quantum dots (WS2) from their bulk counterpart. The average size of the WS2 QDs is 3 nm ± 1 nm (N=102) with few layers. This unprecedented electrochemical avenue offers a strategy to synthesize size tunable WS2 nanostructures. Time dependent Transmission Electron Microscopy investigations revealed that time has played a vital role in this electrochemical transformation. This electrochemical transformation provides a facile method to obtain WS2 QDs from their bulk counterpart which is expected to have greater impact on the design and development of nanostructures derived from 2D materials. Further, the QDs thus obtained exhibited higher photoluminescence (PL) quantum efficiency (5%) and exhibit an excitation-wavelength dependent photoluminescence.

Integration of Silver Nanowires onto Boron-doped Graphene Nanosheets

A collaborative effort between CSIR-CECRI with MG University and UNSW Australia reported the integration of silver nanowires onto the boron-doped graphene nanosheets by a simple two-step process. In this work, the growth of AgNWs is supported by the choice of boron-doped graphene sheets as the template. The strong adsorption and the partial reduction of boron-doped graphene sheets towards metal ions in the solution provided the initial nucleation sites, moreover, it enhances the growth of long metal nanowires and therefore it facilitates the charge transfer. This one step process resulted in the formation of interconnected graphene-AgNWs networks without any interfacial problems.

This is the first report on the in situ reduction of AgNWs over boron-doped graphene sheets for ORR applications. Furthermore, according to authors, the BG wrapped AgNWs show excellent ORR activity, with very high onset potential and current density and followed four electron transfer mechanism with high methanol tolerance and stability towards ORR. The results are comparable to the commercially available 20% Pt/C in terms of performance.

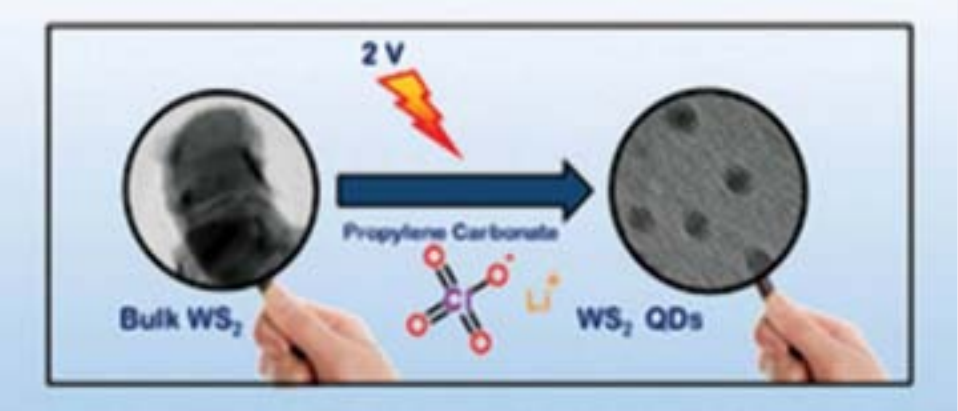


Fig. 8.2.2 (a) Synthesis of AgNMs

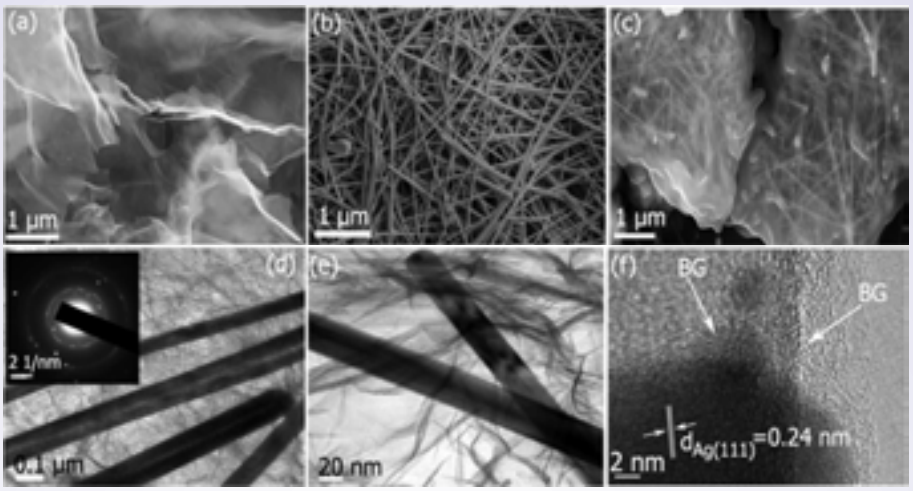


Fig. 8.2.2 FESEM images of (b) boron-doped graphene (BG); (c) Silver Nanowires (AgNWs); (d) BG wrapped AgNWs; (e, f) High resolution image of BG wrapped AgNWs; the inset shows selected area electron diffraction pattern of BG wrapped AgNWs; (g) High resolution transmission electron microscopic image of BG wrapped AgNWs

Corrosion Resistant Inhibitive Admixture For Portland Pozzolana Cement

CSIR-CECRI has developed a process to get corrosion resistant inhibitive admixed Portland Pozzolana Cement Concrete. The process involves a simple step of adding inhibitors during manufacturing of cement or while making concrete at site. The added chemicals are in powder form and can be mixed at the factory itself, while producing cement or during making concrete. Due to corrosion resistant, this product can be used for constructions in aggressive marine environments. The technology has been transferred to Cleanflo India Pvt Ltd., Delhi.

New Device to Detect Cracks in Bridges

CSIR-CECRI has developed a portable device to monitor weak structures and send alerts whenever a crack is observed. The smart device alerts structural engineers about cracks on large structures and bridges well in time. The device called the Triboluminescence (TL) camera uses a light emitting compound and a smart camera that allow detection of cracks – invisible to the naked eye – on structures made of concrete, metal and fibre-reinforced plastic. This compound is coated on a surface which when rubbed, scratched, pulled or ripped emits light due to excessive pressure and the smart camera is programmed to capture it. The images can be shared through cloud storage or a mobile app, web browser or Bluetooth. The central portion and beams of a bridge or a flyover, considered the weaker parts, can be coated with the compound. When vehicles move on the structure and these portions come under pressure, a red light is emitted wherever there are cracks. These cracks may otherwise not be visible to the naked eye. A record of these cracks can be kept through a smart camera that is programmed with an image sensor analysis software. The camera

identifies the light emitted by the compound and captures an image. The images can be accessed with details like date and time and width of the crack. The technology could be a boon for the railways where there are several old bridges.

High grade gelatin and protein hydrolysate from trimmings waste of leather manufacturing industry

A simple process technology has been developed by CSIR-CLRI to extract gelatin and protein hydrolysate from the trimmings waste with zero wastewater discharge incorporated in the system. Gelatin obtained is of high gel strength > 200 g and is suitable for making capsules. The developed technology not only addresses the issue of solid waste disposal; it also provides scope for high value realization from the trimming wastes. Great opportunity for substitution of gelatin import as annually India imports gelatin worth US$ 80 million (Rs 512 crores), mainly utilized for making capsules. The technology has been transferred to M/s. Anipro manufacturing Company, Chennai

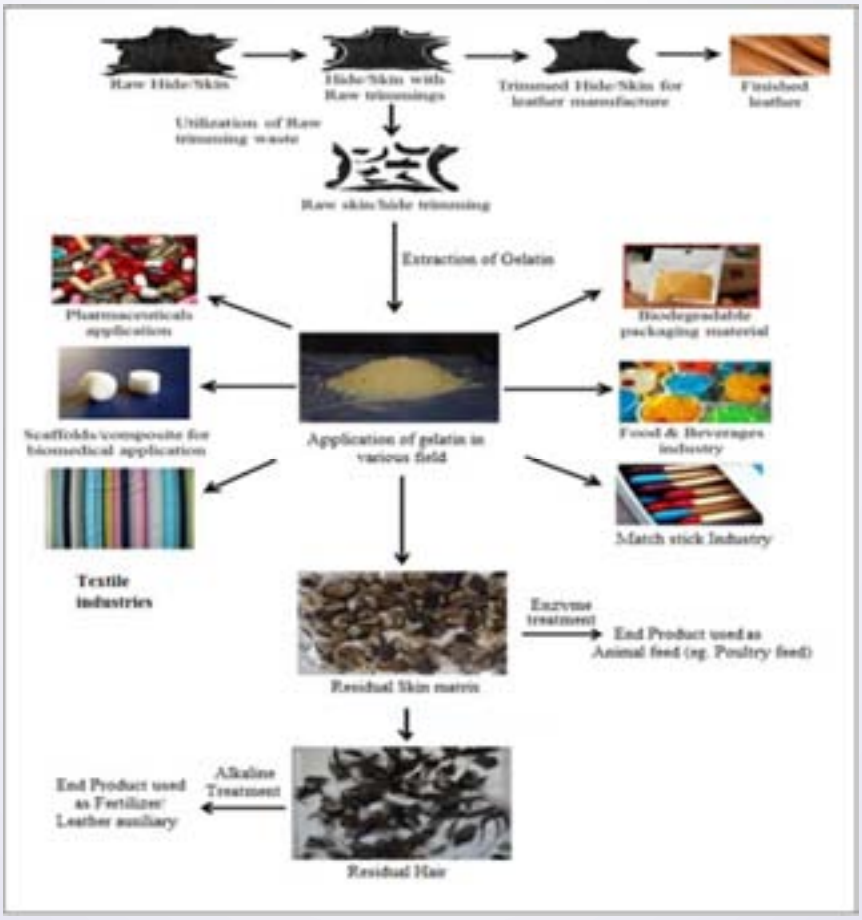


Fig. 8.2.3. process for extraction of gelatin and protein hydrolysate for leather waste

Spent wash management technology

CSIR-CSMCRI, in collaboration with M/s Chem Process Systems Private Limited, have developed complete technology solution for valorization of spent wash generated in sugarcane molasses based alcohol distillery. The process allows utilization of spent wash for production of value-added by products, viz., potash fertilizer, animal feed ingredient etc., while achieving statutory compliance with 'zero liquid discharge' norms. Preliminary economic analysis for implementation of the technology in a 100 klpd distillery suggest a CAPEX payback period of about 3.5 years. The process know-how have been licensed to M/s Aurangabad Distillery Limited, in January 2018.

Recovery of sodium salts from tannery wastes

Separation of pure sodium chloride and sodium sulfate from solid waste of tanneries: Presently, in order to conform to ‘zero liquid discharge’ norms, the effluent released from tanneries is subjected to reverse osmosis (RO) for water recovery and the RO reject stream is evaporated to dryness. While the water recovered in course of evaporation is recycled, the solid residue (salt mixture) is stored. Increasing quantum of the stored salt mixture has created huge environmental problem and necessitated development and implementation of technology solution(s) for recovery of commercially acceptable material(s), thereby eliminating/minimizing the need for storage/disposal. CSIR-CSMCRI has developed a cost effective process to recover pure sodium sulfate and sodium chloride from the solid waste.

Development of Quast-Solid Polymer Electrolyte

A new class of quasi-solid polymer electrolyte matrix that supports appreciably fast single-ion conduction has been synthesized by CSIR-IICT. The institute showcased as the first example of tailoring a lithiated anionic polymer employing semi-interpenetrating polymer networks approach, the study probes several key factors, such as, (i) polymer–polymer/ion–polymer interactions (ii) phase homogeneity, (iii) effect of oligomeric plasticization, (iv) transition temperatures and thermostability, and (v) H-bonding and degree of crystallinity for a series of binary and ternary compositions, and determines their effect on the overall electrochemical properties.

Development of Anti-TB Cocrystal 4-FDC Drug with Improved Stability

CSIR-NCL in collaboration with University of Hyderabad has developed an Anti-TB cocrystal drug with improved stability. The pharmaceutical cocrystals of INH (INH-Caffeic acid and INHVanillic acid) were used to improve the stability of 4-drug FDC (4 drugs Fixed Dose Combination). The team showed that the pharmaceutically stable cocrystal of INH is able to improve the stability greater than 5-fold compared to the current 4-FDC drugs. The conformer additives which stabilize the formulation are pharmaceutically accepted excipients. Stability studies were carried out under accelerated conditions of 40°C temperature and 75% relative humidity. The first time

improvement of stability of anti-TB 4-FDC drugs using cocrystals of INH in a fixed dose formulation was reported.

Efficient Delivery of Pesticide to Plants and Crops

CSIR-NCL has identified a natural material that can force water drops to stick to the surface of plant leaves. This natural material when mixed with a pesticide can address major environmental problems occurring due to contamination by pesticide wastage. Typically, pesticides are mixed into water and sprayed on plants and crops. But these sprays bounce off leaf surfaces due to the protective waxy layer that coats all leaves. So, to ensure that sufficient pesticide reaches the plants, an excess of it is sprayed accounting for these losses. Agricultural run-off due to pesticide overuse contaminates soil and groundwater, posing a significant environmental challenge. Some adjuvants are typically used to improve the delivery of pesticides, but these have limited efficacy and several of them affect the leaves adversely. At present, oil-based adjuvants are used to reduce the surface tension of drops of spray that slows down its retraction and bouncing off.

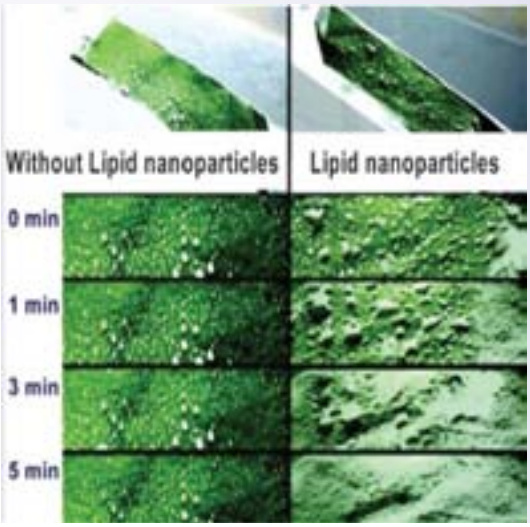


Fig. 8.2.4 Dispersion of pesticide solution (A) without lipid nanoparticles (B) with 1% lipid nanoparticles

The mixture of nanoparticles prepared from plant oils in small quantities and water form a 2 to 3 nanometres thin coat on the leaf and allows this mixture to stick to the surface of plants. This material remarkably coats the leaf surface within a few milliseconds; subsequently the droplets spread. A natural lipid compound was extracted from the sunflower oil which is edible, biocompatible and is also used as a food emulsifier. This can improve the efficiency of delivering pesticides to the targeted area on plants. In an experimental study, 10 gm of material per litre was found enough for effective pesticide spray; that may vary after the field trials.

Artificial Leaf Creates Fuel from Sunlight & Water

CSIR-NCL has developed an artificial leaf that absorbs sunlight to generate hydrogen fuel from water, promising clean energy for powering eco-friendly cars in the future. The ultra-thin wireless device mimics plant leaves to produce energy using water and sunlight. The natural leaf system is simulated by means of semiconductors stacked in a manner to mimic plant leaves to produce energy using water and sunlight. Production of hydrogen from natural resources such as sunlight and water could be the ultimate solution to our energy and environment problems. At present, hydrogen is produced from fossil fuels by steam reforming that emits a large amount of carbon

dioxide. Sunlight could be exploited through the year to produce energy or hydrogen. When visible light strikes the semiconductors in the device, electrons move in one direction, producing electric current. The current almost instantaneously splits water into hydrogen, which is believed to be one of the cleanest forms of fuel as its main by-product is water. The device of an area of 23 square centimetres could produce 6 litres of hydrogen fuel per hour. The device has been patented and efforts are being made to look out for industrial partners to move ahead.

8.3. ENGINEERING SCIENCES

Deflouridation of drinking water using Nano adsorbant based domestic filter

Deflouridation of drinking water using Nano adsorbant based domestic filter is very useful to the society for providing fluoride free safe drinking. The domestic filter developed by CSIR-AMPRI works on the principle of gravitational force and no electricity is required for purification of water. The developed filter is user friendly as one can simply put fluoride water in filter and get treated water.

Fig. 8.3.1 (a) Applicable for 2-5 mg/l fluoride water treatment (b) Applicable for 1.5-2 ppm fluoride water treatment

Development of Pervious Concrete

Pervious concrete is a kind of concrete with little or no fine aggregate and has a high interconnected porosity. Because of its high permeability, pervious concrete is being used widely in parking lots and pathways to allow rain/storm water runoff to permeate into the ground. CSIR-CBRI developed pervious concrete have 10-25% porosity with 10-25MPa compressive strength using locally available materials.

Development of a process to manufacture Sand: An Alternative to Natural River Sand

A boom in infrastructure development has led to the extensive extraction of natural river sand that physically alters rivers and coastal ecosystems. In addition, stringent guidelines of the National Green Tribunal (NGT) and Hon'ble Supreme Court of India have forced the construction industry to choose an alternative to river sand without compromising the quality in construction. To overcome these issues, CSIR-CBRI researchers have started to explore the use of manufactured sand in construction.

Manufactured sand is a fine aggregate manufactured from other than natural sources, by processing materials, using thermal or other processes such as separation, washing, crushing and scrubbing. It can be classified as natural Crushed Rock Sand (CRS), Recycled Fine Aggregates (RFA) and industrial by-products. These sands can be used either as full or partial replacement of natural sand in construction. It is a cost effective and eco-friendly solution.

A schematic representation of benefits of the manufactured sand over the natural sand is shown in in the Figure 15.0. The natural Crushed Rock Sand (CRS) is produced by crushing rock deposits to obtain a well-graded sand, which is generally more angular and has a rougher surface texture than naturally weathered sand particles. Diorite, metamorphic siltstone, granite, limestone, sandstone, feldspathic quartzite, etc. are some of the parent rocks used for CRS production. The properties of crushed rock sand depend on their lithological character, composition and production process. Recycled fine aggregates growing waste disposal problem it will also help conserve natural sand.

CSIR-CBRI has initiated experimental investigation on natural Crushed Rock Sand (CRS) – characterize and compare the mechanical properties of the concrete with control having natural sand. It was observed that the fineness modulus of river sand was 2.31 and that of CRS was 2.60. In addition, CRS was found conforming to Zone II of IS 383:2016. Figure 16.0 shows the sieve analysis graph drawn for CRS and river sand. Concrete of M30 grade was proportioned in accordance with the produced from the reprocessing of C&D waste can be used in concrete.

Fig. 8.3.2 Benefits of manufactured sand over natural sand

Fig. 8.3.3. Schematic description of production of CRS

Flyash based geopolymer concrete for road construction

CSIR-CBRI and NTPC-NETRA jointly developed high strength and high-quality fly ash based geopolymer concrete for the construction of road transforming waste materials like fly ash and other materials into a valuable product as per the IRC specifications. This achievement paves the way for large-scale fly ash utilisation which is a major industrial waste produced in mammoth quantity in India. The fly ash produced by the burning of powdered coal, from NTPC, Dadri is used for the project. A geopolymer concrete road 50 m long and 3 m wide and having 40 MPa concrete strength has been successfully laid at CSIR-CBRI using this technology. It is the first of its kind in India. The road is made from fly ash, aluminate and silicate-bearing materials. As opposed to conventional cement concrete roads, this road will not need water curing. It also paves the way for bulk fly ash utilization.

Packaged fiber laser modules for industrial and medical applications

High-power fiber lasers have seen astonishingly rapid progress over the last decade in a wide range of configurations, spectral ranges, and temporal formats, and are now leading contenders for many important applications like material processing (material cutting, marking, engraving, welding etc), additive manufacturing/ 3D printing, medical surgery and defense requiring powers from a few watts to several kilowatts. CSIR-CGCRI has achieved Fiber laser characterization and prototype demonstration of 1micron commercial grade fiber laser module and field trials have been carried out for stent cutting Prototype demonstration has been made of 2micron laser and preclinical testing completed in soft tissue surgery.

Specialty Glass for HEHP Laser Systems

High power high energy (HEHP) lasers are widely used in the fields of controlled laser thermonuclear reactions, high energy density physics like equation of states experiments, plasma physics and physics of its interaction with matter. Nd3+ doped phosphate laser glass is the most preferred material as active medium in HEHP laser systems. CSIR-CGCRI has developed of indigenous technology for the production of this specialty glass to meet the national demand.

Fig.8.3.4. Specialty Glasses

Development of Solar Tree/Artifacts for generation of power utilizing lesser ground area

Solar Power Tree is the perfect solution to the question of availability of the land in the future for generating solar power - It take up only a fraction of land consumed by conventional systems. To bring visibility to solar technology and to enhance the beautification of a site, CSIR-CMERI has developed solar artifacts. Solar artifacts can be installed in various places to produce electricity. Moreover they add to the beautification of a place with their aesthetic design. The following are various types of solar tree:

(i) **Attapatram** is of 1kWp capacity and can provide 0.5kW electricity for 3 hours. These can be installed in the beaches, river banks, parks and even in the lawn of a bungalow.

(ii) **Solar Flora** is of 3kWp capacity and can be installed in the road side, parks and other remote areas to provide electricity.

(iii) **Surya Banaspati** is of 5kWp capacity and can be installed in the road side, parks and other remote areas to provide electricity.

Fig. 8.3.5. Different types of solar trees

The technology has been transferred to nine Industries for commercialization in non-exclusive basis for a period of five years.

Development of fluoride removal filter

CSIR-CMERI has developed a domestic filtration unit for addressing the fluoride contamination of water. This filter is an effective solution that provides fluoride free drinking water to each and every families of the fluoride affected areas. The filter constantly keep Fluoride content in water below the permissible limit (1.5 mg/L) upto filtration of 2000L water. The filtration unit can also remove microbial contents. The features of the unit are: Flow rate: ~ 5 L / hour (approx.). Adsorbent life (average): ~2000 L. and Storage capacity: ~12 L.

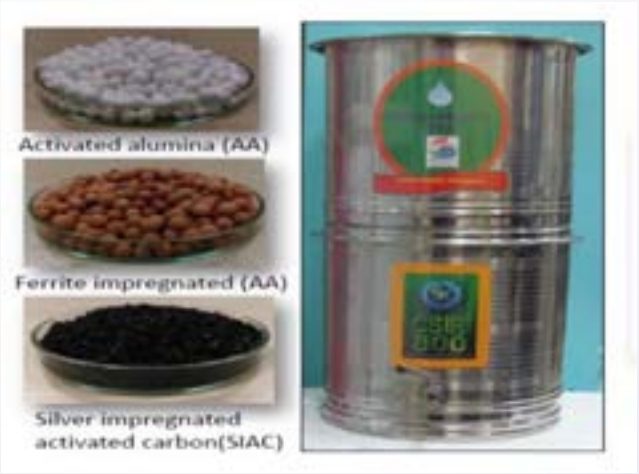


Fig. 8.3.6. Components of Fluoride removal filter

Development of Intelligent and powered wheel chair

CSIR-CMERI developed wheel chair system having immense societal value for the physically challenged people, old age population for mobility and rehabilitation purpose. Intelligent & powered wheel chair design provides enhanced mobility and stability and capability to turn full 360 degrees in any narrow corridor. It can also go up

slant pavements, maintaining stability. Its light weight components (main body and seating) decrease the overall weight without compromising on safety; differentially steered, six wheel configurations; longer endurance (8-10 hrs for intermittent running).

Fig. 8.3.7. Intelligent and powered wheel chair

It offers high degree of maneuverability to navigate smoothly on slopes/ramps with angle of 8-9 degrees in indoor environment; incorporation of intelligent sensor system has increased the safety of the system. The technology has been transferred to an Indian Industry for commercialization.

Large Scale Production of Graphene Oxide

Graphene oxide is extensively used in energy storage devices, polymer composites, desalination of water, conducting ink, aqueous lubrication, nano-coolant, additive for phase change materials, etc. Graphene oxide is not toxic and hazardous for the environment. The cost of commercially available graphene oxide is very high (Rs. 35,000 for 0.2 g) and thus it is very difficult to use it in the aforesaid areas. CSIR-CMERI has developed technology for the production of graphene oxide starting from natural flake graphite (200 g/batch) without pre-treatment. The salient features are: production yield = 80% thickness = 1-1.8 nm; number of layers: few layer (3-4 layers);dispersible in water and most of the polar organic solvents; and oxygen content = 25-28%. The technology has been transferred to one Indian Industry for commercialization.

Fig. 8.3.8. Laboratory setup for Production of Graphene

Salivary Fluoride Detection Kit

CSIR-CMERI has developed an indigenous salivary fluoride level detection kit for diagnosis of salivary fluoride level . The solution kit has been prepared by employing a chemical compound where a colour chart has been provided for the convenience of the users. One can easily operate and determine the range of fluoride level present in the body by simply tallying the colour change of the solution with the provided colour scale in the sachet. This is immensely helpful since a person by own can carry out the test without the aid of any trained personnel or experts in related domain The technology has been transferred to two Indian Industries for commercialization.

Fig. 8.3.9. (a) Sensor solution; (b) Sensor remained silent with non-fluorosis tooth sample; (c) Sensor turns red within 5 minutes of dipping the fluorosis affected tooth sample

Water Filter for Arsenic Removal

CSIR-CMERI has developed a filter for filtration of arsenic contaminated water for drinking purpose. This purification device is a commercial product that can compete with high-end water treatment products to remove arsenic contaminants from drinking water. The salient features are: domestic type adsorption based multi-stage water filtration unit; remove both arsenic (III) and arsenic (V) to the desired permissible limit (~10 ppb) of drinking water; no electricity; no running water required; Flow rate: ~ 4-5 L / hour; Adsorbent life (average): ~1800 L; and Storage capacity: ~25 L. The Technology is in high demand and the process of Transfer is under negotiation with different industries.

Fig. 8.3.10. Water filter for Arsenic removal

Laying of Trial Sections of Cement Grouted Bituminous Mix (CGBM) in Surat City

Cement grout bituminous mix is a semiflexible type of pavement comprising of open graded aggregates in the bituminous mix resulting in high air void content in the mix. The voids in the bituminous mix are filled with cement grout. Cement grouted bituminous mixes have advantages of both flexible and rigid pavements.

Fig. 8.3.11. View of pouring of grout and squeezing on high voids bituminous mix

This hybrid mixture provides good rut resistance and a surface highly resistant to fuel and oil spillage. CSIR-CRRI laid a section of CGBM on experimental basis (two sections each 100 m length in July 2017) on roads under the Surat Municipal Corporation.

Development and Evaluation of 'Soil Nailing Technique' for stabilisation of Slope for Underpass Intersection below Road/Railway

The rapid growth in population, industries and infrastructure development in country has led to shortage of land space in the metropolitan cities and also resulted in tremendous increase in traffic volume and congestion on roads. Often, further widening of road or provision of flyovers is not feasible due to many constraints. The underpass is the only viable solution in such situations. Today, precast RCC segments are gaining popularity in underpass construction due to many advantages. The shallow underpasses can be constructed by pushing pre-cast boxes under live loading and traffic conditions. However, due to soil instability problems, often the idea of construction of underpass is dropped. CSIR-CRRI has attempted to resolve this problem by inventing a Soil Nailing Technique by which underpass construction becomes simple, easy, safe, time-saving, economical and user friendly in live loading condition. A stepwise de-stabilization and stabilization of Soil Nailing Technique for construction of underpass below live road/rails has been patented in India and abroad.

Fig.8.3.12. Completed underpass, Yamuna Bazar, Delhi

CSIR-CRRI Designs Noise Barrier Based on Different Frequencies

At the global level, noise barriers are not designed based on the disturbing frequency generated from the transport sector. In this study, noise barriers have been designed based on three types of frequency classes for maximum reduction of noise:

- Low frequency based Noise Barrier (<200Hz),
- Middle frequency based Noise Barrier (200-1k Hz) and
- High frequency based Noise Barrier (1k-20k Hz)

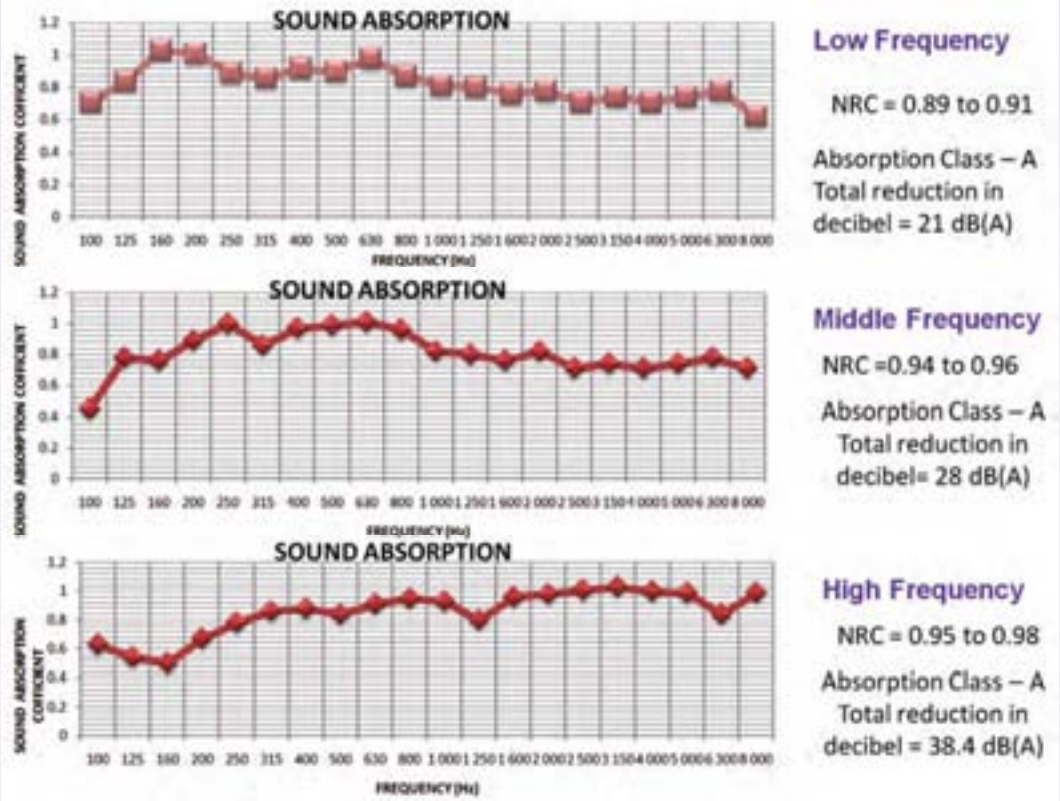


Fig.8.3.13. Results achieved by CSIR-CRRI in different types of noise barriers

Maximizing the recovery of iron values from lean grade iron ore by reduction roasting and pelletization of high LOI and high Blaine number iron ore fines:

To maximise the iron recovery from low and lean grade iron ore resources, CSIR-IMMT has carried out extensive work by adopting reduction roasting followed by low intensity magnetic separation. In reduction roasting process, iron phase minerals i.e., goethite and hematite converts to magnetite and the swelling properties associated clay minerals is simultaneously removed. After reduction roasting, the ore is ground to its liberation size of iron phase minerals and concentrate the magnetite using low intensity magnetic separator. As the kaolinite losses its swelling properties, dewatering and filtration problems do not arise. Both tailings and concentrate can be filtered using low cost vacuum filter. The process was tested in continuous scale of 100kg/hr.

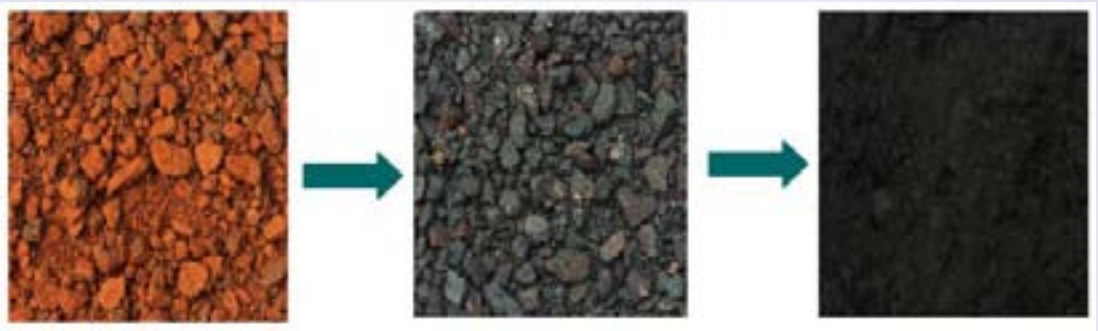


Fig. 8.3.14. (a) ROM Ore (b) Reduction Roasting Product and (c) Magnetic Product

The capital cost on the beneficiation plant as compared to the conventional one will be same. The capital cost for magnetite concentrate pelletisation plant will be less. Ore having more than 40% Fe can be utilized for reduction roasting. All low grade iron ores, slimes, BHQ, BHJ and BGQ can be used to maximize the iron recovery in reduction roasting process.

Process Development for Production of Flaky Graphite, High Purity Graphite and Graphene from Natural Graphite

CSIR-IMMT has developed a process for graphite beneficiation is to maximize the flaky graphite production by introducing scrubbing technique at the beginning of the process using screw scrubber to scrub the fine ore (-10mm size). The liberated flaky graphite goes along with the other fines as overflow of screw scrubber during scrubbing. Then it is classified at 150 micron and the +150 micron contains more flaky graphite. This can be floated separately to maximise the recovery of flaky graphite.

The process has been developed at pilot scale level. CSIR-IMMT has developed an improved process for preparation of graphene oxide from natural graphite by dry process using dual drive planetary ball milling process. It is a novel process for preparation of graphene oxide from high pure natural graphite using shearing action of balls in dual drive vertical swing planetary ball mill. High pure graphite produced earlier is used as the feed material for preparation of graphene. It is worth mentioning that no acids and chemicals are used to produce graphene oxide in this present process. It is a single step operation for mass production of graphene oxide from natural high pure graphite powder. Then this graphene oxide is reduced using hydrogen gas purging in the ball mill. The process yields more than 30% graphene rich high purity graphite.

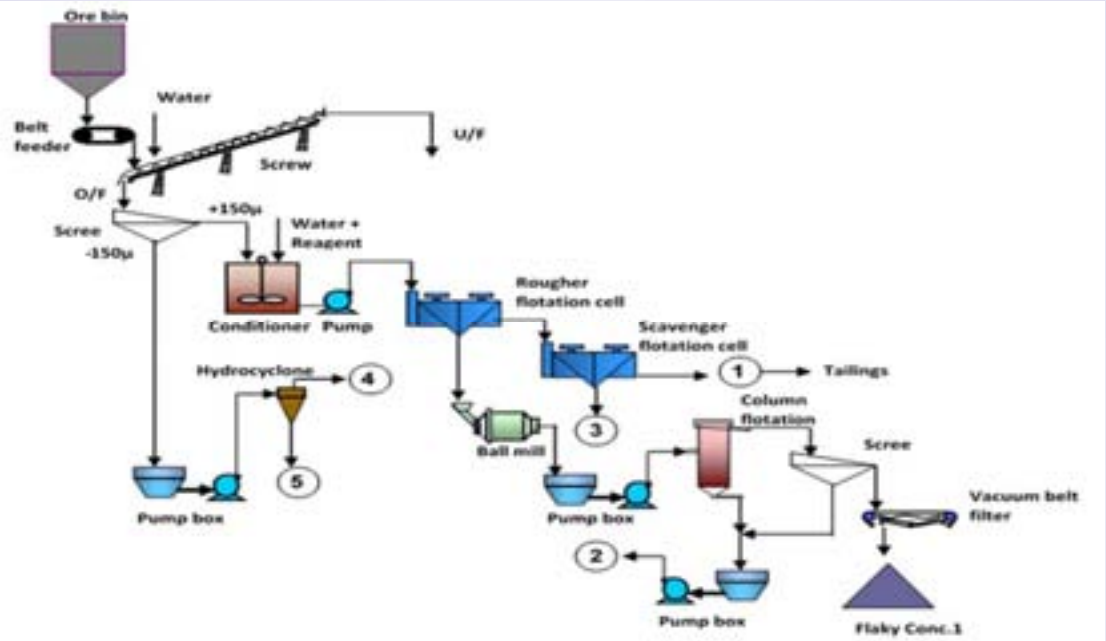


Fig. 8.3.15. Schematic representation of the process for production of graphite

Development of Electrophoretic coating technology for industrial application in Prevention of choking of delayed Coker tubes in Petroleum refinery and Prevention of erosion in boilers

Appropriate coating technology has been developed by CSIR-IMMT to meet the industrial needs at Reliance refinery and Pressler boiler tube manufacturers. Samples sent to Reliance refinery have met simulated operating conditions satisfactorily. Robotic coating technology is under development to coat operational tubes at the refinery site.

Electroless RGO-Ni nanocomposite coating for corrosion protection

CSIR-IMMT has developed Reduced graphene oxide (RGO)-nickel nanocomposite coating by electroless deposition process. This nanocomposite coating can replace the existing electroless Ni coating currently used in the industry. Presently, the work is done at a laboratory scale which can be scaled up to industrial size. In electroless deposition, no electric current, no major equipment such as rectifier, no anode and cathode is required for deposition. Also deposits are less porous then electroplating, elctrophoretic deposition and hence have better corrosion resistance. Further due to the addition of RGO in the conventional Ni coating the hardness, hydrophobicity and corrosion resistance property of the coating increases. The technology has the application in Automotive parts; Aerospace component; Electronics goods; Military equipment; Printing and textile.

Fig. 8.3.16. Electroless RGO-Ni nanocomposite coated components

Electrolytic-membrane process for conversion of effluent sodium sulphate solution to sodium hydroxide and sulphuric acid

Various hydrometallurgical processes usually generate a variety of effluents or raffinate solutions containing different salts such as sodium sulphate, ammonium sulphate, sodium chloride etc. which needs an appropriate way for disposal. However, processing such raffinate solutions for the recovery of valuable chemicals will not only address the effluent disposal problems, but also may improve the overall economics of the process. Considering this industrial problem, an electrolytic-membrane process was developed by CSIR-IMMT for splitting of effluent sodium sulphate (12-15% w/w) to produce pure sodium hydroxide (25% w/w) and sulphuric acid (5% w/w) solutions. In addition, a prototype cell was designed for Heavy Water Board (HWB), Mumbai to carry out splitting of sodium sulphate effluent for the production of sodium hydroxide and sulphuric acid. Three varieties of effluents with respect to their sodium sulphate concentrations, pH values, acid content and impurity concentrations were collected from HWB and pre-treated for the removal of solid/particulates, oil/organics and metallic impurities prior to splitting for the production of sodium hydroxide and sulphuric acid. A process flow sheet has been developed for the pre-treatment of the effluents to make them suitable for electrolytic-membrane splitting operation. Demonstration runs for 145 h and 48 h were carried out to test the splitting process. Performance of the electrolytic-membrane process has also been validated.

Fig.8.3.17. Test setup for validation of electrolytic-membrane process

Advanced entrained flow gasification system

A 30 kg/hr capacity entrained flow gasification system has been developed by CSIR-IMMT to extract useful heat from agro & industrial wastes. The gasification system was designed by conceptualizing the reverse cyclone principle to maximize ash separation from the particle laden product gas. Experimental studies were carried out by blending coal with dolochar (Size: < 150 µm) wastes in different weight ratios as feedstock material for gasification process. The technology has been successfully demonstrated to NMDC, Hyderabad and Ministry of Steel, New Delhi.

Design & development of hybrid dryers for minor forest produce

In order to enhance the socio-economic condition of tribal people, field demonstration & training program on biomass & solar cum biomass dryers were carried out by CSIR-IMMT in four tribal dominated states of the country for efficient drying of minor forest products such as Mahua, Harida, Bahada, Amla, Sal seeds etc. These dryers were installed at Tamia & Mawai village of Madhya Pradesh, Amadubi & Dumariya village of Jharkhand, Kutra village of Odisha and Pargaon village of Maharashtra.

Fig. 8.3.18. Installation of hybrid dryers

Design & installation of a vertical slurry transport facility

Pipeline transport of coarse particles in form of heterogeneous mixtures is of potential importance in dredging and mining industries. In order to optimize the transport parameters and energy requirements to improve quality, safety, economic and reliability of the vertical lifting of minerals/ores slurry, a vertical slurry transport facility was designed and installed by CSIR-IMMT. The pipe flow parameters and basic design for lifting manganese nodules slurry from a sea depth of 6.5 km were provided to M/s National Institute of Ocean Technology, Chennai.

Fig. 8.3.19. Installation of a vertical slurry transport facility

Processing of Tungsten Alloy (TA) Cubes

CSIR-IMMT has developed a process for manufacturing of Tungsten alloy cubes in 10kg scale for DRDL, Hyderabad for their R&D requirement in armour piercing penetrator in missile programme. Processing stages involved in making of TA Cubes with desired sintered density and mechanical properties include (i) Elemental powder characterization, (ii) Blending, (iii) Granulation, (iv) Powder compaction, (v) De-binding and (vi) Sintering. It is worth noting that each of the above processes require thorough optimization of all the parameters in order to develop the TA Cubes.

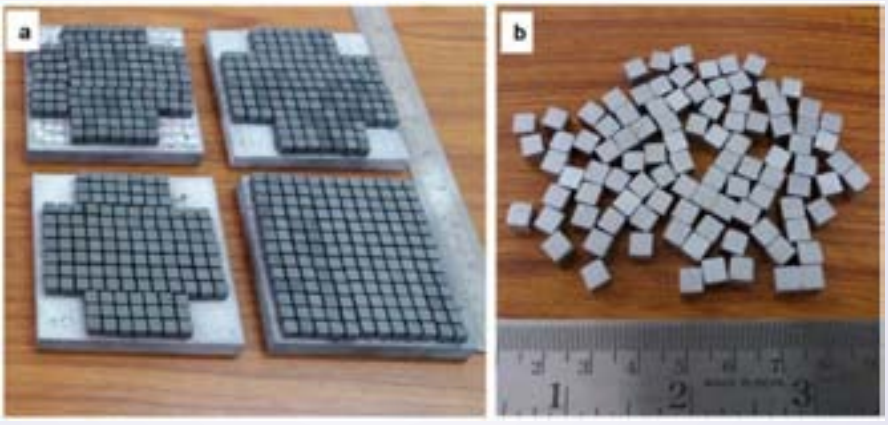


Fig. 8.3.20. Photographs of Tungsten alloy (TA) cubes (a) green and (b) sintered

Potassium enriched Biochar fertiliser from banana peduncle waste

CSIR-IMMT has developed a unique technique for utilization of potassium rich abundantly available plantation waste biomass for faster production of potash enriched biochar. The specific available potassium content in potash enriched biochar was 26 %. With reference to raw biomass, specific available potassium content was enriched

by 4.3 times in biochar. Due to the conversion of bulky biomass to highly concentrated potassium enriched biochar, it will be utilized easily by farmers and it can substitute the K-fertiliser use in potassium deficit soil and high potassium requiring crops and plants like wheat, corn, cotton, potato, alfalfa, sugarcane, tea, and banana etc.

Development of Ceramic Substrates for Electronics, Oxygen Sensor and Solid Oxide Fuel Cell Applications

Ceramic substrates are used for a wide range of applications in electronics, including thin and thick film microelectronics, high power and high frequency circuit RF/microwave components and capacitors or resistors. Alumina and Aluminium Nitride (AlN) are well known electro-ceramics which are being used as substrates for electronic packages, heat sinks, IC packages, microwave device packages, etc. Other ceramic substrates like Yttria Stabilied Cubic Zirconia (YSZ), Scandia Stabilized Zirconia (ScSZ), NiO-YSZ, glass sealant, Gadolinia Doped Ceria (GDC), etc. find applications in Solid Oxide Fuel Cells (SOFC). There is also a great demand for thin YSZ and Al_2O_3 ceramic substrates for the fabrication of oxygen sensors.

CSIR-NAL in partnership with M/s. Carborundum Universal Ltd. (CUMI) has developed 100 and 250 µm thick Al_2O_3 and YSZ tapes (Fig. 1). The properties of the developed Al_2O_3 and YSZ substrates are at par with the imported substrates.

CSIR- NAL has also developed expertise in the fabrication of free standing ceramic substrates with various thicknesses using both aqueous and non-aqueous based slurries. Currently, these substrates are being used for the fabrication of amperometric oxygen sensor in collaboration with Defence Bio-Engineering and Electro Medical Laboratory (DEBEL).

CSIR-NAL has also developed tapecasting grade powders and process for technologically important tapecast products like doped Al_2O_3, GDC, ScSZ, glass sealant, etc. Among these, ScSZ is considered as the futuristic electrolyte material for SOFC which has a large market potential.

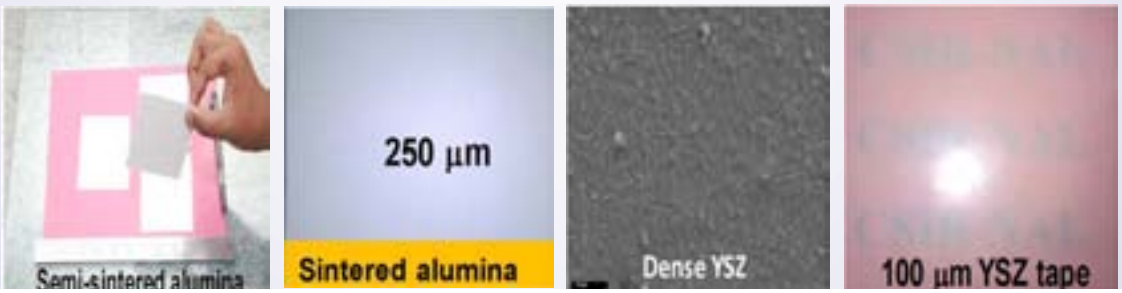


Fig. 8.3.21. Photographs showing the free standing ceramic tapes of alumina and YSZ along with the dense microstructure of YSZ

For carrying out all these activities, a customised tape caster was fabricated in-house. Dense AlN tapes are in high demand for space electronic packaging application.

Development of Desktop Autoclave

The desktop autoclave was developed by CSIR-NAL to meet the expectations of academia and research institutions in establishing an affordable, low energy consuming, aerospace grade autoclave. with a working volume of 450mm diameter and 500mm length, operating conditions of 200°C temperature and 7bar pressure and an intuitive control system, the user can develop small size aerospace grade composites. The desktop autoclave was successfully commissioned and number of cure trials were carried out. Non-Exclusive License Agreement for production and marketing of Desktop autoclave was signed with M/s. Milvus Aero Solutions Pvt. Ltd. Bengaluru and M/s. Datasol India Pvt., Ltd.

Fig.8.3.22. Desktop Autoclave

Tungsten recovery from low grade resources

CSIR-NML has carried out large Scale efforts at Tunsten Extraction and recovery from lean sources, through projects funded by DRDO to the tune of Rs.~5 Crores.

Fig.8.3.23. Commercialization of NML tungsten extraction process

These include Development of Process Flowsheet for Extraction of Tungsten Metal from Hutti Tailings, and, Extraction of Tungsten Metal Powder from Recycling of Tungsten Base Heavy Alloy Scraps.

Process for extraction of Gadolinium

CSIR-NML has developed a process for production of Gadolinium (Gd) Metal by fused salt electrolysis and the desired amount of Gd (>99% purity) was provided to IGCAR.

Development of high hardness steels

CSIR-NML has developed a process for improving in the operational life of manganese steel blow bars of limestone primary crusher steel for development of hardened steel.

Fig.8.3.24. Development of high hardness steels for grinding operations

Natural Composite for Stronger Bone Grafts

CSIR-NML, Jamshedpur has developed a novel nanocomposite that has shown potential to be used as a regenerative bone graft especially in regions that need high strength. The nanocomposite was synthesised through a simple and cost effective route. The composite contains carboxymethyl cellulose, gelatin and hydroxyapatite, with the hydroxyapatite in nanoscale (25-10 nm size). Since bone grafts to be used in load-bearing applications must match the strength of the natural bone, strength and elasticity of the nanocomposite was evaluated and found it to be in the same range as human cancellous and cortical bone. Since all bone grafts need to be steam sterilised before use, the substance should be able to withstand at least 120 degree clues. The new polymer nanocomposite is thermally stable up to 200 degree clues. It is biodegradable and also accelerates the formation of new bone apatite under simulated body fluid. Human bone cell line (MG-63) cells were also found to be biocompatible and proliferated in the presence of the nanocomposite. In fact, the nanocomposite accelerated the bone cell line for new bone tissue formation. The compressive strength and modulus of the nanocomposite developed is in the range of human bone. So, there is no risk of damage to adjacent bones after implantation. The nanocomposite

gets absorbed inside the body and new bone is formed in that place. And unlike metallic implants, there is no need to take out the new implants.

Technology for Manufacturing Textile Reinforced Concrete Panels

CSIR-SERC has developed toilet units that are cost effective, durable, ecologically safe and provide sustainable sanitation using textile reinforced concrete panels. Concrete segmental panels are light in weight and can easily be handled by two persons. The roof slab is designed as two parts for easy lifting which provides confinement to the wall panels by preventing lateral movement. The construction of septic tank for the toilet is also with the same precast thin concrete segmental panels. Assembling/erection of the panels for the construction of toilet can be completed in 3 hours without any special equipment, like cranes. Construction Industry can make use of this technology for mass production of toilet core panels. This technology has been transferred to M/s. Smart Built Prefab Pvt Ltd., Hyderabad.

Fig. 8.3.25 Textile Reinforced Concrete Panels

8.4 INFORMATION SCIENCES

As part of its Climate Change Informatics (CCI) programme, CSIR-NISCAIR has developed curriculum for skill development for islanders in Lakshadweep. And also developed a report and prepared a programme for archiving the inherited traditional navigation manual 'Rahmani' of Lakshadweep Islands, Arabian Sea. The report has been accepted to be published as a book chapter from UK.

An analogue dynamical model for forecasting fog-induced visibility: validation over Delhi Meteorological Applications

Accurate forecasts of fog and visibility are important for many applications; while prolonged fog can adversely affect many crops, even a short duration of dense fog can lead to disruption of air and highway traffic. A forecast model of the occurrence of fog, measured in terms of visibility, is developed by CSIR-NISTADS. The model is formulated as an analogue model; thus the merit of the model is primarily based on its validation against observation. Two forecasts using two sets of meteorological fields

are considered: one as the benchmark forecasts with visibility calculated from observed meteorological fields and the other based on meteorological forecasts from an atmospheric mesoscale model (Weather Research and Forecasting). While the benchmark (perfect) forecasts from observed meteorological fields provide the potential skill of the model, the mesoscale forecasts provide an assessment of realizable skill in an operational setting. The validation was carried out against hourly visibility data recorded at Indira Gandhi International Airport over Delhi during the winter months (December and January) for the period 2009–2012. Error statistics show that the analogue fog model can capture a significant part of the observed variability of fog. The forecasts have more success in forecasting intense (visibility < 500 m) and persistent (duration > 4 h) fog events. The model provides a useful forecasting tool, as shown by measures such as average error, number of false warnings and the number of misses.

8.5 PHYSICAL SCIENCES

LTCC/Thick-film Hotplate-based Warming of Micro-farming Unit

Micro-farming is a technique to grow tiny plants. Such plants are essential in providing the required nutrients and water content to the soldiers of the Indian Army posted in the extremely low-temperature and high-altitude regions. The germination and growth of the plants do not take place in the extreme cold climatic conditions. To solve this problem and grow the plants on a regular basis, hotplates play an important role in maintaining the required temperature inside the micro-farming unit. The thick-film hot-plates operate at 12 V DC (using portable power supplies) and get heated up in a temperature range of 80-100°C (consume low-power) and help in heating the entire micro-farming unit developed by CSIR-CEERI. The required temperature inside the micro-farming unit would be maintained at about 15-20°C for germination and growth of the seeds. The integration of hotplates inside micro-farming unit makes it portable and easily transportable to the high altitude regions for the cultivation of various crops in a single unit The hotplate integrated microfarming unit has been successfully demonstrated at DRDO-DIHAR, Leh, Ladakh and seeds of crops viz. Fenugreek, Radish, Moong and Cabbage were germinated.

Fig.8.5.1. Microfarming unit

Fig. 8.5.2. Germinated seeds at DRDO-DIHAR, Leh

LTCC/Thick-film Hotplate Integrated Warm-Insoles for Shoes:

A special type of hotplate with unique interconnection technology has been designed and developed by CSIR-CEERI using Low Temperature Co-Fired Ceramic (LTCC)/thick-film technology for the purpose. The hotplates are highly rugged, reliable and provide mechanically and thermally strong interconnections. They can be battery operated with a charging time of 3-4 hours and battery runtime of 6-7 hours. The fabrication process is environmentally friendly.

Fig.8.5.3. LTCC/ thick-film hotplate integrated warm-insole

The insoles integrated with LTCC/thick-film hotplates are capable of keeping the feet warm near to body temperature (insole temperature around 37°C). These warm-insoles are useful for people living in extreme cold climatic regions, high-altitude cold deserts and army soldiers serving at high-altitude posts. These warm in soles are reliable and have a long battery life.

Instant Water-warming Unit using LTCC/ Thick-film Hotplates:

A hotplate-based instant water-warming unit has been developed by CSIR-CEERI that warms the running-water flowing through a pipe with less waiting time (~1 min.) and with low-power consumption as compared to the conventional water heating systems. The water at the outlet is heated 15-20°C more than the inlet water and flows with a flow-rate of about 250 ml/min. The instant water-warming unit does not require a storage tank and thus it requires less installation space. The product will be used in domestic applications such as kitchen, washroom, etc.

Mercury free plasma based ultraviolet light source for water treatment

CSIR-CEERI has developed a Mercury Free Plasma-UV (MFP-UV) Lamp for water purifier system which can be used in household water purifier systems, storage/sewage/waste water treatment plants, municipality water treatment plants. The mercury-free plasma UV lamp with a novel structural design and an optimized gas mixture that produces strong spectral bands peaking at wavelengths 253 nm and 172 nm along with a weak band peaking at wavelength 265 nm, which are useful for water sterilization. Filament less light source, no end sleeves, negligible start-up tim, scalable in dimesnion, easily repaiale, boad waelength coverage due dimer (or molecular) radiations, medium pressure lamp and mercury free. The technology has been transferred to M/s YOUWE (UV) Purifier, Jaipur, M/s ARKEN Techno Pvt. Ltd., Pune.

Fig.8.5.4. Plasma based ultraviolet light water treatment system

Solar PVT Co-Generation System

CSIR-CEERI has developed Solar PVT Co-Generation System for Potential applications Electrical Power Electricity for domestic and commercial applications. Its advantages are: Low Temperature(40^0C-80^0 C) heat Direct hot water, Preheating Pressurisation, Bleaching, Washing, Pasteurisation, Desalination etc. The Engineered Solar Photovoltaic and Thermal Co-generation System could be used for simultaneous generation of electrical and thermal energy in a single system. The system has a

Combined efficiency: 30-40%>20% cost savings>50% roof top savings Pack back time: 3-4 years.

Fig.8.5.5. Solar PVT Co-Generation System

IoT Ready Smart Solar Tree

CSIR-CEERI has developed IoT enabled Smart Solar Tree for Smart cities, Decentralized Power Generation, Agricultural land, border security and gram panchayats. The 1kW and 3 kW solar tree designs optimized for a particular geographical location; Integrated lighting and cell phone charging; IoT enabled sensors for electrical performance monitoring; IoT enabled sensors for distributed sensing of environmental parameters (Temp, humidity, CO_2, PM 2.5, PM 10 etc.; Integrated smart cameras for surveillance; IoT enabled solar tree has applications ranging from decentralized power generation applications, agricuture lands security borders, smart cities and EV charging stations. The technology has been transferred to M/s Star Rising Energy Pvt. Ltd., Jaipur.

Fig.8.5.6. IoT enabled Smart Solar Tree for Smart cities

Rapid Milk Analyser

The most common adulterant was found to be the addition of water, glucose, skimmed milk powder, urea, detergent, refined oil, caustic soda and white paint which, according to studies, are "very hazardous" to human life and can cause serious diseases like cancer. CSIR-CEERI has developed a rapid milk analyser for detect of adulterants. The adoption and deployment of the innovation in as many villages and milk societies possible would be a step forward in increasing the standards and quality of the milk. The innovation represents the first fully Indian 'concept to implementation' effort in the milk related instrumentation sector. The technology has been transferred to M/s Rajasthan Electronics & Instruments Ltd., Jaipur (Rajasthan)

Fig.8.5.7. Rapid Milk Analyser

Handheld Milk Adulteration Tester

CSIR-CEERI has developed Handheld Milk Adulteration Tester System. The system is capable of detecting adulterants such as urea, salt, detergents, boric acid, caustic soda, Lye (NaOH), soda, hydrogen peroxide and many more unknown adulterates in raw milk. The system has the following specifications:

- Portable and user friendly system
- Electrochemical detection
- Low cost system and Green technology
- Measurement time: 40-45 Sec.
- Minimum Detection level: Urea:1gm/l; Salt: 2gm/l; detergent: 2gm/l; soda: 1gm/l; boric acid and hydrogen peroxide in ppm.
- Indigenous technology

The Technology has been transferred to M/s Rajasthan Electronics & Instruments Ltd., Jaipur (Rajasthan).

Precision Iodine Value Analyzer

CSIR-CSIO has developed Precision Iodine Value Analyzer, which measures the degree of unsaturation (iodine value) in vegetable oils, has applications in a host of industries such as oil extraction units, quality control and assurance laboratories, food regulatory authorities, soaps and cosmetics, bakeries, meat industry, paint industry, biodiesel analysis and charcoal industry. It is also useful in determining adulteration in edible oils and fats. Conventionally, iodine value is determined using manual titration but this method takes longer analysis time, is costly and uses toxic chemicals. The technology has been transferred to startup M/s Comfax Systems Chandigarh.

Postural Stability System

CSIR-CSIO assesses postural stability or standing balance of a person. Postural stability is achieved by maintaining an upright body alignment against gravitational force and preserving the equilibrium of the centre of mass (CoM) in an individual's base of support. Successful postural control requires the contribution from a complex sensory system comprising visual, somatosensory, and vestibular modalities as well as motor control systems. Assessment of standing balance is essential to the treatment of instability in the neurologic patient.

System assesses pressure fluctuations produced by the heels and toes of the subject standing on a platforms having force sensors placed at the specific locations for each foot. Calculated parameters help in assessing interactions of the neurophysiological and neuro-anatomic subsystems involved in balance control.Ground reaction forces is amongst the prominent parameters used for Gait assessment. It gives an approximation of the projection of body's centre of mass on the ground. The developed system measures centre of foot pressure estimation, gait events like balance stability and lateral fall are also detected.

Portable Harness Ambulatory System

Portable Harness Ambulatory System developed by CSIR-CSIO is a gait supporting aid for patients undergoing gait rehabilitation. It helps in eliminating/minimizing fall and fear of fall in patients during rehabilitation therapy. It is used in physical therapy and exercise training for people with neurological or musculoskeletal injuries or muscle weakness. It supports patient by using a body harness and patient is lifted partially against gravity. The amount of support provided is dependent on the musculoskeletal strength and stability of the patient. Suspension systems function by offsetting a percentage of body mass while providing balance Support. Gait rehabilitation therapy/training using Portable Harness Ambulatory System (PHAS) are more effective and efficient. The salient features of the system are:

- Controllable and modular design which adjusts geometry according to patient needs

- Compatible with support for lifting patient from seated position such as a wheelchair
- Includes adjustable parallel arm supports / hand rails and control boards accessible from either side of machine.
- Supports patients weighing from 60kgs to 180kgs.
- Includes support for vest size 65-140 cms (adults) and 40-90 cms (children)

Gas clouds/Chimneys from Seismic Data using Artificial Neural Network Developed

CSIR-NGRI has developed a workflow based on neural network for the computation of new attribute(s) from a set of other seismic attributes that can discriminate geologic features from gas clouds or chimneys. Application to time migrated 3D seismic data in the Maari field of highly structured and deformed Taranaki basin of New Zealand has brought out clear gas clouds that have originated from the Late Cretaceous source rocks (Pakawau Group) and migrated into the Eocene (Kapuni Group) and Miocene (Mahakatini Group) formations (Mentioned in the figure). The study also reveals that gas has seeped through the overlying Pliocene to recent formations, the imprints of which are observed as pockmarks on the seabed. The findings correlate reasonably with the results from Moki-1 well in the study region. This workflow can be used for interpreting plausible geological features such as faults, mud diapirs, mud volcanoes, salt bodies, slum deposits, debris flows etc. from seismic data. Several fault intersection zones (weak zones) within the reservoirs exhibit a high probability of gas chimneys. This study acts as an add-on-tool for understanding the petroleum system and provides preventive clues for mitigating hazards in the future exploitation programme. The technique can be extended in characterising reservoir properties such as the porosity, permeability, saturation, etc.

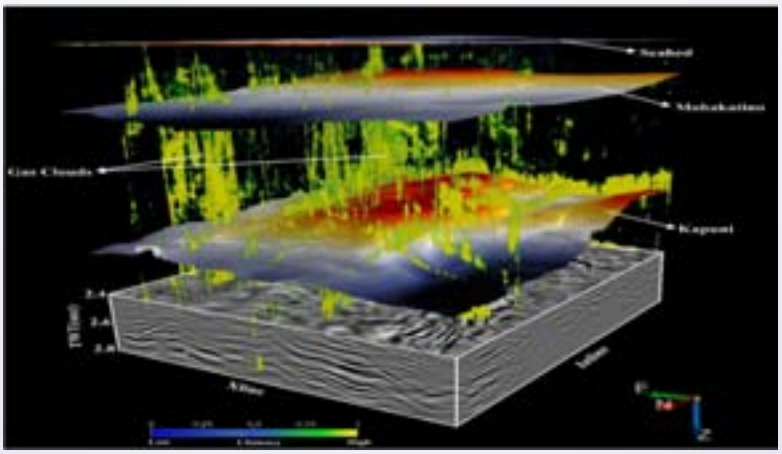


Fig. 8.5.8 3D visualisation of gas clouds rising from thermally matured source rock and propagating through Eocene and Miocene sandstone reservoirs to the seabed

Middle cretaceous geomagnetic field anomalies in the eastern Indian Ocean and their implication to the tectonic evolution of the Bay of Bengal

The occurrence of a major plate reorganisation during the Middle Cretaceous period has added to the dilemma in understanding the early evolution of the Eastern Indian Ocean. The detailed evolution of the Bay of Bengal and its conjugate Enderby Basin has remained speculative to date due to various constraints such as lack of good geophysical datasets and drill sites, and the presence of thick sedimentary load. CSIR-NIO has carried out a study to validate the occurrence of the Middle Cretaceous internal time markers in the Eastern Indian Ocean. These time markers are used to provide additional constraints for tracing the evolution of the Eastern Indian Ocean since Late Jurassic. Identification of these markers helped confirm the timing of spreading ridge extinction in the Perth Basin as 102 Ma. The study suggests that excess crustal accretion occurred on the Indian plate since the Middle Cretaceous.

River discharge as a major driving force on spatial and temporal variations in zooplankton biomass and community structure in the Godavari estuary India

CSIR-NIO investigated variability in horizontal distribution of zooplankton biomass distribution for over 13 months in the Godavari estuary, along with physical (river discharge, temperature, salinity), chemical (nutrients, particulate organic matter), biological (phytoplankton biomass), and geological (suspended matter) properties to examine the influencing factors on their spatial and temporal variabilities. The entire estuary was filled with freshwater during peak discharge period and salinity near zero, increased to ~ 34 psu during dry period with relatively high nutrient levels during former than the latter period. Due to low flushing time (< 1 day) and high suspended load (> 500 mg L−1) during peak discharge period, picoplankton (cyanophyceae) contributed significantly to the phytoplankton biomass (Chl-a) whereas microplankton and nanoplankton (bacillariophyceae, and chlorophyceae) during moderate and mostly microplankton during dry period. Zooplankton biomass was the lowest during peak discharge period and increased during moderate followed by dry period. The zooplankton abundance was controlled by dead organic matter during peak discharge period, while both phytoplankton biomass and dead organic matter during moderate discharge and mostly phytoplankton biomass during dry period. This study suggests that significant modification of physico-chemical properties by river discharge led to changes in phytoplankton composition and dead organic matter concentrations that alters biomass, abundance, and composition of zooplankton in the Godavari estuary.

Impact of dredging activities on tropical monsoonal estuary

CSIR-NIO studied impact of maintenance dredging activities on the macrobenthic community structure of a tropical monsoonal estuary (Cochin estuary), located in the southwest coast of India for three consecutive years. The results of the study indicate apparent differences in benthic fauna and sediment characteristics between dredging

and non-dredging sites, while most of the hydrographical parameters (temperature, pH, DO and BOD) exhibited inconspicuous variations. The study reveals the extent of impacts associated with maintenance dredging activities in a tropical estuary, which can be used to formulate effective management strategies for the protection of ecologically and economically significant benthic communities of estuarine ecosystems.

Investigating the impacts of treated effluent discharge on coastal water health (Visakhapatnam, SW coast of Bay of Bengal, India

CSIR-NIO investigated the impacts of treated effluent discharge on physicochemical and biological properties of coastal waters from three pharmaceuticals situated along the coast of Visakhapatnam (SW Bay of Bengal). Seawater samples were collected from different sampling locations (Chippada (CHP), Tikkavanipalem (TKP) and Nakkapalli (NKP)) at 0- and 30-m depths within 2-km radius (0.5 km = inner, 1 km = middle and 2 km = outer sampling circles) from the marine outfall points. Phytoplankton cell density and total chlorophyll (TChla) concentrations were significantly correlated with dissolved inorganic nutrient concentrations. CHP (December) represented a diatom bloom condition where the highest concentrations of diatom cells, total chlorophyll (TChla), dissolved oxygen coupled with lower zooplankton abundance and low nutrient levels were noticed. The centric diatom, Chaetoceros sp. (> 50%) dominated the phytoplankton community. TKP (March) represented a post-diatom bloom phase with the dominance of Pseudo-nitzschia seriata; zooplankton abundance and nutrient concentrations were minimum. Conversely, NKP (April) represented a warm well-stratified heterotrophic period with maximum zooplankton and minimum phytoplankton density. Dinoflagellate abundance increased at this station. Relatively higher water temperature, salinity, inorganic nutrients coupled with very low concentrations of dissolved oxygen, TChla and pH were observed at this station. Copepods dominated the zooplankton communities in all stations and showed their highest abundance in the innermost sampling circles. Treated effluent discharge did not seem to have any significant impact at these discharge points.

Efficient bioremediation of tannery wastewater by monostrains and consortium of marine Chlorella sp. and Phormidium sp.

CSIR-NIO evaluated the bioremediation potential of two marine microalgae Chlorella sp. and Phormidium sp., both individually and in consortium, to reduce various pollutants in tannery wastewater (TW). The microalgae were grown in hazardous 100% TW for 20 days, and the reductions in biochemical oxygen demand (BOD), chemical oxygen demand (COD), total nitrogen (TN), total phosphorous (TP), chromium (Cr) and total dissolved solids (TDS) of the wastewater monitored periodically. Both marine isolates reduced the BOD and COD by ≥90% in the

consortium and by over 80% individually. Concentrations of TN and TP were reduced by 91.16% and 88%, respectively, by the consortium. Removal/biosorption efficiencies for chromium ranged from 90.17-94.45%. Notably, the TDS, the most difficult to deal with, were reduced by >50% within 20 days by the consortium. The novel consortium developed in this study reduced most of the ecologically harmful components in the TW to within the permissible limits of discharge in about 5 to 15 days of treatment. Thus, both the tested marine strains of Chlorella and Phormidium sp. are promising for bioremediating/detoxifying TW and adequately improve the water quality for safe discharge into open water bodies, in particular when used as a consortium.

Vitamin D Deficiency due to Air Pollution in Delhi

CSIR-NPL has carried a study which shows that increase in aerosol pollution is responsible for deficiency of Vitamin D in the residents of Delhi. Air pollution is majorly caused by the burning of fossil fuels, plastic waste, industrialization, agricultural waste, etc. By all these activities aerosols, which are solid and liquid particles, are spread in the atmosphere. According to the study, there is an increase in Aerosol Optical Depth (AOD), which indicates the amount of sunlight that is prevented from reaching the earth's surface by aerosol particles has decreased the ultraviolet radiation over the Delhi region. A major decrease in UVB radiation is causing Vitamin D deficiency in citizens of Delhi which may lead to bone mineralization resulting in bone softening diseases such as rickets among children. UVA reach the earth's surface to the maximum which causes many health and skin problems whereas most of the UVB radiations are absorbed by the earth's atmosphere. During the last one and a half decade, it has been observed that there is a 10% decrease in UVA and a 20% decrease in UVB. Due to the heavy pollution in the capital, the residents prefer to stay indoors and because of high temperature are forced to avoid sun exposure as much as possible which leads to the deficiency of Vitamin D. It has also been observed that for almost the last 17 years UVA and UVB are decreasing at the rate of 0.07 W/m2 and 0.003 W/m2 respectively every year with a 0.005 increase in AOD every year over Delhi.

Indigenous Anti-Counterfeit Ink

CSIR-NPL has developed a process for making a high security ink that makes counterfeiting difficult. Security inks are essential and crucial for printing of currency. They help prevent any counterfeits, and in such an event make their detection easy. The first step followed in detection of a counterfeit is to scan it under UV light. One could then clearly see features that are normally not visible, since those features are printed with a special ink that glows or fluoresces only when exposed to ultraviolet radiations. However, many such inks already in use need a special surface that is "UV bland" to be effective. In other words, they need a special paper that itself does not glow under UV light. The ink developed does not need such special surfaces. It is

printable on all papers and surfaces. Not only that, the ink can be tested both under UV and Infrared lights. This dual-mode glowing by the ink adds to its secure nature making it doubly counterfeit proof. The “ink is formulated from a cost-effective dual mode luminescent composite pigment. It is prepared by a combination of rare earth elements like Gadolinium, Ytterbium and Erbium oxides with phosphors such as Zinc and Manganese Sulphide. The ink designed by CSIR-NPL shines bright yellow under UV and intense red when under IR.

Fig.8.5.9. Prints Using The New Security Ink Appear Differently Under Normal Light (Upper figures) And Under UV Light (lower figures)

9.0 CENTRAL MANAGEMENT ACTIVITIES

9.1 Governing Body

The 189th Governing Body (GB) meeting of CSIR was held on 21st November, 2017. The Chairman, GB, CSIR, Dr. Girish Sahni made a brief presentation covering the S&T diversity of CSIR and its inherent strength to the recently constituted Governing Body.

The presentation also covered the overall efforts pertaining to repositioning the CSIR so as to serve the common man or woman; and also reorient science and technology efforts to advantageous applications on an accelerated scale. In his presentation, he covered: mandate and mission of CSIR; the organizational structure; the pan-India presence of 38 CSIR Laboratories and 5 Units; the new direction adopted in CSIR after the Society Meeting in April 2016, to connect CSIR to the masses. It also included the Scimago rating of CSIR, positioning it among the top 10 Govt. funded scientific organizations worldwide. the external earnings of CSIR and the re-orientation of Labs to move towards earning about of their total budget 20-30% for this purpose the External Cash Flow and budget figures were also presented.

The economic impact of select CSIR technologies was elucidated citing examples of streptokinase, tractors for agricultural and other uses etc. In this context it was mentioned that CSIR has direct value creation of more than Rs. 32,000 crores, which by itself is more than the plan budget of CSIR for the past 21 years i.e. Rs. 26,000 crores. The boundless contributions of CSIR over the past decades were highlighted in areas of Pharma, Chemicals, Pesticides; and the significant contribution of CSIR technology in the TEJAS aircraft in strategic sector was also highlighted. The concept of Mission Projects and Fast Track Translational Research projects were also explained. Some contributions such as Divya Nayan - personal reading machine for visually impaired, solar power tree, drug developed like BGR 34, Saheli, Clot busters, Anti-arthritis herbal formulations, etc. Chemical and Petrochemical technologies such as the Wax plant at Numaligarh and US standard grade Gasoline plant at Jamnagar, Waterless chrome tanning technology- which is a gam changer, Blight resistant Samba Mahsuri Rice -which is a great societal contribution, "Drishti" for visibility monitoring at airport and Hand held Ksheer (milk) scanner for testing adulteration were explained. The goals and targets for the next 3 years were presented. Linkages of CSIR established with FICCI, CII and NRDC or technology transfer and business development activities were highlighted as well for delivering next landmark technologies in the near future.

Dr. Anjan Ray, Head RPPBDD and Dr. Sudeep Kumar, Head MD presented 'CSIR Thrust Areas' and 'Fast Tracking the Translational Research in CSIR System' respectively to the GB.

The GB recommended/ ratified significant items which are as follows:

- Acquiring of land (320 Kanals and 16 Marias) at Leh on lease basis fora period of forty years under J&K Grant Act 1960 on free of premium and normal ground rent of Rs. 6416/- at Rs. 20/- per kanal per annum; and Establishment of research station at Leh (ladakh) by CSIR-IIIM, J&K;
- Demolition of the old existing KV class rooms situated in a single storey building measuring plinth area of 857.00 Sq. meter which is approximately 45 years old at the CSIR-IIP, Dehradun;
- Amendment to Administrative Service (Recruitment & Promotion) Rules,1982 - Recruitment Rules for the post of Private Secretary;
- Amendment in the Recruitment Rules for the posts of Security Assistant, Watch and Ward Assistant and Croup-D [Non-Tech] & Safaiwala Wash boy (Canteen) and Bearer, Tea/Coffee Maker (Canteen) (Now classified as Group 4C' and known as MTS staff) in CSIR as a consequence of discontinuation of interviews for various junior level posts in line with the instructions of DoPT, Govt, of India
- The formation of Theme Directorates under eight innovative themes which supports multidisciplinary and trans-disciplinary approaches, was deliberated in the meeting. It was observed that each theme directorate meets the mandate of CSIR and provides a novel interface for stakeholders. These theme directorates are follows:
    - ❖ Aerospace, Electronics, and Instrumentation & Strategic Sectors;
    - ❖ Civil Infrastructure & Engineering;
    - ❖ Ecology, Environment, Earth & Ocean Sciences and Water;
    - ❖ Mining, Minerals, Metals and Materials;
    - ❖ Chemicals (including leather) and Petrochemicals;
    - ❖ Energy (conventional and non-conventional) and Energy devices;
    - ❖ Agri, Nutrition & Biotech; and
    - ❖ Healthcare

9.2 CSIR's 76th Foundation Day Celebration: CSIR Platinum Jubilee Foundation Day 2017 function and awards distribution

9.2.1 Conclusion of the Platinum Jubilee Year celebrations

The President of India, Shri Ram Nath Kovind, graced the concluding ceremony of the Platinum Jubilee celebrations of the CSIR in New Delhi on September 26, 2017.

Fig.9.2.1. President addressing the assembly at the Foundation Day

While appreciating the work of CSIR in bringing about sustainable improvements in the quality of life of Indians, as well as in helping business and industry with specific applications of science and technology, the Hon'ble President of India Shri Ram Nath Kovind called upon CSIR to continue to make new technologies as well as basic research relevant to our developmental hopes.

The President also said that it is very telling that the staff of CSIR constitutes only about three to four per cent of India's scientific manpower but contributes nearly 10 per cent of India's scientific output. "This is extremely creditable and emphasizes how important CSIR is to the nation building process," he said. The Hon'ble President said that from the earliest days of our Independence, our country has been clear about the use and deployment of science and technology to achieve the goals of social development. This has meant both exploiting India's rich wealth of traditional knowledge and intellectual property – of which CSIR is the custodian – as well as being open to the latest in science and technology, not being afraid of cutting-edge research and its discoveries, and where possible using these to help our common citizens.

Fig.9.2.2. Hon'ble President of India Shri Ram Nath Kovind with lead personal of CSIR

"This aspiration remains important as ever as we strive to achieve a New India by 2022, when we complete 75 years as a free country," he said. "Our ambitious national programmes – such as Start-up India, Make in India, Digital India, Swachh Bharat, Namami Gange and the Smart Cities Mission – cannot be successful without our scientists and our technology incubators, particularly CSIR, contributing."

In all these areas, the President said, the need for socially inclusive and yet cost-effective applications and products of science and technology are a national priority. Once these are realized, they can become a model for other developing countries. For us, this has always been and will always be a paramount goal. For India, science and technology is a force multiplier in the quest for development. "In this context," the President said, "I am pleased to note the widespread social benefits of the two CSIR technologies that are being dedicated to the nation today. The first is a hand-held milk tester that will allow us to more easily identify. adulterants in milk. The second is Waterless Chrome-Tanning Technology that eliminates the use of water in two processes before and after tanning – and also reduces the solids dissolved in wastewater during tanning. This has an obvious environmental impact."

Fig.9.2.3. Hon'ble President of India releasing the CSIR technology "Ksheer Tester"

He also mentioned that CSIR's anaerobic digester was making a big difference to the Swachh Bharatmission, as it converts biodegradable kitchen waste to biogas and manure that can be used for family kitchen gardens. Each anaerobic digester has the capacity to convert up to three kg waste per day and produce 400 litre of biogas, which can be used as a clean fuel. "Another commendable CSIR creation I have been told about is DivyaNayan - a reading device for the visually challenged," he said. "Inventions and innovations such as these provide simple and user-friendly solutions to the most underprivileged and deprived sections of our people. They make science and technology so meaningful –and I should say potentially so magical – as India seeks to achieve the Sustainable Development Goals." Shri Ram Nath Kovind said that technology had taken human society to the edge of a brave new age. "Dazzling

technological products are changing our lives almost in real time," he said. "And the Fourth Industrial Revolution is set to transform our world in ways we still cannot imagine. We are entering an era of Artificial Intelligence and Robotics, 3D manufacture and custommade biological and pharmaceutical products, even driverless cars. The relationship between human and machine is evolving before our eyes.

In the midst of all this, we cannot let the excitement of technology and newer and newer products divert our attention from basic science research. For that remains fundamentally important." Shri Ram Nath Kovind also called for taking accelerated steps to promote the participation of girl students and women in science and technology. "If this disparity is not addressed," he said, "our scientific achievements will

always be less than perfect and less than desirable." Shri Ram Nath Kovind said the participation of women in science in India was distressingly small – less than two of every 10 scientific researchers in India are women. Of those who join the Indian Institutes of Technology each year, just about 10 per cent are women. "These numbers are simply not acceptable," he said. On the occasion the President also distributed various awards to the awardees.

Fig.9.2.4. Awards distributions at CSIR Foundation Day Celebration on 26th September 2017

9.2.2 Key address by Dr. Harsh Vardhan, the Hon'ble Union Minister of S&T and ES, and Vice President, CSIR

Earlier, in his Welcome Address, Dr. Harsh Vardhan congratulated CSIR for having lived up to the challenge posed by Prime Minister Shri Narendra Modi a year back where he appealed to CSIR to work on at least 100 new technologies which we could deliver to the people of India. "I feel so happy that just after 365 days, we are not only working on 100 technologies but at least 250 new technologies which are absolutely people-centric," he said.

Fig.9.2.5. Address by Dr. Harsh Vardhan

Dr. Harsh Vardhan said, "We feel so happy that last year amongst the 5000 private and public aided scientific institutions in the world, as per *Scimago* rating we were the only Indian Institution that enjoyed the 99th position. But today after one year our position has become 75th. Last year we were 12th amongst a list of 1200. Today I feel so happy to announce that from that 12th also, we have come down to 9th. I think this is no small achievement." He said that during the last one year many successful events have been organized with the help of CSIR, for instance the India International Science Festival with participation of over 5 lakh people, over 10,000 scientists and hundreds and thousands of students. Apart from the large number of exhibitions organized by CSIR laboratories all over the country, Dr.Harsh Vardhan informed that an ambitious programme *Jigyasa* was launched during the Platinum Jubilee Celebrations. "We are now trying to develop scientific passion amongst over a lakh of students from Kendriya Vidayalayas every year," he said.

He also appreciated CSIR for taking up 75 Skill Missions ensuring that those who don't get enough of education in their life could be imparted good quality skills so that they can be adopted by industries. Dr. Harsh Vardhan said that we must reassert our

pledge and ensure that the next five years would be the greatest years for CSIR's great history. He said the Prime Minister had given us a very ambitious goal of delivering a new India to 125 crore Indians by the year 2022. An India where we can wipe out the miseries of the people and where we can bring back smiles on everybody's faces. "I am sure you can be the most worthy tool for helping our Prime Minister in delivering the new India," he said.

9.2.3 Detailed address by Dr. Girish Sahni, Director General, CSIR

Presenting the CSIR Report, Dr. Girish Sahni, Director General, CSIR said, "The mission of CSIR is linked to excellence in science, development of technology and using both as a magic combination to connect to society, poorest of the poor, mightiest of the mighty, mighty industries, village industries, medium and small industries. So, it's a very wide canvas that CSIR chose for itself and a role that our founding fathers destined for us." Dr. Sahni further said, "I feel, in future, our role will not be limited to only help or enable. We would want to be the major driver in the progress of the country. We expect ourselves to contribute maximum in future." He said that through the 75 years of existence, at every junction CSIR rose to the challenges the society and the nation gave it. "From the times of import substitution, at the time when foreign exchange was a priority, we gave the foundation of not only the chemical industry of the country but the pharma industry as well," he said. "Today India happens to be the generic drugs capital of the world, in major part due to contributions from our labs."

Fig.9.2.6. DG, CSIR presenting the CSIR Report

DG-CSIR also said that CSIR with its rich legacy and richness of soil in terms of fundamental research, in terms of the scientific strength that we have, and also the patents that we filed and also the public mindscape that we occupy in terms of service to society, the Scimago rating which is a composite of all these properties has rated CSIR 9th in the whole world amongst government supported institutions. "This is a thing of great pride but this also goads us to go forward and look at getting the number one position," he said. Dr. Girish Sahni said, "Last year Shri Narendra Modi Ji came here, inspired us and gave us firm directions and told us to become connected to the

common men and women, and solve the problems of society. With Dr. Harsh Vardhan and Shri Chowdhary at the helm, we are poised to go forward. The areas in which we work vary from Pharma, Health, Mining, Minerals, Strategic sector, Filing patents, Publications, Producing technology, Transferring technology, Nurturing technology and helping industry to take it to the society." "In recent times," he said, "when globalization set in, the challenges were to rise and become innovative, file patents, file meaningful patents, create value for patents. CSIR happens to be the number one in the country filing patents. The challenge now is to see which are valuable patents, how to take them forward, how to connect them with industry, how to see that the recipe does not remain a recipe but becomes a product and the product is taken for the benefit of the last man and the last woman who looks to the nation and the scientists for the solution to their problems."

DG-CSIR informed that CSIR had recently launched a herbal medicine for diabetes which is doing great. "Our contribution to the production of India's first world class Light Combat Aircraft, the fighter Jet LCA-TEJAS is also very significant," he said. Dr. Sahni informed that the carbon-fibre body of the aircraft, the control systems, the head-up display are all from CSIR Labs. Another contribution is standardization of coal so that the real calorific value is obtained and genuine quantification of the coal prices is made. New varieties of rice, helping the farmers, milk testing, earthquake first transmissometer on air fields, these are among the many achievements of CSIR in recent years, he said. The socio-economic impact of only a handful of technology has been rated to be more than 30,000 crores, the combined budgetary support in the last several decades of its existence. So, the contribution towards society from CSIR is virtually immeasurable. He said, "Now we have refocused our attention and our energy in such a way that outcomes in healthcare, outcomes in energy sector and outcomes in strategic sector are the focus of our attention, not the subject areas alone. Subject areas are the means to an end where we will deliver tangible outcomes. We have resolved to solve societal problems. Right now we are close to 300 projects in which the direct outcomes in the next two years would be of direct benefit to the society.

9.2.4 Detailed Foundation Day Lecture by Prof. Rajendra Srivastava, Dean of the Indian School of Business (IBS)

While delivering the CSIR Foundation Day lecture, Prof. Rajendra Srivastava, Dean of the Indian School of Business (IBS) said, "When I hear the statistics about CSIR, it's really amazing and aspirations are just the right aspirations. CSIR provides 3% of the manpower in research but 10% of the output. That is a great achievement."

Fig.9.2.7. Prof. Rajendra Srivastava, Dean of the Indian School of Business (IBS)

Prof. Rajendra Srivastava is the Dean of the Indian School of Business (IBS). He comes with an experience of over 30 years as an academic and administrator. He has held several tenured faculty and administrative positions during his career. Before joining the ISB, he was Provost and Prof. Rajendra Srivastava said that research coming out from CSIR has been increasingly cited globally and at the same time impact factor has also gone up. The question is, are we good enough? Globally India does not rank well in scientific research and innovation at the moment. So we have a long way to go. We are number one in Central and South Asia but that number one is not very good when you start comparing it to global standards. Our aspirations should be what Dr. Sahni noted – to be number one in the world. We provide the talent to Silicon Valley, to Cambridge research; why can't we utilize this talent at home.

If we look at the cell phones that we hold, if a cell phone is a year old, it has probably lost about 50% of the value, so we are losing 1% a week. So time is of essence. I think it's important to recognize the value of speed these days. If I go back 30-40 years ago, the technology cycles were very slow. But now, technology cycles are a year, 18 months or 2 years. He said those companies that fail to recognize the need for change become moments in history. Kodak is still much known for the Kodak moments but that company doesn't exist anymore. Kodak was a chemical company believing in silver halide, but the new technology was digital. He also cited the example of Sony that developed a reader in 2006. The price point was about 350 but the Sony reader is hard to be found these days. On the other hand Amazon Kindle came up with a product a year later but their focus was on ecosystem. What will be the connectivity, what will be the downloading mechanism and what will be the pricing of the books that will be available. "Amazon Kindle as everybody knows had a global share of 48% back in 2011 but now it has really taken over the market," he said. "If we go to the Sony product, it was technologically better; its screen was brighter and used lower power. But I want to you understand that the best product doesn't always win, the best network product wins."

He said Cisco India built a router that would operate in the heat and on low energy. The first order they got was not from India, but from AT&T, USA for 10 million dollars. So, we need to not only do well by doing good things but we also need to innovate for emerging markets. Nutrichoice, took two years to develop a product that has low sugar and high fiber as in India about 30% people are diabetic, a very big market for business. The product failed in the market as they forgot to innovate the product according to Indians, who have a habit of dipping the biscuit in the tea which then disappears immediately after dipping. He said that emerging markets need Innovation; Process & Product Innovation Integration; Labs and Markets Integration; Frugal & Reverse Innovation, and Innovation for Emerging Markets. He advised young scholars

to focus on use-driven innovation, integrate theory and practice, seek multidisciplinary assignments and focus on impact-learning from the future. He said there is lot of potential, lot of human talent and it is not just a CSIR responsibility, it is a responsibility for all the academic institutions and all the research organizations.

9.2.5 Shanti Swarup Bhatnagar Prize Presentation Ceremony for Science & Technology

Shanti Swarup Bhatnagar Prize for Science and Technology was instituted in the year 1957, in the memory of late Dr. (Sir) Shanti Swarup Bhatnagar, FRS, the founder director of the Council of Scientific & Industrial Research (CSIR). The SSB Prize is awarded each year on the basis of conspicuously important and outstanding contributions to human knowledge and progress, made through work done primarily in India during the five years, preceding the year of the prize.

The SSB Prize, comprising a citation, a cash award of Rupees five lakh and a plaque, is given to each person selected for the award in the following disciplines:

- Biological Sciences
- Chemical Sciences
- Earth, Atmosphere, Ocean and Planetary Sciences
- Mathematical sciences
- Medical Sciences
- Physical Sciences

Winners of Shanti Swarup Bhatnagar Prizes for 2017 were declared by Dr. Girish Sahni, DG-CSIR during the Foundation Day Function. The prize recipients are

- Dr. Deepak Thankappan Nair, Regional Centre for Biotechnology National Capital Region - Biotech Science Cluster and Dr. Sanjeev Das, Molecular Oncology Laboratory, National Institute of Immunology under Biological Sciences;
- Dr. G. Naresh Patwari, Department of Chemistry, Indian Institute of Technology, Bombay under Chemical Sciences;
- Dr. S. Suresh Babu, Space Physics Laboratory, Vikram Sarabhai Space Centre (ISRO) under Earth, Atmosphere, Ocean and Planetary Sciences;
- Dr. Amit Dutt, Advanced Centre for Treatment, Research and Education in Cancer Tata Memorial Centre and Dr. Deepak Gaur, School of Biotechnology Jawaharlal Nehru University under Medical Sciences;
- Dr. Nissim Kanekar, National Centre for Radio Astrophysics, Tata Institute of Fundamental Research and Dr. Vinay Gupta, OPV Laboratory , CSIR-National Physical Laboratory under Physical Sciences; and

❖ Dr. Aloke Paul, Department of Materials Engineering Indian Institute of Science and Dr. Neelesh B. Mehta Department of Electrical Communication Engineering Indian Institute of Science under Engineering Sciences.

9.2.6 CSIR Young Scientist Awards 2017 Presentation Ceremony

CSIR introduced, in 1987, a scheme of awards for Young Scientists in the CSIR system in order to promote excellence in various fields of science and technology. These awards are known as 'CSIR Young Scientist Awards'. CSIR scientists below 35 years of age, as reckoned on 26 September (CSIR Foundation Day) of the preceding year, are eligible for the award. These awards are given annually in the following disciplines:

- Biological Sciences
- Chemical Sciences
- Earth, Atmosphere, Ocean and Planetary Sciences
- Engineering Sciences
- Physical Sciences (including instrumentation)

Each award consists of a citation, a cash prize of rupees fifty thousand and a plaque. CSIR Young Scientist Awardees are also entitled to a research grant of rupees five lakh per annum for a period of five years and an honorarium of rupees seven thousand and five hundred per month till the age of 45 years. The following awards were given this year:

Biological Sciences

- No award

Chemical Sciences

- Dr. Sakya Singha Sen, CSIR-National Chemical Laboratory, Pune for his innovative and explorative work in developing new inexpensive catalysts for a variety of organic transformations of potential commercial applications.

Earth, Atmosphere, Ocean and Planetary Sciences

- No award

Engineering Sciences

- Dr. Prosenjit Das, CSIR-Central Mechanical Engineering Research Institute, Durgapur, for his outstanding contributions towards understanding and developing novel automotive products through semisolid processing for industrial use; and

- Dr. Sathravada Balaji, CSIR-Central Glass & Ceramic Research Institute, Kolkata, for his outstanding contributions towards developing novel extended IR transmitting low phonon oxide glass for various laser and photonic applications

Physical Sciences (including instrumentation)

- Dr. Amit Laddi, CSIR-Central Scientific Instruments Organisation, Chandigarh, for his important contributions on the development of novel drive control systems for mobility carts for people with motor disability; based on minimal physical inputs like finger, facial features or head gestures

9.2.7 CSIR Technology Awards-2017

Instituted in 1990 and Given annually, CSIR Technology Awards seek to foster and encourage multidisciplinary in-house team efforts and external interaction for technology development, transfer and commercialization. These awards include awards for:

(i) Life Sciences;

(ii) Physical Sciences including Engineering;

(iii) Innovation;

(iv) Business Development and Technology Marketing; and

(v) Most Significant CSIR Technology of the Five-Year Plan Period

Each Technology Award comprises of a cash prize of Rs 2 lakh, except the award for the Most Significant CSIR Technology of the Five-Year Plan Period, which has a cash prize of Rs 5 lakh. Besides, a plaque and a citation are also given to the awardees. The winners of the CSIR Technology Awards-2017 are:

Technology Award for Life Sciences

No Award.

Technology Award for Physical Sciences including Engineering

- CSIR-Institute of Minerals and Materials Technology, Bhubaneswar has won the technology ward for “Technology for Recovery of Iron Values from Low and Lean Grade Iron ore Resources”. CSIR-IMMT has developed and deployed economic eco-friendly, sustainable technologies and innovative technology packages for maximized the utilization of iron ores resources for long term sustainability. More than 14 clients, national and international, have benefited from these technologies for production of sponge iron and steels.
- CSIR-Central Road Research Institute, New Delhi has won the technology award for “Sustainable Cold mix Technology for Construction and Maintenance of Roads”. The new technology is green, construction laborer friendly and superior to existing

ways of laying roads. The technology saves 1500 litre fuel oil per km (3500m2) of rural road construction, 12% energy in premix construction and 20% energy in mix seal surfacing construction.

Technology Award for Innovation

- CSIR-Central Leather Research Institute, Chennai has won the technology award for "Waterless Chrome Tanning technology". The environment friendly technology does not need additional use of water for chrome tanning while also eliminating the need to carry out pickling process associated with the use of acid and salt. It also reduces the TDS in effluents by 20% and brings down the usage of chromium by 15-20%.
- CSIR-Central Mechanical Engineering Research Institute, Durgapur has won the technology award for "Development of Community Level Iron Removal Plant & their Implementation in Rural areas to Supply Iron Free Drinking water". The novelty of the present invention lies in the ability of the device to deliver instantly iron free safe drinking water without affecting water quality parameters and that too without electricity.

Technology Award for Business Development and Technology Marketing- 2017

- CSIR-Central Institute of Mining and Fuel Research, Dhanbad has won the technology award for "Significantly Enhancing the Business and Marketing of their Knowledgebase". It has introduced technology partnerships and collaborative business models to address the energy security issue of the country. It also has led to a sustainable and consistent growth of over 400% in its External Cash Flow in a period of five years.

Following technology received Certificate of Merit under CSIR Technology Awards-2017

- The technology for Manufacturing Special Glass Beads for Nuclear waste Immobilization of CSIR-Central Glass & Ceramic Research Institute, Kolkata, received Certificate of Merit under CSIR Technology Awards-2017.

  The borosilicate glass beads developed and implemented by the institute is a precious material required for management of radioactive waste in a closed nuclear fuel cycle that is followed by India. The innovation also assists in recovery and recycles of valuable during nuclear waste immobilization and is of significant importance for nuclear power programs.

9.2.8 G N Ramachandran Gold Medal For Excellence in Biological Sciences & Technology 2017

CSIR instituted a Gold Medal in 2004 in the fond memory of Prof. G N Ramachandran, a pioneer of protein chemistry and the founding father of structural biology in India, for

recognizing excellence in the interdisciplinary subject/field of Biological Sciences & Technology.

Prof. Kandala Venkata Ramana Chary, Tata Institute of Fundamental Research, Mumbai, has been awarded for his contributions in the development of NMR methods for structural biology, especially, Protein NMR. He applied these methods to determine structures of proteins, which have provided insights into their biological functions

9.2.9 CSIR Innovation Award for School Children 2017

CSIR instituted the Diamond Jubilee Invention Award for School Children on 26 April 2002 in order to enhance creativity amongst school children. The day is also celebrated as the 'World Intellectual Property Day' throughout the world. The objectives of this competition are to capture creativity and innovativeness amongst school children and create awareness about IPR. From the year 2011 the Award has been renamed as 'CSIR Innovation Award for School Children. During the last fifteen years, i.e. from 2002 to 2017, 5008 proposals were received for these Awards from various parts of the country and 101 inventions/innovations were selected for various prizes by High Level Awards Selection Committee. In the year 2016 and 2017, the competition has been renewed with an intervening training-cum-awareness programme. CSIR received 450 innovation proposals which were screened.

Total four innovation proposals were selected for the award. The award comprises a cash prize, trophy and a certificate. The following 6 children are being awarded for four innovations, one First Prize, one Second Prize and two Third Prizes:-

First Prize (Rs. One lakh only)

- Atharva Avinash Dhebe and Pavan Shankar Ingale, class IX & VII students of Sainik School Satara, Maharashtra for the invention ' Artificial Gill System for Divers and Commandos'.

  The device comprises of two compartments, compartment-one extracts oxygen from seawater using high oxygen affinity chemical and compartment-two dissociates this oxygen received from compartment-one using catalyst or reducing agent. Oxygen is further carried to the mouth piece by a rubber pipe for breathing.

Second Prize (Rs. Fifty thousand only)

- A. Siva Bharathi, class IX student of N.S.N. Matriculation Higher Senior Secondary School, Nehru Nagar, Chennai for the invention ' Innovative method of raising rice seedlings by an economically viable and ecologically sustainable method'.

  It is an innovative method of raising rice seedlings in an innovative medium which is bio degradable, comprising 50% of coconut coir, 30% of press mud from sugarcane industry and 20% of rice husk (Percent by volume). It takes only 14

days for seedlings to grow and the irrigation frequency is just once in a day and water consumption is 4.5 times lesser as compared to conventional practice. Innovative seedling mat grown in this way is 50% lighter in weight and can be easily rolled up for transportation. Cost of this medium is 33% lesser as compared to the conventional practices.

Third Prize: (Rs. Thirty thousand only for each invention)

- Tanmayi Appasaheb Kokare and Tanishka Appasaheb Kokare, Class of V and VII students of M. E. S. Waghire High School, Saswad for the invention 'Two-in-One Dustbin'.

  The students have devised a dustbin which is capable of containing both wet and dry garbage in a single unit. This dustbin is divided into two compartments where the lower portion is to contain biodegradable or wet garbage and upper one contains dry garbage. The lower partition can be opened by lifting the interfacing disk (connected through a chain) upwards.

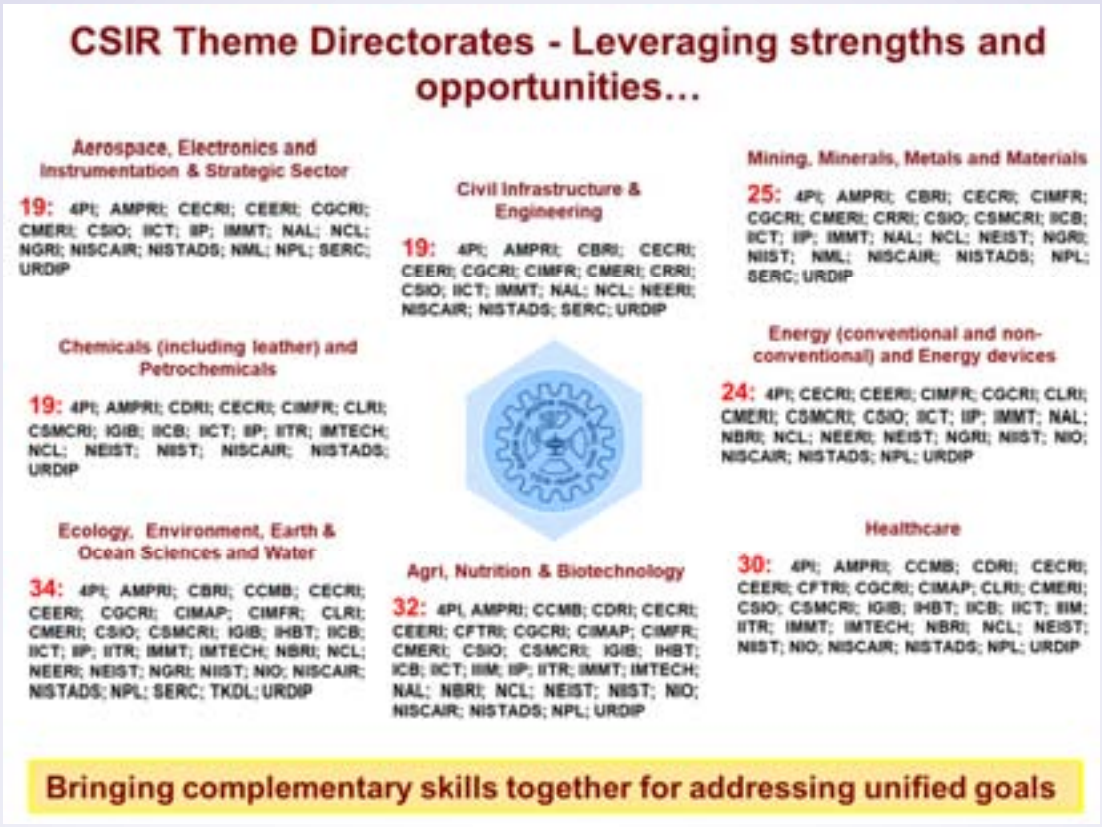
- S. Mukkani of Panchay of class VII at Union Middle School, Narthangudi, Valangaiman Tiruvarur, Tamilnadu for the invention "Self-confident Wheel for two Wheelers and Electricity Generation'. The student has designed a two wheeler device with the attachment of a self-confident wheel in the back wheel. By this device one can continue the travel without interruption when the two-wheeler gets puncture in the middle of the journey. Additionally, by adding the dynamo in the saw tooth wheel, electricity can be generated easily.

9.3 CSIR's new initiatives: R&D Focus – Product/ Technology and High Science

Recently, CSIR has undertaken several initiatives to translate laboratory leads to marketable/value-added technologies/products and thereby enhance interactions and connect to stakeholders for enabling ease of doing technology licensing. The initiatives include:

- Thematic approach to harness multidisciplinary talent and infrastructure for solving specific challenges in identified sectors is a focused new initiative being pursued by the CSIR. Thematic Directorates have been formed and cover specific sectors: (i) Aerospace, Electronics, and Instrumentation & Strategic Sectors; (ii) Civil Infrastructure & Engineering; (iii) Ecology, Environment, Earth & Ocean Sciences and Water; (iv) Mining, Minerals, Metals and Materials; (v) Chemicals (including leather) and Petrochemicals; (vi) Energy (conventional and non-conventional) and Energy devices; (vii) Agri, Nutrition & Biotech; and (viii) Healthcare.

  The Theme Directorates shall provide for greater alignment to and for enhancing industrial/stakeholder focus of CSIR R&D activities. The roadmap and activities of each theme would focus at substantial contributions towards each of the parameters - public good, private good, strategic good and societal good.



- R&D activities are being pursued by the CSIR under focused verticals, based on the objectives and outcomes envisaged:
    - Fast Track Translation (FTT) Projects: Close to market, business plan driven; Duration: 18 to 24 months;
    - Fast Track Commercialization (FTC) Projects: Positioned to create new business opportunities or expand existing businesses; Duration: 6 to 12 months;
    - Mission Mode (MM) Projects: Focus at technology development, scale up and deployment for national unmet needs; Duration: 24-36 months;
    - Niche Creating High Science/ High Technology (NCP) Projects: Based on the specific scientific niche created by a group in the laboratory; Focused on retaining and developing the domain expertise, aimed at global leadership;
    - Focused Basic Research (FBR) Projects: Focus at High end basic research;

- Facility Creation (FC) Projects: Capital intensive projects, aligned to key R&D pursuits, aimed at providing the required state-of-art infrastructure to labs.

The 12th FYP leads, based on identified criteria, are being pursued for further development under any of the aforementioned project categories. In addition, efforts are also being made to create projects in co-development mode with industry or in collaboration with stakeholder Ministry/Dept./State Govt. in the identified cases.

- CSIR has signed Agreements of cooperation with Technology Transfer Organizations and Industry Associations. The efforts are to enhance technology commercialization and deployment of CSIR interventions and also enabling synergy with the needs of the line ministries. CSIR has also signed an Agreement with the international agencies for enabling reach of its S&T interventions beyond the Indian borders.

  For the purpose, CSIR has signed Agreements of cooperation with Technology Transfer Organizations and Industry Associations such as Confederation of Indian Industry (CII) and National Research Development Cooperation (NRDC). CSIR has also signed an Agreement with the Federation of Indian Chambers of Commerce and Industry - FICCI-LEAD, Rwanda for enabling international reach of its S&T interventions;

- Utilization of CSIR's intellectual property will be an integral part of knowledgebase marketing and overall business development strategy;

- A CSIR Innovation Fund of about Rs 400 Crores has been created for the purposes of seed funding of S&T based entrepreneurs and for the handholding of S&T based start-ups; and

- Technology Incubation Centres were proposed to be set up across CSIR laboratories to provide support to start-ups. Technology Demonstration and Deployment Centres are proposed to be set up at strategic locations in the country, in collaboration with the State Governments.

10.0 HEADQUARTER ACTIVITIES

The various scientific divisions and directorates at CSIR headquarters carried out number of significant activities and coordinated well with CSIR laboratories. Their important activities are outlined as follows.

10.1 Research Project Planning and Business Development Directorate (RPPBDD)

The Directorate is the nerve centre of CSIR Headquarters, which is mandated to assist the overall R&D Planning for CSIR with inputs from other divisions/ directorates. Its main activities are: preparation of background papers for allocation of Finances in consultation with Heads of other Directorates and FA, CSIR and release of funds with the approval of DG,CSIR; approval of R&D projects/ schemes; preparation of required background papers including detailed Demands for Grants and notes for Parliament Consultative Committee; interaction with Finance Ministry, NITI Aayog, and other Central and State Ministries as well as Govt. Departments; CSIR Annual Report; All activities relating to business development including marketing guidelines; MoUs / Agreements with foreign entities with their security and sensitivity clearances; Management of Innovation Fund; Parliament matters relating to the above activities; Policy matters pertaining to the above activities; Awards - CSIR Technology Awards, CSIR Diamond Jubilee Technology Award and CSIR Award for S&T Innovation for Rural Development.

10.1.1 Outcome Review of CSIR Schemes

Another major responsibility undertaken and completed successfully by RPPBDD was the constitution and Expert Committee under the Chairmanship of Dr T. Ramasami, Ex-Secretary, DST and DSIR to review the outcomes of the National Laboratories Scheme for its continuation beyond 12th Five Year. This is based as per the directions of the Ministry of Finance vide OM No. 24(35)/PF-II/2012 dated 5/8/2016, who had directed that existing 12th FYP Schemes of the Ministry be reviewed for their outcome. RPPBDD provided compiled significant achievements in terms of outputs & outcomes, reports on Economic Assessment studies on selected technologies, additional data and information sought by the Committee. The Committee has provided a report to CSIR with key observations and recommendations on the schemes/sub-schemes/ programmes. The report of the Committee on the Outcome Review of National Laboratories Scheme/Sub-schemes of CSIR was presented to DG, CSIR and the Hon'ble Minister for approval.

The main Conclusions and Recommendations of the Committee are as follows:

1. Council of Scientific and Industrial Research has been implementing National Laboratories Scheme for several Plan periods. The scheme has delivered

excellent outcomes by way of Public and Strategic Goods. The scheme is recommended for continuation with no sunset date.

2. Outcome appraisal of the scheme demands forecasting methods based on past records when Private and Social Good dimensions are concerned, on account of time phasing necessary.
3. During the review period 2012-17, industrial turnover in excess of 10 times of the R&D investments made by CSIR in earlier plan periods has been registered proving the potentials of Private Good benefits of R&D of National Laboratories.
4. The committee is of the opinion that from the R&D outputs delivered in the form of 744 technologies and 2045 patents, CSIR could establish substantial Private Good outcomes during the next three to five years.
5. Business plan approach for the consolidation of the technology & IP assets and establishing an ECF flow in excess of ₹1200-1500 crore per year is recommended.
6. External Cash Flow of ₹2960 crores of which the business incomes could be large fraction. However, it does not meet the global benchmarks. CSIR might need to increase their business incomes to the tune of at least 35% of the R&D Funds (Total Plan plus Non Plan minus pensions). CSIR might be advised to prepare a road map and business plan for achieving the business income targets.
7. Since limitations in professional capacities on business processes at both laboratory and Head Quarters level might be one of the factors limiting the level of internal accruals, suitably designed marketing arrangements with companies/professional agencies (from both India and abroad) for increasing revenues are recommended.
8. Social contract of R&D outcomes of CSIR requires to be made visible and impactful. CSIR is advised to position a suitably modified scheme in place of CSIR-800. Such a scheme could also ensure suitable deployment strategies and mechanisms. New partnerships with industrial clients under CSR and partnerships with ICAR and ICMR are suggested.
9. CSIR may establish Performance-Reward relationship between investment and Private and Social Good indicators and position a suitable Performance Related Incentive System by way of budgetary allocations and some flexibilities for deployment of such funds in generating revenue flows and social incomes.
10. Innovation complexes scheme is recommended for continuation. Setting up Incubation centres and Technology Parks for catalysing technology / product development may also be considered as an integral part under the sub-scheme.

The innovation complexes may be set up / be seeded in a place where there is a need and opportunity for such complexes based on business plan. It is further recommended that CSIR should set up incubation centres at many of its laboratories to move the innovations into technologies through start-ups.

11. The sub-scheme on National Civil Aircraft Development which could not be operationalized during the 12th FYP might be taken up at higher level.

10.1.2 Detailed Demand for Grants of CSIR for FY 2018-19

RPPBDD prepared the Detailed Demand of Grants (DDG) of CSIR for the year 2018-19. As both the Plan and Non-Plan budget were merged from FY 2017-18, The document provides financial statements, major achievements, outputs and outcomes of Schemes and future targets. Also prepared response to Parliamentary Standing Committee on Science & Technology, Environment & Forests, Questionnaire-I, II and III on the Detailed Demand of Grants (DDG) of CSIR and submitted a consolidated response of DSIR & CSIR to Rajya Sabha Secretariat.

10.1.3 Constitution of CSIR Thematic directorates created at RPPBDD

CSIR has put in place a new R&D management strategy for planning and participative performance of R&D projects through the formation of sector-specific theme based clusters. CSIR constituent laboratories across the country have been grouped under the Theme based Clusters: (i) Aerospace, Electronics, Instrumentation & Strategic Sectors (AEISS); (ii) Civil, Infrastructure & Engineering (CIE); (iii) Ecology, Environment Earth & Ocean Sciences and Water (E3OW); (iv) Mining, Minerals, Metals and Materials (4M); (v) Chemicals (including leather) and Petrochemicals (CIP); (vi) Energy (Conventional & Non-Conventional) and Energy Devices (EED) ; (vii) Agri., Nutrition & Biotech (ANB); and (viii) Healthcare (HTC). CSIR formalized its activities through above eight theme directorates to

(i) functionally derive synergy from complementary skills and expertise across labs;

(ii) bring in sector-specific industry focus;

(iii) inter-ministerial/ departmental interaction/ coordination;

(iv) align to Stakeholder needs: and

(v) enhance business focus.

Theme: Aerospace, Electronics, and Instrumentation & Strategic Sectors (AEISS)

The theme focus on design and development of critical technologies in different areas of aerospace, electronics and instrumentation specially for strategic sector. Under AEISS Theme, there were four sub-themes and their focus are as follows:

Name of the Sub-Theme	Focus Area of Sub Theme
I. Electronics & Instrumentation	Avionics, UAV technologies , Sensors & Instrumentation , Semiconductor/ Microwave devices , analytical & industrial Instrumentation , Optronics IOT technologies , Cyber security , ASICs etc.
II. Aerospace materials coatings & chemicals	Special materials, Pre-peg, Radomes, adhesives , coatings , carbon fiber, bio fuels stealth technologies etc.
III. Mechanical Systems	ECS, Hydraulics, Fuel sub systems, mechanical enclosures, Valves, actuators etc.
IV. Civil & Military Aviation	Civil Aircrafts, UAV, MAV, Fighter aircraft systems etc.

Theme: Civil Infrastructure & Engineering (CIE)

This theme cluster endeavors to significantly contribute to the development of national infrastructural assets and engineering industry through challenge-driven solutions based on research and development and industry-centric and common man centric innovative scientific interventions. The sub-themes and identified focus area of the theme as follows:

Sub-Theme	Focus Area
i. Building Materials, Construction & Chemicals (BRISK)	Green, sustainable and functional materials- Alternative to depleting construction materials and gainful utilization of industrial/construction/agro/ Municipal solid wastes
ii. Manufacturing, Robotics, Automation and Engineering (MORALE)	Mechanization and automation in manufacturing, construction and agriculture
iii. Roads, Bridges, System of Transportation and Tunnels (ROBUST)	Energy efficient housing and infrastructure
iv. Structural Engineering and Housing (STRENGTH)	• Smart and intelligent technologies in infrastructure and manufacturing • Resilient infrastructure for multi-hazard and disaster mitigation.

Theme: Ecology, Environment, Earth & Ocean Sciences and Water (E3OW)

This theme cluster endeavors to significantly contribute to the sustainable development of environment by addressing critical issues related to national Ecology, Environment, Earth & Ocean Sciences and Water through cutting edge innovative R&D and S&T solutions. The sub-themes and identified focus area of E3OW theme area as follows

Sub-Themes	Focus Area
i. Earth & Ocean Science	• Marine conservation • Sustainable coastal development • Reducing siltation of river mouth and harbour basin • Appropriate protection measures to combat coastal erosion • Understanding Role of sub-ducting ocean bottom features in modulating the seismicity in the Andaman region. • Understanding Tectonic setting responsible for frequent earthquakes (swarm) in the off Nicobar region. • Understanding Risk assessment due to submarine volcanoes in the Andaman region.
ii. Water & Wastewater	• River and Water Bodies Rejuvenation • Alleviating water crisis in remote areas and for poor population • Urban flood forecasting • Augmenting Water supply and treatment management • Contaminants incursion prevention to avoid additional costs/efforts in treatment
iii. Air Quality & Climate Change	• Improving Rural area cooking related air pollution control • Understanding Health impacts and development of warnings and tools for management • Devising Pollution control methods for Urban regions, Biomass, Municipal Solid Waste (MSW) burning, Vehicular emissions • Climate resilience cities, models for predicting future scenario

	• Determining role of Microbial communities on Dissolved Organic Caron (DOC) reservoir which plays role in regulating earth climate. • Impacts of climate change on biodiversity and adaptation strategies
iv. Waste Management and Remediation	• Integrated Solid Waste management for Cities • Resource Recovery, Waste Utilization and Disposal • Remediation of Contaminated sites • Recycle and reuse of wastes, domestic and industrial wastewaters • MSW management with big data analytics
v. Natural Resources & biodiversity	• Natural Resource Augmentation • Mapping of cold seeps to find locations of major methane fluxes associated with shallow methane hydrate • Possibility of discovering novel bioactive compounds from the chemosynthetic organisms in the cold seep ecosystem. • Environment Big Data Analytics and Supercomputing for solving Environmental Problems
vi. Environmental Policies & Regulations	• Policy documents for India's positions

Theme: Mining, Minerals, Metals and Materials (4M)

CSIR Theme Directorate 'Mining, Minerals, Metals and Materials' is one of the eight Theme Directorate, created in 2018. The theme directorate is envisaged to provide for larger alignment to and for enhancing industrial/stakeholder focus of CSIR R&D activities. It is focused on following areas:

(i) Prospecting, mining and extraction of rare earth, energy critical, noble and refractory elements;

(ii) Realizing metal values from leaner, finer ores and from recycled/waste materials;

(iii) Extraction of iron from magnetite ores;

(iv) Production of ultra-high purity metals and precursors of metals and ceramics;

(v) Technology for high purity spheroidal particles for additive manufacturing;

(vi) Materials for protection against extreme environments, radiation and high energy Impacts;

(vii) Advanced fibers and composites for engineering applications;

(viii) Digital and advanced manufacturing of lightweight structures;

(ix) Technology for coking coal from non-coking coals;
(x) Advanced refractories for metals, cements and other industries; and
(xi) Materials for prosthesis and bionic applications.

Further the activities of the theme have been distributed into five subthemes, Viz., Materials Design, Materials Development, Materials Engineering,Materials Manufacturing and Materials Sustainability.

Theme: Chemicals (including leather) and Petrochemicals (CIP)

Chemical (including Leather) and Petrochemicals is one of the eight Theme Directorates, created in 2018. The theme directorate is envisaged to provide solutions for sustainable Indian Chemical Industry. The sub-themes and identified grand challenges under each sub-them are provided below:

Sr. No.	Sub-Theme	Grand Challenge
i.	Bulk Chemicals and Marine chemicals	Potash import substitution
ii.	Petrochemicals and Lubricants	Green BTX
iii.	Polymers and Surfactants	Affordable biodegradable plastics
iv.	APIs (Pharma and Agro) (with emphasis on import substitution from Ministry list)	Import substitution
v.	Specialty and Performance Chemicals (Leather, Paper, Textiles, Fiber processing etc.)	Leather and Pulp Mill waste valorization to chemicals
vi.	Biomass valorization and bio based processes to value chemicals	Lignin conversion
vii.	Electrochemistry and Corrosion	Pipeline and heat exchanger corrosion
viii.	Coal to chemicals, C1 chemistry	Coal to methanol
ix.	Exponential technologies (Industry 4.0, block chain, AI, IOT, 3D printing, circular economy)	Material resource efficiency

Theme: Energy (conventional and non-conventional) and Energy devices (EED)

Energy Theme Directorate identified 4 sub-themes which included:

(i) Conventional Energy Technologies
(ii) Renewable and Non-Conventional Energy/Energy Systems

The sub-theme was further divided into four categories as below:

- Solar/Devices

- Biomass/Waste
- Gas Hydrates/Geo-Thermal
- Hybrid/Wind/Tidal

(iii) Energy Storage and Devices
- Fuel cell and associated activities
- Storage Materials and Battery Associated Devices

(iv) Environmental Issues

The grand challenges identified were aligned to national priority areas. Some of the areas identified included the following for prioritization of projects:

- Distributed Renewable Energy Hybrid Technologies customized for rural India;
- Energy Neutral (Net-Zero Energy) Buildings;
- Efficient Biomass/ Coal Gasification Technologies;
- Methanol Economy (Biomass/Coal to Methanol/DME/ blending);
- Solar inverters/ solar water pump inverters;
- Low quality coking coal beneficiation;
- Solar thermal drying systems at installed capital cost (including land cost) of less than Rs 1500 per Watt thermal;
- Technologies for large scale energy storage;
- Fuel Cell/ Batteries/ packs for EVs/strategic applications; and
- High efficiency (>15%) and high stability (10,000 hr) Dye-Sensitized Solar Cells/ modules.

Theme: Agri, Nutrition & Biotech (ANB)

Agri, Nutrition & Biotechnology theme is aligned to national priorities, sustainable development goals. The theme identified seven sub-themes viz ,

(i) Pre and post harvesting processing;
(ii) Agro technologies;
(iii) Processing and value addition;
(iv) Nutrition;
(v) Enzyme and Microbial technologies;
(vi) Metabolic engineering and synthetic biology; and
(vii) Fisheries and livestock, for above purpose.

Theme: Healthcare (HTC)

The Healthcare theme one of above eight themes, wherein the activities were categorized under 5 Subthemes i.e.(i) Disease Biology; (ii) Therapeutics (Bio therapeutics) ;(iii) Therapeutics (Chemical Therapeutics) ;(iv) Diagnostics & Devices; and (v) Regulatory & Safety. The Grand Challenges identified under this theme are:

(i) **Genomic Route to Preventive Healthcare (GRouP-Health):** Designing of diagnostics based on genomic information unique to Indian population and

carry out extensive analysis, preferable in the regions where there is evidence for high genetic disease burden.

(ii) **Medicines of Tomorrow (MeT) :** The challenges lies in integrating existing cutting edge technologies and creating exponentially greater capacity to provide precision medicine that addresses currently intractable problems in human health.

(iii) **Pushback Infections (PIn):** Despite the tremendous gains made through vaccines and drugs, people around the world find themselves still fighting some of the same old diseases: tuberculosis, malaria, viral infections (flu, dengue, encephalitis) etc. HTC has identified the need to draw new strategies and new approaches if we are to make any further progress, leave alone win the battle.

(iv) **Nutritional India [NuIndia]:** The role of micronutrients in health and disease is getting realised. Several forgotten micronutrients having small daily requirement also predict risk for common diseases. This extremely important challenge can be addressed by multiple CSIR labs. Capability exists to take indigenised approach – to do what is needed for our population and from our natural means.

(v) **Knowledge Integration with Translation [KIT]:** This is big impact making activity of connecting our knowledge to societal needs. Hand holding industry and entrepreneurs to rise to the needs of the society, being the prime goal of it.

RPPBDD organised the first meeting of the Nodal Theme Directors on 26th March 2018. Concept Notes were invited from the participating laboratories in each theme under various project categories namely, FTT/FTC and NCP/FBR for each theme.

10.1.3 Formulation of Facility Creation Projects

A new category of projects called Facility Creation Projects (FCP) was initiated during the reporting period. These projects aim at building new infrastructure or upgrading the existing one in order to meet new technological challenges and for generating revenues at the CSIR laboratories. Some of the facilities so created cater to the laboratories and the ultimate purpose to serve to other R&D and academic institutions. During the reporting period

10.1.4 CSIR Technology Awards

The CSIR Technology Awards were instituted in 1990 with a view to foster and encourage in-house multidisciplinary team efforts and external interaction for technology development, transfer, marketing and commercialization. These awards include: (i) Life Sciences; (ii) Physical Sciences including Engineering; (iii) Innovation; (iv) Business Development and Technology Marketing; and (v) Most significant CSIR Technology of the Five Year Plan Period (awarded to the best technology which has proven in the market place, at least for 5 years). Each award carries a cash prize of

Rs. 2 lakh (Rupees Two lakhs only), except the "Most Significant CSIR Technology of the Five Year Plan Period" which carries a cash prize of Rs.5 lakh (Rupees Five lakhs only). Besides, a plaque and a citation are also given to the awardees.

The Honourable President of India, Shri Ram Nath Kovind in presence of Dr. Harsh Vardhan, Hon'ble Minister of Science & Technology and Earth Sciences and VP CSIR gave away the CSIR Technology Awards 2017 to the winners in a specially organized ceremony on September 26, 2017, the CSIR Foundation Day.

10.1.5 Audit Inspection of CSIR

28 projects implemented under XI Plan period by 10 CSIR laboratories were audited by PDA. A detailed report covering several aspects/statements related to projects and its monitoring and implementation was received. The report was deconstructed to make project wise queries and forwarded to laboratories for providing factual replies. There were almost 300 queries. CSIR prepared factual response based on the inputs received from laboratories. The appropriate replies were prepared as per the format of Report Section. Subsequently, PDA forwarded Action Taken Notes/ Audit paras to be replied by CSIR. Applicable replies to ATNs were prepared and were forwarded to PDA for consideration.

Response to Audit para on AVRA (Drishti)

RPPBDD prepared CSIR Response to Para No. 5.3 titled "Unfruitful expenditure on supply of Automatic Visual Range Assessor (AVRA) Systems" pertaining to CSIR-NAL, Bengaluru received from the Principal Director of Audit. The audit commented that "National Aerospace Laboratories, Bengaluru could not operationalize Automatic Visual Range Assessor Systems –Mk1 at Indian Navy establishments even after more than 14 years resulting in unfruitful expenditure of Rs.1.10 crore". The AVRA are the previous versions of latest Drishti developed by CSIR-NAL. After number of interactions and information exchanges, the audit para was dropped by PDA.

10.1.6 Action Taken Note on 297th report of the Parliament Standing Committee

RPPBDD prepared the statement to be made by the Hon'ble Minister of State for Science & technology and Earth Sciences in both Lok Sabha and Rajya Sabha regarding status of Action Taken Report Note on the recommendations contained in the 297th Report of the Department related Parliamentary Standing Committee On Science & Technology, Environment & Forests

10.1.7 Parliament Questions

Directorate has prepared the suitable responses to Parliament Questions on varied issues such as performance of CSIR, financial details of CSIR laboratories, Development of S&T Linking S & T laboratories to the needs of the people , Budget Allocation For S & T , Expedition of research work to boost indigenous technology ,R&D in Earth Sciences, Biological changes of coastal seas, Waste Management

technology program, Medicinal plants, Development of New Drugs ,Clinical Trial of HIV patients,Scientific Publications , funds allocation for science research, Intellectual property exchange ,Brain Drain, AYUSH medicines for different diseases,Food Safety Mission etc. During the year, around 160 questions were replied including inputs to DST and other ministries.

10.1.8 CSIR Annual Report 2016-17

Based on the inputs received from all the constituent labs of CSIR and Divisions of Headquarters, Division prepared draft CSIR Annual Report for the year 2016-17. The report contains Executive summary, Scientific Excellence, Technologies developed, Central Management Activities, Headquarters Activities, list of cluster wise publications etc.

10.1.9 Security & Sensitivity clearance

The R&D proposals involving overseas scientists/ agencies were examined and deliberated in the Directorate from security and sensitivity angle. The proposals covered collaborations, agreements, MoUs. During the year twenty four proposals were processed by the Division. Some of the clientele covering these proposals were: DMT GmbH & Co. KG, Germany ; Hexcel, France ; Univ. of Adelaide, South Australia; Harper International Corporation, USA;GE, Ohio & Massachusetts; ISU EXACHEM Co. Ltd. Seoul, Korea ;PTB, Germany; UK consortium, UK etc.

10.1.10 CSIR-HARIT (formerly CSIR 800)

CSIR, during 12th Five-Year Plan operated CSIR-800 program for rural sector and successfully implemented 55 projects of 1-2 year duration; and benefitted more than 4.5 lakh people and generated revenue of about Rs.50 crores. Nevertheless, considering the population and the geographical extent of the country, a lot more needs to be done. In pursuance to directions of “Dr T Ramasami CSIR schemes review committee”, CSIR-800 is being revamped into CSIR-HARIT (Harnessing Appropriate Rural Interventions and Technologies).

The objectives of the CSIR-HARIT program are as follows:

- Enhancing incomes and quality of lives of 5 lakh rural people, contributing towards fulfilment of Sustainable Development Goals (SDGs)/ National Mission.
- Third party Socio-Economic Impact Assessment (SEIA) of identified 100 CSIR offerings for societal purposes already implemented on ground.

CSIR-HARIT being an umbrella program, individual projects would be submitted by CSIR laboratories after due diligence at lab level for direct contribution in socio-economic development of the rural people. Projects found suitable after rigorous

examination of proposals through structured process at CSIR headquarters level would only be supported. The program is under process of approval.

10.1.11 Field study to ascertain the effectiveness of different measures taken-up by OMCs on Benzene Emission at Petrol Stations in India- an RPPBDD coordinated project

In recent years, there is an increase in *'Benzene'* concentration in the air of major cities. *'Benzene'* is a carcinogenic and harmful chemical for human health and it gets into the air mainly from petrol vapors escaped during loading, unloading and refueling of petrol at petrol station. Therefore, immediate action was required to curb the *'Benzene'* emission in atmosphere to improve air quality of cities and minimize the economic losses by recovering petrol from its vapours. Under an PMO directives, in association with CSIR heaquaters (RPPBDD), CSIR-Indian Institute of Petroleum has completed a field study to ascertain the effectiveness of different measures taken-up by OMCs (Oil Marketing Companies) to curb benzene emission in petrol stations across the country. The sampling stations were selected based on geographical variations, status of installation of Vapor Recovery System (VRS), quantum of petrol sale, type of ownership (ROs & COCOs), both private and public-sector manufacturing companies etc. In addition, the study covered training provided by OMCs to the dealers and delivery sales men for safe handling of products, preventive maintenance of petrol stations, installation of leak detectors on pipelines, etc.

Typically, a low Benzene content (from 0.01 to 0.44 ppm) was observed in the forecourt of petrol stations where Vapor Recovery System (VRS) particularly Stage - II has been installed. These values are significantly lower than the imposed safer Short-Term Exposure Limit (STEL) i.e.,1 ppm of NIOSH's as mentioned earlier and much lower than the Factories Act of India. However, Benzene concentration in air as high as 2.89 ppm was recorded at petrol stations where there were no installed Vapor Recovery System (VRS). About 375 delivery salesmen interviewed for their health status few complained about headache, dizziness, vomiting, breathing problem, skin allergy etc., which might be due to long term exposure of petrol vapors. The field study recommended remedial measures and those were shared among stake holders for necessary actions.

10.1.12 Project formulation on Mob Control Vehicle (MCV)

RPPBDD coordinated the development and finalisation of a laboratory centric proposal of CSIR-CMERI titled 'Design and Development of Mob Control Vehicle (MCV)' with extensive involvement of appropriate stake holders including PMO. The proposal has been confirmed with MHA and RAF as participants. It was transferred to respective directorate for its implementation as an FTT (Fast Track Translational) project.

10.1.13 Brainstorming meetings on Non-Polluting Fire Crackers

With a demand for Non-Polluting Fire Crackers, Brainstorming Meetings were held during January to March 2018 at CSIR headquarters in presence of Dr. Harsh Vardhan, Hon'ble Minister, S&T, ES & EFCC and Vice President, CSIR and Dr. Girish Sahni. DG, CSIR. The meetings were also represented by members from Fireworks Research and Development Centre (FRDC), Sivakasi, High Energy Materials Research Laboratory, Pune, Central Pollution Control Board, Delhi, Dept. of Chemicals and Fertilizers, Delhi and Dept. of Commerce, Delhi. The brainstorming meetings were coordinated by RPPBDD.

Even though few state of art works on the subject are available at international level, not much progress are seen in India for having Non-Polluting Fire Crackers/Fire Works. CSIR is planning them in holistic manners with new dimensions by inclusion of both customary fire crackers as well as electronic non-polluting fire cracker substitutes. Successful ideas, required coordination and fireworks/ products need to be invented through R&D at CSIR to protect the economy as well as interest of stake holders were planned through the referred meetings with appropriate timelines.

10.1.14 CSIR Directors - Industry Leaders Interaction Meet

A CSIR Directors - Industry Leaders Interaction Meet was held on 19th – 20th June 2018 at Renaissance Mumbai Convention Centre Hotel,Powai, under leadership of Dr.Girish Sahni, DG CSIR, coordinated by RPPBDD and CSIR Theme Directorates. About 17 distinguished key leaders of various industrial theme participated in the meeting and interacted with Directors at CSIR laboratories. Prof. Srivastava, Dean, ISB provided an inaugural talk on Marketing and Monetizing Research and Innovation. Industry experts shared their business perspective and models as engine for commercialization of R&D as well as role of innovation by R&D organizations. These thematic Inspiration talks were followed by open discussion.

Fig.10.1.1. CSIR Directors- Industry Leaders Interaction Meet

10.1.15 Completion of review of 12th Plan Projects

CSIR as a part of 12th plan initiative has implemented a total of 159 projects under 13 thematic groups viz., (i) Adequate and Clean Energy; (ii) Advanced materials;(iii) Aerospace Engineering; (iv) Agri, Food & Nutrition; (v) Biotechnology and Biology; (vi) Drugs Discovery and Development / Healthcare; (vii) Earth System Sciences; (viii) Ecology and Environment; (ix) Electronics and Instrumentation;(x) Housing, Road, Construction, Structures and Safety; (xi) Information Sciences - Data intensive and Informatics; (xii) Mining, Metals and Minerals; and (xiii) Sustainable Chemical Industry. The goal was to address advancement of knowledgebase and development of technologies/products in associated S&T domains through concerted R&D efforts.

The abovementioned plan projects have been reviewed by 13 different thematic Sectorial Monitoring Committees comprising national experts from industry as well as academic/research organizations, constituted by DG, CSIR.

10.2 Human Resource Development Group (HRDG)

The Human Resource Development (HRD) Group has a mandate to develop and nurture S&T manpower at the national level. It also promotes, guides and co-ordinates scientific & industrial research through research grants to scientists/professors working in universities / R & D institutes. The activities of the HRD Group include: Selection of Junior Research Fellows (JRF) through National Eligibility Test (NET); Selection of Senior Research Fellows (SRF), Research Associates (RA), Senior Research Associates (SRA) and Shyama Prasad Mukherjee Fellows (SPMF); Award of Shanti Swarup Bhatnagar Prizes (SSB), CSIR Young scientist Awards (YSA) and GN Ramachandran Gold Medal; Funding of Extra Mural Research (EMR) Schemes at universities/ R&D organizations; Travel / Conference / Symposium grants.

Significant achievements of HRD Group for the period from April 2017 to March 2018 are as follows:

10.2.1 National S & T Manpower Development:

10.2.1.1 Junior Research Fellowship(NET)

CSIR-UGC National Eligibility Test (NET) June 2017 for Junior Research Fellowship and Eligibility for Lectureship was conducted on 18th June 2017 at 27 centres throughout the country. 1,85,148 candidates registered and 1,33,100 appeared for the examination. The result of CSIR-UGC NET June 2017 was declared on 30th November 2017. A total number of 3529 candidates qualified for CSIR/UGC Junior Research Fellowship & lectureship and 3732 qualified for lectureship only. Out of 3529 candidates qualified for JRF, 2029 are to be supported by CSIR and rest by UGC.

Subject	Chemical Sciences	Earth Sciences	Life Sciences	Mathematical Sciences	Physical Sciences	Total
Qualified-JRF	878	143	1278	604	626	3529
Qualified-LS	1016	151	1325	608	632	3732

The CSIR-UGC NET December examination was held on 17th December 2017. 2,36,321 candidates registered and 1,76,397 appeared for the examination. The result was declared on 9th May 2018. A total number of 5560 candidates qualified for CSIR/UGC Junior Research Fellowship & lectureship and 4442 qualified for lectureship only.

Subject	Chemical Sciences	Earth Sciences	Life Sciences	Mathematical Sciences	Physical Sciences	Total
Qualified-JRF	1391	236	2057	915	961	5560
Qualified-LS	1186	226	1707	637	686	4442

Out of 5560 candidates qualified for JRF, 4060 are to be supported by CSIR and rest by UGC.

10.2.1.2 Shyama Prasad Mukherji Fellowship (SPMF)

The objective of the SPM Fellowship Scheme is to identify and nurture budding scientific talent in pursuit of scientific research. Under this scheme, the fellowship is given to top JRF-NET scholars in five disciplines of basic sciences. During April 2017-March 18, SPM Fellowship was awarded to 30 students from five disciplines - two from Physical, three from Earth, four from Chemical, five from Mathematical and sixteen from Life Sciences .

10.2.1.3 Senior Research Fellowship (SRF) and Research Associate-ship (RA)

The expert committee meetings for the selections of SRFs and RAs in 18 disciplines were held during 2017-18. Out of total 2771 candidates called for interview, the candidates selected for SRF and RA were 723 and 170 respectively.

10.2.1.4 Senior Research Associate-ship (SRA) / Scientist's Pool Scheme

The Senior Research Associate-ship (SRA-ship) is primarily meant to provide temporary placement to highly qualified Indian scientists, engineers, technologists,

and medical personnel who are not in regular employment in the country and including those returning from foreign countries. During the year 2017-18, sixty nine(69) Senior Research Associates were selected and their total number as on 31st March 2018 was 151.

10.2.1.5 Junior Research Fellowship for GATE qualified engineering and pharmacy graduates (JRF-GATE)

CSIR introduced a research fellowship known as the Junior Research Fellowship (JRF)-GATE in 2002 for the GATE qualified candidates with BE/ BTech / BPharm degree to pursue research leading to PhD in engineering and pharmaceutical sciences. JRFs selected under this scheme get an excellent opportunity to work with CSIR scientists with state-of-art R&D facility. During 2017-18, twenty (20) JRF-GATE fellowships were awarded and around 88 JRF-GATE Fellows are working at present in different CSIR laboratories.

10.2.2 Promotion and Recognition of Excellence

10.2 2.1 CSIR Young Scientist Awards

The CSIR Young Scientist Awards (YSA) are given to scientists below the age of 35 years in 5 disciplines of Science & Technology (S&T) with the objective to recognize in-house excellence. In the year 2017, four scientists were selected for Young Scientist Awards, one each from Chemical Sciences and Physical Sciences(including Instrumentation) and two from Engineering sciences. These Awards were presented by Shri Ram Nath Kovind, Hon'ble President of India at the Foundation Day Function and Celebration of the Conclusion of CSIR Platinum Jubilee Year held on 26th September 2017 at Vigyan Bhawan, New Delhi.

10.2.2.2 Shanti Swarup Bhatnagar Prize for Science & Technology

The Shanti Swarup Bhatnagar Prize (SSB) for Science & Technology is given every year to Indian scientists below 45 years of age for their notable & outstanding contributions, applied or fundamental, in seven disciplines of Science & Technology. Name of the ten recipients of the Shanti Swarup Bhatnagar Prizes in 7 disciplines for the year 2017 were announced by Dr.Girish Sahni, Director General CSIR and Secretary, DSIR.

10.2.2.3 GN Ramachandran Gold Medal for Excellence in Biological Sciences & Technology

GN Ramachandran Gold Medal for Excellence in Biological Sciences & Technology is given every year for notable and outstanding research, applied or fundamental, in the interdisciplinary subject/field of Biological Sciences and Technology. For the year 2017, GN Ramachandran Gold Medal was presented to Dr. Kandala Venkata Ramana Chary, Tata Institute of Fundamental Research, Mumbai by Shri Ram Nath Kovind,

Hon'ble President of India at the Foundation Day Function and Celebration of the Conclusion of CSIR Platinum Jubilee Year held on 26th September 2017 at Vigyan Bhawan, New Delhi.

10.2.2.4 Funding of Extra Mural Research Schemes to promote R & D

CSIR provides financial assistance to promote research in the field of Science and Technology including Agriculture, Engineering and Medicine. It is given in the form of research grants to Professors/ Scientists working in Universities/ Academic Institutes/ IITs etc. The number of research schemes recommended and renewed during 2017-18 are as given below:

Schemes	No. of Proposals Considered	Proposals Recommended	Proposals Renewed
General	815	246	572
Emeritus Scientist	80	9	100
Sponsored	34	3	7

10.2.2.5 Travel / Conference Grants

Travel grant is provided by CSIR to young researchers for presenting research papers at International Conferences abroad. Total of 1310 travel grant applications from students were considered and 621 cases were recommended for support. Travel grant committee also considered 398 applications for travel support from regular employees and recommended 239 cases for support. For organizing national/international conferences/ symposia/ workshops etc., a total of 1637 proposals from universities/institutes/scientific societies etc were considered and 451 cases were recommended for support.

Schemes	Total Considered	Total Recommended
Travel Grant to students	1310	621
Travel Grant to regular employees	398	239
Symposia Grant	1637	451

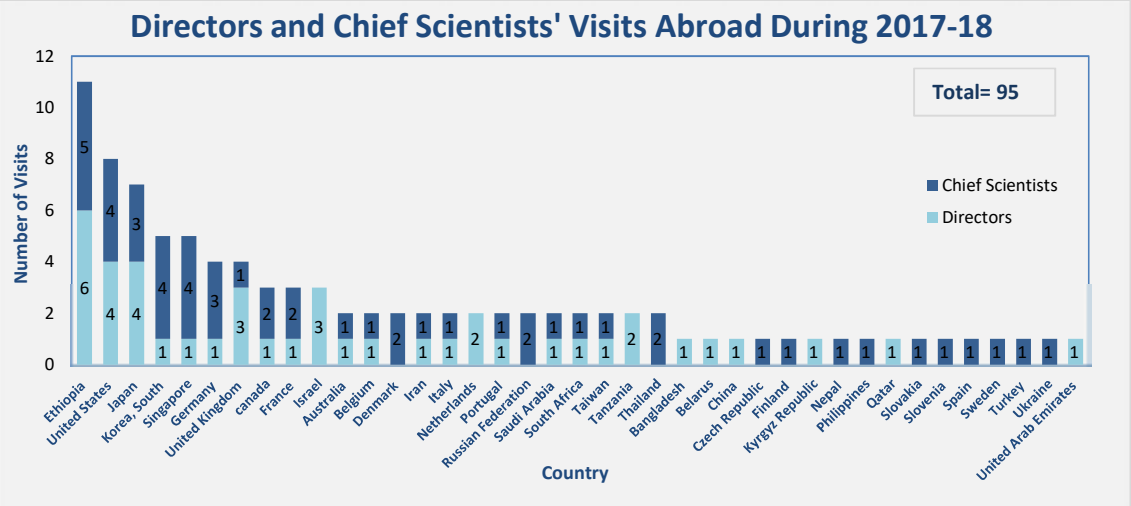
10.3 International S&T Affairs Directorate (ISTAD)

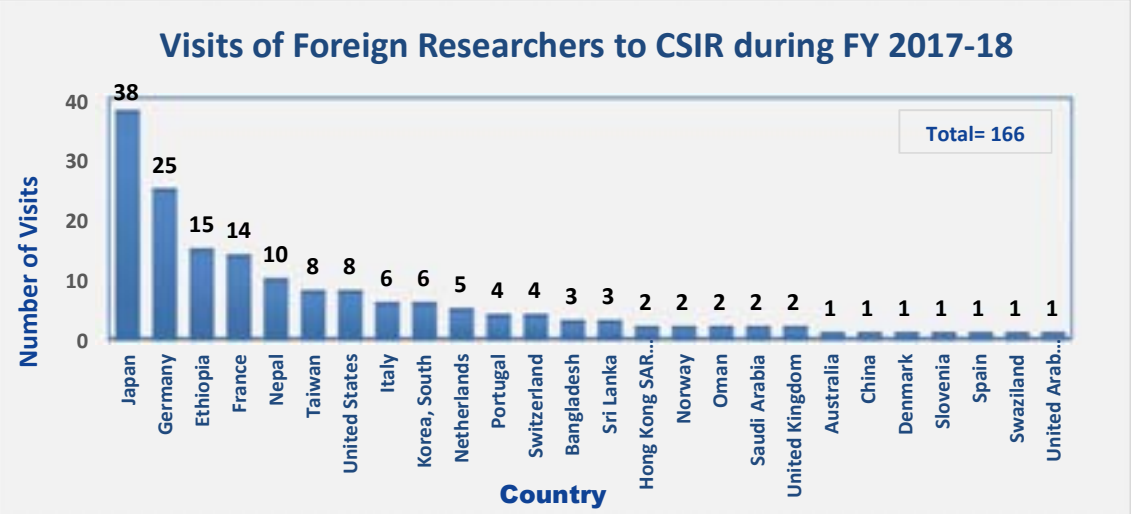
International S&T Networking

ISTAD continued playing a vital role in fostering and expanding CSIR's international partnerships by initiating new cooperation tools with leading international agencies across the globe, managing / supporting collaborative projects, joint / international workshops and conferences and coordinating scientific visits of CSIR delegations / scientists abroad and of foreign delegations / distinguished researchers to CSIR and its research institutes.

10.3.1. Scientific Interactions Through Exchange Visits

95 visits of CSIR Directors and Scientists 'G' were facilitated during 2017-18 as part of internalization strategy and for international benchmarking. These visits facilitated projecting CSIR globally. Scimago Institutions Ranking also positioned CSIR India as the 12th institution amongst the publically funded R&D institutions of the world.





166 scientists / research scholars from abroad visited CSIR institutes for collaborative projects, conference participation, business meetings and research internship programmes that further provided S&T networking opportunities.

10.3.2. BILATERAL COOPERATION

a) Country Specific Bilateral Cooperation

Australia

The collaboration between CSIR and Australian partners received an impetus through several collaboration activities and initiation of new bilateral cooperation linkages. Cooperation MoU between CSIR-NAL and University of New South Wales (UNSW) for collaboration in the field of Composite Materials and Structures was concluded on Apr 10, 2017 in the sidelines of the state visit of Australian Prime Minister to India. Also, cooperation between CSIR-CECRI and Deakin University (DU) for partnership on Corrosion Mitigation and Energy Storage (Batteries & Frontier Materials) was formalized through signing of MoU on April 20, 2017.

Fig.10.3.1. Exchange of MoU between CSIR-NAL and UNSW

The year witnessed several interactions with Australian partners. With an aim to promote CSIR partnership with Australia and establish and enhance Brand CSIR in Australian Continent, a 2-member senior level CSIR team visited Australia during July 24–28, 2017 to a) participate in Academic Sharp Brain event and Chemeca and RACI Conference by RMIT University, b) showcase CSIR's technological achievements in Chemical S&T by putting up a booth at the conference venue; and c) further technology and research partnership dialogue with Deakin University (DU), University of South Wales (UNSW) and Commonwealth Scientific and Industrial Research Organisation (CSIRO). Interactions were held with experts from DU and UNSW both in India and Australia. An Australia Roadshow was organized at IICT on 22-23 Nov. 2017.

Germany

Germany continued to be one of the most active S&T partners of CSIR. CSIR's network with major research agencies of Germany including BMBF, DLR, DAAD progressed well in terms of joint research effort.

CSIR - BMBF Cooperative Science Programme: Out of a total of nine ongoing projects, three of which started in 2016-17, four below listed research projects got successfully completed and one project was granted one year extension.

Topic	CSIR Inst.	German Institution	Outcome
Combustion and Emissions Characteristics of Diesel from Waste Plastics	CSIR-IIP	Friedrich-Alexander Universität Erlangen	Diesel from waste plastic (DWP) prepared and tested. It complied with most commercial diesel fuel (BS-IV) fuel specifications. Performance / exhaust emissions of engine fueled with DWP were found comparable with BS-IV
Alteration of caffeine content of coffee plants by manipulating plant xanthosine metabolism using TALEN genetic scissors	CSIR-CFTRI	Freie Universitaet Berlin	Indian coffee samples screened in German lab for Putative GSDA and NSH1 genes; CAS9 constructs of GSDA transformed to a highly virulent Agrobacterium strain "GV3101" at CFTRI which was confirmed by colony PCR using Kanamycin Hygromycin and CAMV primers. It was mobilized into coffee somatic embryos.
Light dependent flavonol biosynthesis by MYB transcriptions factors: Identification of interacting Factors	CSIR-NBRI	University of Cologne	Analysis of transgenic plants in various genetic background suggested a) involvement of HY5 in regulating expression of various MYBs and genes involved in biosynthesis of these medicinally important molecules; b) requirement of interaction of HY5 and MYB transcription to promoters of genes involved in flavonoid biosynthesis for regulation.
Thulium-doped fiber laser at 2 µm	CSIR-CGCRI	TU Braunschweig	Development of a) a universal simulation model for rare earth doped CW fibre lasers based on generic rate and gain

for Surgical Urology	equations - very compact, can be used for any fibre doped with one or several rare earth ions and b) High average power CW and pulsed laser with controllable pulse width, pulse energy and peak power at 1.94 µm suitable for blood less surgery in Urology.

With an aim to further STI cooperation with Germany through BMBF, a joint workshop co-piloted by CSIR-NEERI on "Sustainable Water Supply and Wastewater Management (disposal & re-use) - Research for Sustainable, Affordable Solution" was held at Delhi on Feb 26-27, 2018 with participation of 14 German and 17 CSIR experts. Intense Interactions were organized on five themes for the purpose of pre-proposal formulation. The interactions resulted in formulation of 12 pre-proposals that would be reviewed and recommended proposals will be developed into full technology development proposals.

CSIR-NAL – DLR Civil Aviation Partnership: A joint meeting between CSIR-NAL and German Aerospace Center (DLR) was organized at NAL on Jan 11, 2018 with participation of 3-member DLR team. The meeting underscored potential cooperation possibilities.

Linkages of CSIR with Germany got further boosted with the visit of H.E. Dr. Frank-Walter Steinmeier, President of the Federal Republic of Germany to CSIR-Institute of Genomics and Integrative Biology (CSIR-IGIB) on Mar 23, 2018. President was accompanied by his wife Mrs. Elke Büdenbender and several high ranking state as well as German Embassy officials.

Fig.10.3.2. Dr. Frank-Walter teinmeier at CSIR-IGIB

Italy

The ongoing CSIR-CNR, Italy exchange programme has the following projects and CSIR Labs involved. This is the last year for the completion of the projects.

SN	Title	Indian Partner
1	Development of catalytic renewable process by converting Indian origin non-edible oil to valuable chemicals	CSIR-NCL
2	A rapid high performance biosensor based on gold nano particle anchored graphene sheets for the elctrochemical detection of biomarkers and DNA mutations for clinical and environmental applications	CSIR-CECRI
3	Sonochemical synthesis of biobased composite materials for energy applications	CSIR-CECRI
4	Improved safe management of arsenic rich waste generated from arsenic removal plant	CSIR-CMERI
5	Design, Materials Development and Fabrication of Capacitive Micromachined Ultrasonic Transducer (CMUT)	CSIR-CEERI

Nepal

A 9-member Nepal Academy of Science and Technology (NAST) delegation led by its Vice Chancellor visited CSIR during July 3 - 10, 2017 under CSIR - NAST Exchange Programme. The main objective of the visit was to understand and identify potential partnership opportunities.

Fig.10.3.3. NAST delegation at CSIR, Rafimarg

During the meeting on 4th July with CSIR officials led by DG, CSIR, the delegation was presented the structure, programmes and policies of CSIR and also its major R&D accomplishments. Discussion was held on potential technology partnership opportunities. Visit of the delegation was organized to NRDC and CSIR institutes in

Delhi (CSIR- IGIB , CSIR- NISTADS , CSIR- NPL , CSIR- NISCAIR) and in Jammu (CSIR-IIIM) to acquaint them with the functioning of CSIR institutes and give them the first hand exposure to R&D effort of CSIR Institutes.

France

CSIR-CNRS Collaboration: A meeting between CSIR officials led by DG, CSIR and the delegation of National Center for Scientific Research (CNRS), France was held at CSIR HQs. on Nov 14, 2017 to discuss modalities of the CSIR-CNRS cooperation.

Fig.10.3.4. CNRS delegation at CSIR, Rafimarg

The meeting recommended a) reactivation of CSIR - CNRS MoU to include LIA, PICS, UMS in addition to Joint projects, b) senior-level visit to France to visit CNRS labs and identify research themes to formulate joint programs, and c) planning theme based workshops on topics of mutually interest.

Russia

Cooperation between CSIR institutes and their Russian partners received considerable boost by the CSIR as well as through cooperation programmes of DST.

CSIR/TKDL Rospatent Collaboration: During the India-Russia Annual Summit on June 1 2017 CSIR and the Federal Service for Intellectual Property (Rospatent) of Russia concluded an Agreement to provide access to Rospatent of India's Traditional Knowledge Digital Library (TKDL) database for objectively determining the prior art status in relation to the patent applications processed by Rospatent and prevent misappropriation of Indian traditional knowledge.

CSIR/IHBT - Lisavenko Institute Partnership: Under collaborative programme with Lisavenko Research Institute of Horticulture for Siberia, IHBT imported elite germplasm of Hippophae Rhamnoides (a high altitude plant with inherent capability to contain soil erosion, its fruit is rich in vitamin C, E and K, carotenoids, lycopene, sterols and dietary minerals) from Russia that have been introduced and are being evaluated at the Centre for High Altitude Biology at Lahaul and Spiti, Himachal Pradesh. To boost

Hill Economy these will be mass multiplied for distribution to farmers and entrepreneurs of high altitude region.

Japan

A Letter of Intent (LoI) for research collaboration between Hiroshima University and CSIR was concluded at Hiroshima University during the visit of CSIR delegation to Japan in October 2017. High Speed Vision and IOT were some of the areas identified for immediate action with CSIR-CEERI as the coordinating lab from CSIR. Joint projects are planned to be formulated for technology development with time-bound milestones. Hiroshima University has created a HU-CEERI Joint Lab for carrying out collaborative projects. Similar facility has also been created at CSIR-CEERI, Pilani. The Project will fund such facilities and visits of scientists directed towards specific technology developments.

Vice President HU visited CSIR-CEERI, Pilani on 10th December, 2017 and formally inaugurated a CEERI-HU Joint Lab at CEERI. This lab will anchor collaborative technology development in the area of high speed computer vision. HU will share the devices developed by them in this area and CEERI-HU will jointly develop state of the art technology in the area of high speed computer vision. The HU team also visited CSIR-CMERI on 11th December, 2017 and detailed out joint project partnership.

Fig.10.3.5. Signing of LoI during Visit to Hiroshima University

Hiroshima University (HU) held its first International Linkage Degrees Program (ILDP) on 17-18 January, 2018. DG, CSIR was invited as a Speaker during this program. Hiroshima University(HU) also organised a CSIR-HU Workshop on 19th January, 2018. This workshop intended to work out the detailed modality of research partnership and also to help identify areas for further research collaborations and knowledge partnerships. It would also facilitate possibilities of Student Exchange between the two organisations.

Iran

CSIR-CIMAP, Lucknow is India's focal point for Indian Ocean Rim Association (IORA)

Fig.10.3.6. DG CSIR with Secretary General IORA at the event of MoU Signing

on widespread subjects related to medicinal plants since May 2014. In the second meeting of the Medicinal Plants Focal Points of the IORA Regional Centre for Science & Technology Transfer (RCSTT) was held at Lucknow in March 2015, in which representatives of the IORA member states unanimously proposed to entrust the task of coordination of all the activities related to Medicinal Plants in the IORA to CSIR-CIMAP. Subsequent to the approval of the Ministry of External Affairs, Govt of India for establishing IORA-RCSTT coordination centre at CSIR-CIMAP, Lucknow, and keeping in view the importance of Iran among Indian Ocean Rim Countries Association, Ministry of External Affairs suggested to hold the MoU signing ceremony between CSIR-CIMAP, Lucknow and IORA-RCSTT, Tehran at the Ministry of Foreign Affairs, Tehran. For this purpose, the draft of MoU was prepared by CSIR-CIMAP, which was endorsed by CSIR, headquarter, New Delhi; JS (IOR), MEA, Government of India, New Delhi and IORA-RCSTT, Tehran. Ministry of External Affairs, Government of India invited Dr.Girish Sahni, Director General, CSIR, Prof. Anil K Tripathi, Director, CSIR-CIMAP and Dr. Ajit K Shasany, Head, ISCD, CSIR-CIMAP for the MoU signing ceremony to be held at Tehran. Keeping in view the importance of this programme, Ministry of External Affairs, Government of India also invited the newly appointed Secretary General of IORA H.E. Dr. Nomvuyo Nokwe to grace the occasion.

Ethiopia

CSIR has entered into an agreement with the Metal Industries Development Institute (MIDI), Ethiopia to implement a "Twinning Programme on Capacity Building to Transform Metal Industry Development Institute (MIDI)". The agreement was signed by the Director of NML, Jamshedpur on behalf of CSIR, India and the Director General of MIDI on 7th June 2017. The financial compensation to the twinning partners (CSIR laboratories) for the twinning program for three-year duration is US$ 6,806,000. This multimillion dollar international project was clinched by CSIR through an internationally competitive process and it is one of the largest programs between a CSIR institute and a foreign entity. Five CSIR laboratories (i.e. NML, CMERI, CEERI, CSIO and CLRI) are involved to implement the program and NML is the Coordinating Nodal Lab for the program. These five laboratories, complementing each other and together, provide the

ideal knowledge and expertise fountainhead for MIDI to embark on its capacity and capability building. They will share their domain expertise in the matters of organization, structure, functional efficiencies, metals processing, manufacturing and post-processing, through twinning with MIDI. The principal objective of this transformation program is to enhance the competitiveness of the metal and engineering industry through speeding up the transformation and development of the sector, through a transformation of MIDI into a globally competitive center of excellence in the field of metals and metals manufacturing. The benefit will have a great impact on Ethiopian metals industries. The need for a Twinning arrangement for Capacity Building of Metals Industry Development Institute (MIDI) has been established through the TOR document prepared by MIDI and the GAP analysis carried out by the experts of the CSIR, India. Thereafter, a proposal for twinning program was made which included the activities plan and strategies to transform MIDI into a centre of excellence focusing on the technical skills development, soft skills development, management system enhancements, curriculum development, laboratory establishment activities, and industrial services activities of MIDI. A team comprising scientists from the five participating labs (CEERI, CSIO, CLRI, CMERI & NML) had visited the Metal Industries Development Institute (MIDI), Addis Ababa, Ethiopia this year (5-16 March, 2018) to finalize the activity schedule and agreed upon the starting date of the project from 1st April, 2018 with a duration of 3 years. The MIDI had sent the 1st installment (0.8 million USD) of the advance payment for the programme. The CSIR labs have started their respective activities as per activity schedule.

Fig.10.3.7. Signing of Twinning Agreement and Visit of MIDI personnel to CSIR

Taiwan

CSIR and Industrial Technology Research Institute (ITRI) signed a MoU on Oct 12, 2017 to promote and support technology based partnership.

Fig.10.3.8. MoU signing CSIR and ITRI

It was proposed to initially focus partnership in three areas, viz, Engineering, Automation, and Biomedical & Health Research. Specific technologies / R&D topics Divya Nayan, Sensor Fablab, Standards, Renewable Energy, Innovation Ecosystem) were identified and cooperation concept notes were prepared followed by intense thematic interactions.

b) CSIR's Participation in Inter-governmental S&T Cooperation Funding Programmes:

Twenty Three (23) collaborative research projects were awarded to CSIR institutes under inter-governmental bilateral / multilateral S&T cooperation programme and by the joint / national / international organizations with a total grant of **Rs. 1740.505 lakhs.**

These projects were scrutinized from security & sensitivity angles and approved for implementation by CSIR institutes in collaboration with their foreign partners:

SN	Country	CSIR Institutes	Topic	Funding Programme	Funding (Rs in Lakhs)
1.	Australia	CSIR-NIIST	Large Area Opto-Electronics for Australia and India: From Materials to Advanced Devices"	DST-Australia-India Strategic Res. Fund Prog.	143.69
2.	Germany	CSIR-NAL	Design, fabrication and characterization of high-NA lenses with dielectric Huygens metasurfaces"	DST-DAAD Project based Personnel	07.19

				Exchange Programme	
3.	France	CSIR-CCMB	Directing the ballet of Meiotic chromosomes: regulation of Separase and control of Monopolar Kinetochore orientation"	IFCPAR Scientific Research Programme	60.04
4.	France	CSIR-NAL	Model Based Design Solutions for Migrating from Hydraulic to Electrical Actuation Systems"	Collaborative programme between TDB and Bpi France of CEFIPRA	99.00
5.	France	CSIR-NML	Developing Effective Extraction and Separation Tech. to extract Rare Earth Elements from Waste (Electrical/ Electronic) Equipment	IFCPAR Industry-Academia R&D Programme	46.71
6.	Norway	CSIR-CDRI	Drug targeting for improved treatment of multi-drug resistant tuberculosis (MDR TB)	ICMR- NRC	78.80
7.	Poland	CSIR-IICT	New Semiconductors Based Solution-Processed Small Molecule for Opto-electronic Devices	DST-MNISW	19.00
8.	Portugal	CSIR-CGCRI	Ultra-broadband light sources based on modified nano-engineered silica glass optical fibers doped with bismuth/ multiple rare-earths for OCT applications	Indo–Portugal Joint Research Programme	17.27

9.	Portugal	CSIR-NIIST	Developing magnetic nanoparticle immobilized enzyme catalysts for biofuel applications	Indo–Portugal Programme	17.49
10.	Italy	CSIR-CIMAP	Development of nature inspired bivalent antiubulline as anticancer agents"	Indo-Italian S&T Cooperation programme	45.91
11.	Italy	CSIR-IIP	Development of catalysts for converting biomass derived synthesis gas to fuels via Fisher Tropsch synthesis”	Indo-Italian S&T Cooperation Programme	12.30
12.	Italy	CSIR-NEERI	Geophysical Methods to Monitoring Soil Bioremediation”	Indo-Italian S&T Cooperation Programme	26.635
13.	Japan	CSIR-CFTRI	Investigating Catalytic Mechanism and Regulation in Era and EngA and Their Role in Ribosome Biogenesis	India-Japan S&T Programme of Cooperation	5.80
14.	Japan	CSIR-IMTECH	Comprehensive Understanding of Cellulae Response to amyloid toxicity at molecular level	India-Japan S&T Programme of Cooperation	5.42
15.	ROK	CSIR-NAL CSIR-CSMCRI CSIR-CEERI	Research on Human Centered Robotics with special emphasis on Field and Biomedical Rehabiliation: implemented by CSIR-NAL, CSIR-CMERI, CSIR-CEERI	DST-MSIP Joint Centre Programme	56.10 66.00 56.10

16.	ROK	CSIR-IICT	Strategic biorefinery platform with integrated bioprocess in a self-sustained closed loop for multi-biobased product output	Indo-Korean Joint Programme of DST	34.13
17.	Russian Federation	CSIR-CCMB	New chromatin insulator-associated factors in Drosophila"	DST-RFBR Cooperative Science Prog.	20.3
18.	Russian Federation	CSIR-IICT	Development of novel heterocyclic compounds as inhibitors of influenza virus neuraminidase"	DST-RFBR Cooperative Science Prog.	24.44
19.	Russian Federation	CSIR-NAL	Development of High Energy Density Piezoelectric Material for Vibration Energy Harvesting"	DST-RFBR Cooperative Science Prog.	31.37
20.	Russian Federation	CSIR-NIIST	Investigation of structural, optical, magnetic properties and electronic structure of binary intermetallic alloys for the spintronic application"	DST-RFBR Cooperative Science Prog.	11.25
21.	Sri Lanka	CSIR-CSIO	Design and Development of Detection and Extinguishing Systems for Forest Fire using Sensor Networks, Aerial, Ground Robots	Indo-Sri Lankan Joint Research Programme	91.25
22.	Sri Lanka	CSIR-IHBT	High throughput genotyping to expedite the genetic characterization	Indo-Sri Lankan Joint Research Programme	96.31

			and dissection of important agronomic traits of tea		
23.	United States	CSIR-CBRI	Improving Building Energy Efficiency"	Indo-US S&T Forum Cooperation	668.0

c) Twinning of CSIR institutes with their partners abroad

With an objective to enhance mutually beneficial subject specific collaboration, Institute to Institute level research linkages were promoted. The following cooperation arrangements were approved for signing during the report period:

I. **Mauritius**: MoU between CSIR-NIO and Mauritius Oceanography Institute (MOI) for cooperation in Marine S&T (climate, ballast water, bio-fouling, pollution and other coastal issues, bio-statistical analyses marine pharma & marine food) was concluded on May 27, 2017 during the VVIP visit from Mauritius to New Delhi.

II. **France**: Agreement for setting up of International Associated Laboratory (LIA) on “Natural Products and Synthesis towards Affordable Health” at CSIR-IICT with multiple partners from France to work together for a period of four years to create knowledge wealth in chemistry at the interface with life sciences towards affordable health care, was supported and approved.

III. **USA:** Agreement between CSIR-CDRI and National Cancer Institute, USA to undertake exploratory research to develop new generation redox based compounds through modulation of inflammatory processes was approved and concluded.

IV. **Netherlands :** Agreement between CSIR-CDRI and Stichting Katholieke Universiteit, The Netherlands was concluded for jointly implementing research for Investigation of the role of lipid droplets by Fluoranthene derivatives in dendritic / myeloid cells.

V. **Switzerland :** MoU between CSIR-IICT and Drugs for Neglected Diseases Initiative (DNDi), Switzerland for implementing research for development of new drugs for the treatment of neglected tropical diseases in open source domain.

10.3.3. MULTILATERAL COOPERATION

a) NAM S&T Centre

Networking with the member states of the NAM S&T Centre was encouraged by organizing participation of four CSIR scientists in 3 relevant workshops organised by NAM S&T Centre in Iran, Zimbabwe and Sri Lanka

b) BRICS S&T Framework

Three (3) research projects out of 26, were bagged by CSIR institutes for funding by DST under BRICS S&T Programme

Research Topic	Partners		
	Partner 1	**Partner 2**	**Partner 3**
Loop "Nano-Engineered Concrete for Sustainable Infrastructure"	CSIR-CBRI	V.G. Shoukhov Belgorod State Technological University, Russia	University of Jinan, China
ADHNMS "All-dielectric and hybrid nanoantennas for multifunctional sensors"	CSIR-CSIO	Saint Petersburg National Res. University of Information Technologies, Mechanics and Optics (ITMO), Russia;	College of Optical Science and Engineering, Zhejiang University, China
Platinum Nano "Platinum as an essential element in an integrated process for efficient energy conversion"	CSIR-IIP	Department of Chemical Engineering, University of Cape Town, South Africa;	Brazilian Synchrotorn Light Laboratory, Brazil

10.3.4. Human Resource Development

a) **Capacity building of CSIR Scientists through Raman Research Fellowship (RRF) Scheme**

As part of HR initiatives to give advanced exposure to CSIR scientists and to promote research networking, CSIR continued its in-house fellowship programme. Following nine promising CSIR scientists were selected for grant of Raman Research Fellowship for 2017-18:

SN	Name and Designation	CSIR Institute	Period	Host Institute
1.	Dr. Arup Ghosh Senior Scientist	CSIR-CSMCRI	3 Months	Faculty of Engineering & Mathematics, **University of Applied Sciences,** Bielefeld, **Germany**
2.	Dr. Ashutosh Kumar Shukla Senior Scientist	CSIR-CIMAP	2 Months 15 Days	**Albert-Ludwigs-University**, Freiburg, **Germany**
3.	Dr. E Bhoje Gowd Senior Scientist	CSIR-NIIST	3 Months	Department of Chemical Engineering, **National Tsing Hua University, Taiwan**
4.	Dr. Ashok Kumar Mohanty Senior Scientist	CSIR-NML	3 Months	Department of Polymer Chemistry, **Kyoto University, Japan**
5.	Dr. M.B. Anoop Principal Scientist	CSIR-SERC	3 Months	Laboratoire Navier, **Ecole des Ponts ParisTech,** **Université Paris-Est, France**
6.	Dr. Mahanth Prasad Senior Scientist	CSIR-CEERI	4 Months	Computer & Systems Engineering Department **Rensselaer Polytechnic Institute, New York, USA**
7.	Dr.Umesh Kumar Tiwari Scientist	CSIR-CSIO	3 Months	Nano-Optics and Forces Team, **Institut Néel, France**
8.	Dr. Gowda Rudraswami Senior Scientist	CSIR-NIO	4 Months	CRNS, Centre de Recherches Petrographiques at Geochimiques (**CRPG), Nancy, France**

9.	Dr. Krushna Chandra Gouda Senior Scientist	CSIR-4PI	4 Months	School of Env. Sciences, Roxby Building, **University of Liverpool, Liverpool, UK**

b) **Capacity building of foreign researchers**

With an aim to provide training and advanced exposure / award higher educational degrees to researchers from developing countries, thereby enhancing CSIR brand, CSIR continued the CSIR-TWAS Fellowship Programme Twelve (12) researchers from Nigeria (7), Cameroon (3), Ghana (1) and Rwanda (1) were awarded the Doctoral Fellowship, whereas seven (7) researchers from Nigeria (3), Egypt (3) and Uzbekistan were awarded Postdoctoral Fellowships to pursue research in CSIR-NIIST, CSIR-CFTRI, CSIR-IMMT, CSIR-CMERI, CSIR-CECRI, CSIR-CDRI, CSIR-CSIO, CSIR-NGRI, CSIR-IIP, CSIR-CECRI, CSIR-CFTRI, CSIR-NIIST, CSIR-IICT, CSIR-NGRI, CSIR-NBRI, and CSIR-NIIST.

10.3.5. International Conferences / Workshops Organized with participation of international experts

Nine (9) international conferences / workshops / courses enhancing international recognition of CSIR, were organized by CSIR institutes with due approvals of the competent authorities.

SN	Event	CSIR Institute	Dates and Venue
1.	International Symposium on 8th East Asia Symposium on Functional Dyes and Advanced Materials (EAS8)	CSIR-NIIST	Sept. 20-22, 2017; Thiruvananthapuram
2.	International Conference on Emerging Trends in Biotechnology for Waste Conversion (ETBWC)	CSIR-NEERI	October 8-10, 2017; Nagpur
3.	Newton Fund Researcher Links - UK-India Workshop on Energy for Economic Development and Welfare	CSIR-IIP	October 23-27, 2017; Dehradun
4.	7th Asian GWADI meeting cum Workshop on Ground-water Hydrology: Safeguarding Water Security in Semi-	CSIR-NGRI	November 26-30, 2017; Hyderabad

	arid regions through Integrated Water Resource Management		
5.	International Workshop on Implementing 2°C and below 2°C - compatible Climate Change Mitigation Scenarios: Implications for India's Coal Sector	CSIR-CIMFR	December 1- 2, 2017; Dhanbad
6.	International Conference on Sustainable Manufacturing, Automation and Robotics Technologies (IC-SMART 2017)	CSIR-CMERI	December 15-16, 2017; Durgapur
7.	International Congress for Cell Biology 2018 (ICCB-2018) on The Dynamic Cell: from Molecules and Networks to Form and Function	CSIR-CCMB	January 27-31, 2018; Hyderabad
8.	Course on Marine Robotics	CSIR-NIO	February 9-19, 2018, Goa
9.	International Conference on Cell Death in Cancer and Toxicology (CDCT-2018)	CSIR-IITR	February 20-22, 2018; Lucknow

Fig.10.3.9. 7th Asian GWADI meeting cum Workshop on Ground-water

Fig.10.3.10. International event at CSIR institutes

10.4 Human Resource Development Centre (HRDC)

CSIR-HRDC had an eventful year in 2017-2018. It has organized a record breaking 56 programmes. That drills down to more than one programme a week. Hence, the pace of the Centre was more than healthy in catering to the dynamic and vibrant needs of CSIR at large. Broadly, the programmes were having training, skill development, orientation, induction, capacity building, competency development, awareness creation, sensitization and collaboration as their objects.

In all, there were 2543 participants for programmes organized last year (It was 1268 during the corresponding period in the previous year). Out of this figure, 23 were the Directors themselves from different labs, 598 were S&T personnel, 200 were Common Cadre personnel, 1714 were of mixed, cross-functional groups and 31 were non-CSIR participants. The whopping number may prompt one to liken CSIR-HRDC to a Corporate University where both strategic organizational goals and tactical traditional training needs are achieved through concerted efforts.

2017-18			
Programme Category	**Programme Subcategory**	**No. of Programmes**	**No. of Participants**
S&T	Directors	01	23
	Scientists	10	291
	Scientists & Technical Officers	08	176
	Technical Officers	03	108
	Technicians	01	
Total		**23**	**598**
Non-S&T	Administration	03	78
	Engineering Services	-	-
	Finance	01	58
	Store & Purchase	01	35
	Hindi Programme	01	29
Total		**06**	**200**
Cross Functional	Women Scientists & Officers	01	14
	General	25	1700
Total		**26**	**1714**
Non-CSIR	Managerial/Executive (Exclusively for Central Electronics Ltd)	01	20
	S&T based (Co-attended by CSIR in 2 instances)	-	11
Total		**01**	**31**
Grand Total		**56**	**2543**

Strategic intent Vs Tactical adeptness:

The Centre has prioritized between its strategic intent and tactical adeptness very well in the said period. On the one hand, the Centre was planning out programmes based on the perceived/felt/unmet needs in line with its mandate i.e., promoting professional and holistic HRD in CSIR. On the other, the Centre rose to the occasion in response to both internal calls and stimuli from the external environment. The former approach churned around 32 such programmes for various target groups such as S&T personnel, exclusively for technical personnel, women scientists/officers, Common Cadre personnel and last but not the least personnel from non-CSIR organizations as well. The latter approach required around 40% of the programmes to meet the needs of such demand-driven scenarios. This aspect shows the Centre's youthfulness, adaptability and resilience to organize itself based on the impulses, and not just based on straight road according to the annualized calendar.

Under the programmes as per the annualized calendar of the Centre, various aspects were touched through programmes on IPR, Socio-economic impact of R&D, Leadership, S&T communication, Technology transfer, Creativity and innovation, Value creation out of scientific research, Technical consulting and flagship induction programme for building organizational and other competencies of the newly recruited scientists. One exclusive programme for Directors in the field of finance was also organized last year in one of the attempts as part of many paradigmatic changes made at the top level to make CSIR a premium technology business organization. Capacity building, Orientation, Managerial effectiveness and Competency development were the aspects covered for inducted and middle level Technical personnel last year. For Common cadre personnel, two officers' level programmes and two assistants' level programmes were conducted. Amongst women-centric programmes, three programmes focused on work-life balance, sexual harassment at workplace and gender sensitization. Remarkably, the well-received programme "Workshop on Gender Sensitization and Sexual Harassment of Women at Workplace: Prevention, Prohibition and Redressal" held during March 2018 at Lucknow had 400 CSIR participants, making it the sole leader in terms of the number attended. An exclusive programme for library professionals and S&T personnel managing the Knowledge Resource Centres of various CSIR labs was organized. Under non-CSIR categories, the Centre had blended approaches: Delivering Programmes for payment and Being a conduit for CSIR labs' self-sustainable programmes. In all, four such programmes were organized last year.

Programmes were organized for e-Procurement implementation in CSIR, Vigilance and related matters, Implementation of RTI Act and Record management, Accounting software and Hindi Workshop. In fact, the series of programmes on vigilance and tendering was prompted by a directive from CSIR HQ to educate the S&T and non-S&T staff of all CSIR labs. A significant stimulus from external environment last year was of GST implementation and related matters. CSIR-HRDC conceived an Awareness series on GST and organized it in different locations of the country covering all the CSIR labs including CSIR HQ.

Remarkable Firsts for CSIR-HRDC in 2017-2018:

There were many firsts for HRDC, since its inception in 2002, during last year. The Centre executed a **Consultancy project with Central Electronics Ltd of DSIR** to cater to their training needs on a time-bound manner. The Centre designed and imparted Managerial Effectiveness skills to CEL's junior and senior officers in three stages. The last of the batches got their training imparted last year thus successfully completing its first ever consultancy project. This kind of Programmes-for-payment is one business model that the Centre has successfully demonstrated.

The Centre also organized three select, open programmes where CSIR labs had core competence. Two Workshops on **Evaluation of Measurement Uncertainty and ISO – 17025** and one Workshop on **Managing Corrosion in the Oil and Gas Sector** were these programmes where CSIR-HRDC played a conduit for some CSIR labs. CSIR-CSIO, CSIR-NPL, CSIR-IIP and CSIR-CECRI partnered with the Centre in such efforts last year.

Fig.10.4.1. Induction training for Scientists, 15-24, January 2018

Fig.10.4.2. Workshop on "Technology Commercialization and Transfer" in association with UN-ESCAP, APCTT , 1-3, November 2017

Training Programme on Socio-Economic Impact Assessment of R&D Outcomes, Programme on Creativity and Innovation for Rural Societies and Certificate Programme in Technical Consulting were newer programmes organized during last

year in tune with the changing times and deliverables expected out of CSIR in the current scenario. As target groups, library professionals and managers of KRCs all over CSIR were invited for the first ever time for a Capacity Building Programme. The programme would prove noteworthy sooner than later in the dynamic context of modern digital libraries.

Fig.10.4.3. CSIR Leadership Development Programme, 22-26, May 2017

10.5 Information Technology Division (ITD)

The major achievements of the Division during the year are as follows:

(i) GIGW compliant CSIR website

The Division facilitated continued up-gradation and up-dating of CSIR website 'https://www.csir.res.in', in compliance with Govt. of India Guidelines (GIGW). The CSIR website conforms, closely as possible, to the Minimum-Required-Content as per the guidelines laid down by several Nodal Ministries and Departments of Govt. of India including Ministry of Electronics & IT(MeitY), Department of Administrative Reforms and Public Grievances (DARPG), Ministry of Personnel, Public Grievances and Pensions, and DSIR.

(ii) PAN CSIR Video Conferencing System

The division facilitated the management and technical support for CSIR-wide, state-of- the - art High Definition Video conferencing facility for CSIR scientific groups and its laboratories. It includes VC sessions for monitoring of various R&D programs, projects and other monitoring activities. Besides the increased productivity and efficiency, significant cost on travel has been saved during the year by conducting more than 60 VC sessions per month (point to point and multiparty). The division

regularly supported office of DG, CSIR for DG addressing all CSIR Laboratories through VC on key occasions such as Technology day, New year etc. This facility has been extended to all the CSIR Labs/ Institutes and its units including CSIR Science Centre.

The Division also facilitated monthly PRAGATI-VC sessions, for monitoring of various inter departmental projects by O/o Hon'ble Prime Minister of India with all Govt. of India Secretaries.

(iii) Webcasting

The division facilitated live webcasting of several central events, such as address by Hon'ble Prime Minister from Vigyan Bhawan on CSIR Foundation day function along with Video Conferencing with premium educational institutes. Webcasting is being supported every year from Vigyan Bhawan to facilitate all Scientific Community and Staffs of CSIR.

(iv) Implementation of e-procurement (C-PPP) portal for CSIR & its labs

For increased transparency and efficiency in procurement, the division contributed as nodal division for PAN CSIR including labs and coordinated with NIC for implementation of e-tendering through central procurement portal. The CSIR and its laboratories saved enormous budget and able to bring transparency in procurement process.

(v) ICT Infrastructure upgradation

To its continued endeavor to empower the scientists, officials and staff, the division facilitated replacement of aged hardware (computers/laptops/printers/Scanners etc for many divisions.

(vi) Supporting IMPACT and other Legacy Software

The Division coordinated and facilitated Finance division of CSIR Hqrs for processing financial data for preparation of their balance sheet and various financial reports to be submitted by CSIR. The technical support for section specific legacy application softwares such as Recruitment, R&I, ISTADS, monitoring /follow up cases by O/o DG CSIR have been maintained by the division.

(vii) Implementation and management of Andhra Enabled Attendance system (AEBAS)

The Division contributed as nodal division for implementation and management of Aadhar Enabled Attendance system (AEBAS) system in CSIR its labs along with implementation of IP based surveillance system.To meet the surveillance requirement, the division implemented IP based surveillance system for CSIR Hqrs and in Science Centre also.

(viii) Coordination with CSIR Labs for IT/ Cyber policies Implementation

The Division coordinated with CSIR Labs to implement IT related policies and followed up for their compliance by all the CSIR Labs.

10.6 Mission Directorate (MD)

Mission Directorate, created in July 2016, has been assigned with the responsibilities of implementing Fast Track Translation (FTT) Projects, Mission Mode Projects (MMPs) and New Millennium Indian Technology Leadership Initiative (NMITLI) Scheme. In addition to its core responsibilities, the Directorate has assisted in organizing mega CSIR events, business and industry meet, providing inputs to DG, CSIR on various subjects, audit and parliamentary questions. detailed activities of directorate are given for the year below.

10.6.1 Fast Track Translation (FTT) Projects:

The Fast Track Translation Projects (FTTs) is a new initiative of CSIR that provides implementation of close to market, business driven projects, in any area of technology or application, without thematic restrictions. Philosophy behind these projects is to build up trans-disciplinary teams in the laboratories including scale up, down-stream processing, characterization, validation and trials to deliver innovation onto the market and/or into society nurturing cross-sector cooperation. The aim is to reduce time from idea to market, stimulate the participation of cross-section of scientists and technical personnel towards a defined goal. During 2017-18, 139 FTT projects were under implementation. FTT projects have been conceptualized on the basis of leads developed under various projects of XII Five Year plan. These projects are of duration 18 months to 24 months with emphasis on product/technology development.
Some of the selected products and technologies developed under FTT projects are given below:

Waterless Chrome Tanning Technology- a Game Changing Technology

Chromium is the most sought after tanning agent with about 2.0 billion sq. ft. of leather being made in India. About 20 thousand tons of chrome tanning agent is discharged in the wastewater. In order to overcome the problem, CSIR-CLRI has developed waterless chrome tanning technology. Significance of this technology is that a) it completely eliminates two processes before and after tanning, b) eliminates the use of water in tanning, c) reduces the total dissolved solids in wastewater from this process by 20% and also d) brings down the usage of chromium by 15-20%, resulting in material saving.

Fig.10.6.1. PAN India acceptance of Waterless Chrome Tanning

The waterless tanning technology has now found PAN INDIA acceptance, with tanners in all clusters enrolling for its adoption. The technology has been put to use in about 50 tanneries in the country. Several countries including Ethiopia, South Africa, Netherlands, New Zealand, Vietnam and Brazil have evinced interest in this CSIR technology. A delegation from Sri Lanka is visiting CSIR-CLRI to witness the technology on September 29, 2017. This is truly a game changing technology that has emerged from the CSIR through CLRI.

Zero liquid discharge leather technology

A zero wastewater discharge process technology based on Electro-oxidation (EO) has been developed for the first part of the leather manufacturing process, the pre-tanning processes. The potential environmental benefits and potential social impacts for India includes: No discharge of wastewater from tanneries; The possible reduction of cost will be about Rs. 96 million per annum from reduction in the cost of wastewater treatment; This system does not result in generation of sludge (about 160 tons' sludge per annum) and less average annual fatalities due to release of H_2S. The technology has been transferred to M/s Leayan Global Pvt ltd, Kanpur; M/s Royal Tanners, Kanpur; and AN Leathers Pvt Ltd, Agra.

Fig.10.6.2. Electro-oxidation based zero wastewater discharge process

High Grade Gelatine and Protein Hydrolysate from Raw Hide and Skin Trimming Wastes

Gelatine is widely used in the pharmaceutical industry to make capsules for drugs as well as in the food industry to make jelly candies, ice cream, and as thickening agent in cakes and soups. Leather processing generates huge amount of raw trimming wastes. CSIR-CLRI has developed technology for making high grade gelatine from waste material-trimmings of raw hide. The technology developed by CSIR-CLRI is towards complete utilization of proteinous constituents present in the trimmings. This technology is exclusively licensed at a cost of rupees one crore to M/s Anipro Manufacturing Company for making gelatine and protein hydrolysate within India.

Fig.10.6.5. Value addition to waste material-trimmings of raw hide

Coal dust collecting and briquetting system

Haul and transport roads are the major generating source of particulate matters for an opencast mine. These particulate matters not only create environmental problem but also pose health hazards. It is pertinent to collect the dust from mine roads and put it to alternative use not only for reducing air pollution but also for improving the health of local populace. Road dust collecting system has been developed. CSIR-CIMFR has transferred the patented technology to M/s Tata Motors Limited, Mumbai. Field trial of road dust collecting system has been carried out in 2 mines of Jindal Saw Limited, Bhilwada, Rajasthan and Hindustan Zinc Limited.

Fig.10.6.4. Value addition to waste material-trimmings of raw hide

Field trial of road dust collecting system has been carried out in 2 mines of Hindustan Zinc Limited and Jindal Saw Limited, Bhilwada, Rajasthan.

Genomics and other Omics tools for Enabling Medical Decisions (GOMED)

CSIR-IGIB has developed a unique platform leveraging its expertise and clinical collaborative network in disease genomics to enable equitable access to genetic testing for patients and caregivers. The platform encompasses capillary sequencing-based genetic test panels encompassing a variety of disease conditions and specialties including Movement Disorders, Motor Neuron Disease, Familial Stroke, Mitochondrial Disorders, Developmental and Inborn error of metabolism, Leukodystrophies and Ophthalmological diseases. The technology enables molecular diagnosis in many genetic diseases leading to evidence based therapy, genetic counselling and prenatal testing.

Around 80 genetic test panel have been developed and deployed through more than 4000 referrals from around 30 hospitals across the country. More than 14,000 tests have been performed till date enabling a unique model for accessible genetic testing in India. The project enabled community level screening of patients with genetic diseases in Buldhana, near Nagpur where SCA3 is of high prevalence. The knowhow of genetic tests developed is now commercially licensed to M/s Dr Lal Path labs.

Fig.10.6.5. Knowhow of genetic tests being licensed to M/s Dr Lal Path labs

Comprehensive pipeline for diagnosis of mitochondrial diseases using next-generation sequencing technology (NGS for mitochondrial diagnosis)

CSIR-IGIB has developed a NGS based technology knowhow for diagnosis of mitochondrial diseases. The knowledge base developed encompasses a comprehensive pipeline, including experimental methodologies to sequence mitochondrial genome using next generation sequencing and appropriately analyze and interpret the data. The commercial application of the knowledgebase would enable fast and accurate diagnosis of mitochondrial genetic mutations with implications in Clinical diagnosis, Prenatal testing and Carrier screening. This technology has been licensed to a M/S Eurofins Clinical Genetics India Pvt Ltd, Bengaluru, India. It is marketed as MitoSure by the industry.

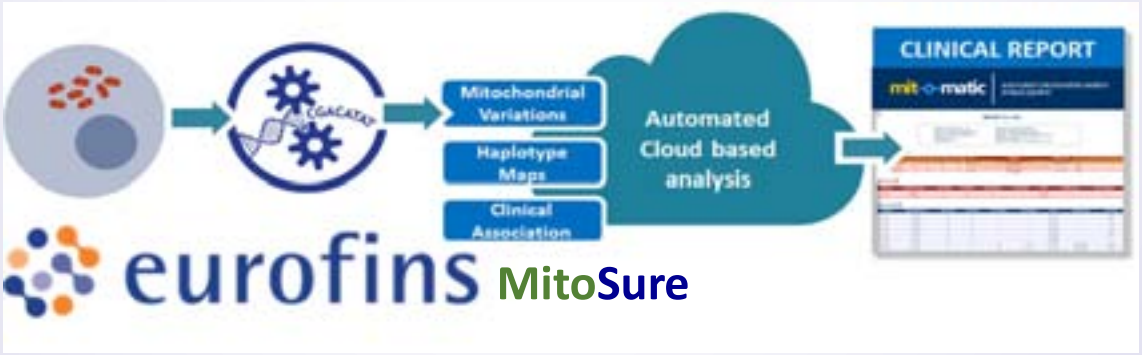


Fig.10.6.6. The advent of next-generation sequencing (NGS) technology

Paper-based affordable microfluidic kit for early pregnancy detection in cattle and buffaloes

CSIR-CCMB in a FTT project has identified a biomarker from dung sample for early detection of pregnancy in cattle and buffaloes. Using this biomarker, an affordable, rapid, easy to use, paper-based prototype kit for early detection of pregnancy is

developed. The prototype of the kit is non-invasive, easy to use at onsite and do not requires equipment or cold chain. The pregnancy can be detected within 3-4 weeks of conception. The prototypes have been tested in laboratory environment and are being tested onsite in field involving dairy farmers. The device would help dairy farmers to detect pregnancy at an early stage and plan for pregnancy management and artificial insemination as needed. This will lead to improved milk production resulting in economic benefit to the farmers. Early detection of pregnancy will have strong socio-economic impact on farmers and dairy industry.

Fig.10.6.7. Kit for early pregnancy detection in cattle and buffaloes

Development of Novel Processes towards Eribulin, Nicotine, Bedaquiline

Under the FTT project, CSIR-IICT has developed bench scale processes for all these three molecules. In all three cases, the developed routes are new and cost-effective. Eribulin (anti-cancer drug) fragments are made in less number of steps, Nicotine is made in one-step, which was achieved using flow-chemistry and Bedaquiline (anti-MDR TB drug) synthesis was achieved from commercially available starting material in low-cost. Eribulin-API synthesized in mg scale and one of the key fragments of Eribulin process has been demonstrated to industry. Nicotine has been successfully synthesized in 100g scale while Bedaquiline synthesis has been achieved on 2g scale. Pilot scale synthesis for these molecules is now being carried out. The developed process for Nicotine has been demonstrated to the industry on 100 g scale.These three molecules are key drugs for human health care

Jet Fuel Derived from Biomass: A Step towards Green Aviation

CSIR-Indian Institute of Petroleum (CSIR-IIP) has developed a process as well as a catalyst to produce jet fuel based on biomass-derived non-edible oils such as jatropha oil. The bio-jet fuel has been able to match all the major specifications for aviation fuels

such as petroleum derived jet fuel. The process developed is very similar to refinery processes and hence can be integrated into the current refinery infrastructure.

Thebaine-rich Opium Poppy Lines through Narcotics Department

Thebaine has $500 to $600 million market in Canada and a multibillion-dollar market in the United States. The demand of opium alkaloids stands at 260 tons per annum in 2016. India produces 3 tons thebaine annually. CSIR-NBRI has developed an improved line of opium poppy producing 10% thebaine, against 1-2% in normal variety.

Fig.10.6.8. Opium Poppy

Calliterpenone for Enhancing Crop Yields

The widespread application of agrochemicals to intensify crop cultivation is known to severely affect the arable soils. CSIR-CIMAP has developed a novel plant growth promoter "Calliterpenone" from an important medicinal plant *Callicarpa macrophylla*. Calliterpenone is about 6 times cheaper to GA3. It is estimated that the application of calliterpenone, which contributes to improved growth and yield of the plant, would reduce the application of fertilizers, growth hormones, etc and hence would reduce the cost of cultivation by 10% and simultaneously enhance the yields by at least 10%.

Calliterpenone is eco-friendly and promotes population of beneficial soil microorganisms like *Rhizobium* and *Bacillus* and retards the detrimental effects produced by allelochemicals. The process for isolation of the molecule and its activity as growth promoter has been patented in many countries. The technology was released for commercial exploitation involving beneficiary farmers.

A Calliterpenone based natural formulation named CIM-UPAJ has also been developed. It is being validated in the farmers' field.

Agrotechnology Transfer and Thymol Crystal from Jammu Monarda

CSIR-IIIM has introduced *Monarda citriodora* in the country. The variety was named Jammu Monarda. The institute has developed agrotechnology and post-harvest processing technology of Jammu Monarda. The essential oil possesses high level of antifungal activity against common post-harvest fungal pathogens of a variety of crops both by direct contact and in the vapor phase. The essential oil contains high amount

of thymol (70-85%) and carvacrol. The demand of thymol containing essential oils is increasing every year. Essential oil of Jammu Monarda has been accepted by pharmaceutical houses as an additional and alternative source of thymol. The prevailing price of the oil in Indian market is Rs.1500/kg.

Novel cost effective process for high purity solar salt production from high sulfate containing brines (particularly for Rajasthan inland/lake brines)

CSIR-CSMCRI has patented a process for high purity salt production. The technology deals with improvement in salt purity and whiteness through chemical treatment of brine in Rajasthan, which typically contain high amounts of carbonates, bicarbonates, suspended impurities and micro algae. Thus, the salt is upgraded from edible to industrial grade and will meet the requirements of chlor-alkali industry in the adjacent areas.

The developed process has been validated at pilot scale in the solar salt works of a private salt manufacturer supplying salt to the chlor-alkali industries. The process has resulted in upgradation of solar salt quality as per the desired specifications of chlor-alkali industries.

Membrane based process technology for commercial production of biomolecules

CSIR-NEIST has developed knowhow for commercial production of oxyresveratrol and natural dyes. A low cost process has been developed for production of high purity biomolecules, which has great market potential. The developed process is membrane based process for separation and purification of biomolecules and is less energy intensive.

Pilot plant studies with a scale up capacity to 2kg of oxyresveratrol per day has been established and the technology for production has also been demonstrated to entrepreneurs. After membrane treatment 98% pure product has been obtained. MOU has been signed with M/s Sira Naturals.

Setting up 1 TPD pilot plant for converting waste plastics to diesel

As a potential solution to address the growing menace of plastic usage and the associated waste generation in the country, CSIR-IIP has developed a facile process for the conversion of waste plastics (polyolefins) to value added hydrocarbons e.g. gasoline, diesel and aromatics.

A 1 TPD plant is being set up at CSIR-IIP for converting waste plastics to automotive grade (Euro IV/VI diesel) with support from GAIL. The development requires pre-treatment facilities for validation of the bench-scale studies for production of diesel and establishment of various technological and process parameters that would facilitate successful commercialization / licensing of technology.

A consolidated biomass process for integrated production of multiple products from fresh marine macroalgae

Seaweed farming has been initiated by CSIR-CSMCRI following tube net method using the seed germplasm maintained at CSIR-CSMCRI cultivation farm at Simar (near Una), Gujarat. The work is focused on scale up and validation of integrated process at pilot plant scale. Ms. HiMedia Laboratories, Mumbai has agreed to take active part in the project by purchasing seaweed produce from beneficiaries from time to time as per prevailing market rate.

The innovation applied in this technology has potential to form marine-based macroalgal biorefinery. It would also open prospects for establishing seaweed bioprocessing industry, creating employment for coastal rural community and promoting socio-economic development of the region.

Anacardic Acids: A potential molecule to increase cotton fibre yield and quality

CSIR-NBRI has developed a formulation, which improves cotton yield. Proof of concept has been established with multi-location trials. The multi-location trials in different cotton growing states showed 10-15% increase in yield of popular cotton hybrids. The formulation also brings earliness in boll bursting. The formulation works by augmenting actions of phytohormones involved in cotton boll development.

Design of Noise Barrier based on different Frequencies:

Globally noise Barriers are not designed based on their disturbing frequency. Frequency based noise barrier design gives highest reduction of noise compared to all existing designs at the same cost. Frequency based noise barriers designed and developed by CSIR-CRRI for the first time in the world. These noise barriers would drastically reduce noise level (about 42 decibel) and improve quality of life in noise affected areas.

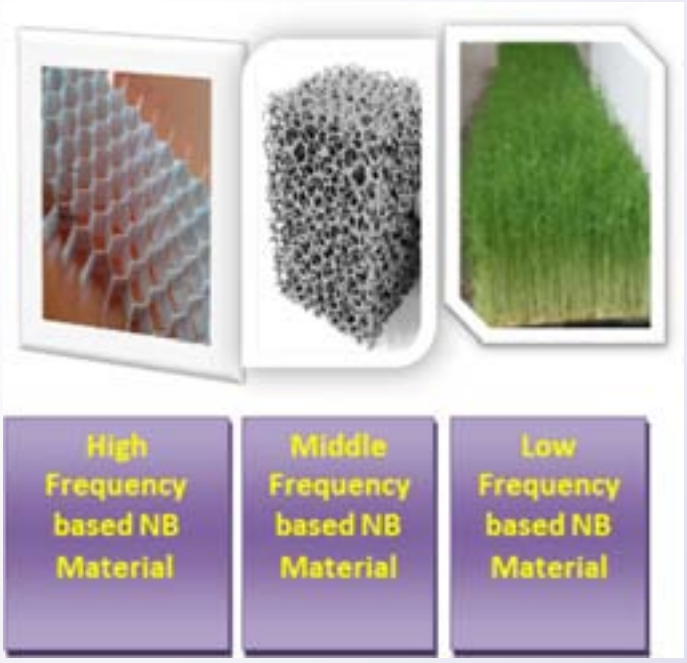


Fig.10.6.9. Design of new noise barriers

Building Products using Kota Stone Cutting and Slurry:

A technology has been developed for recycling and utilization of solid and slurry wastes in making tiles, paver blocks and cellular blocks by CSIR-CBRI. The developed items meet the requirements of Indian Standard Specifications. The utilization of high volumes of Kota stone slurry waste in lightweight concrete leads to higher strengths than that of normal lightweight blocks. The technology would help Kota Stone Industry of Rajasthan in disposing off the huge generated waste economically without effecting the environment. The technology has been transferred to Rajasthan State Pollution Control Board, Jaipur for mass deployment.

Fig.10.6.10. Tiles, Paver blocks, Wall titles & Lightweight blocks using Kota stone wastes

Glass Textile Reinforced Concrete Crash Barrier System:

As of today, the most popularly used crash barrier is made up of reinforced concrete, which has high rigidity but poor energy absorption. When a vehicle collides with such crash barrier, the vehicle is seriously damaged and occupants may be fatally injured due to the impact of the collision. Keeping in mind the safety of road users, a ready to use pre-fabricated Glass Textile Reinforced Concrete Crash Barrier System has been designed and developed by CSIR-SERC. Methodology has also been developed for connecting the pre-fabricated glass textile reinforced concrete crash barrier to ground and to the side barriers to maintain integrity in the event of collision. The developed crash barriers are lighter in weight, flexible and elastic with ability to absorb the energy of vehicle impact. It would provide improved safety to the vehicle passengers and result in less damage to the impacting vehicles. Technology has been demonstrated and negotiations are underway for technology transfer.

Fig.10.6.11. GTRC Crash Barriers

Precast Ferro-cement Toilet Core Unit (Prefer Toco):

CSIR-SERC has developed a Precast Ferro-cement Toilet Core Unit (Prefer Toco) technology as a solution for quality and speedy construction of toilets which are required on a massive scale, especially to promote the Swachh Bharat mission. The developed Toilet Units are modular and portable and requires minimum site work. The developed technology improves the speed of construction, quality and durability to overcome the deficiencies in masonry and plastic toilet structures. It would provide column heads for load transfer, natural day light and ventilation to overcome the deficiencies in existing precast/prefabricated ferro-cement toilet units and suitable for making cluster of toilet which is not in practise. The cluster toilets developed with common centre wall reduces the cost of toilet units about by 22%. The technology can be used at rural panchayats / municipalities, Schools and colleges, Public toilets and Bus stands / railway stations. Technology has been transferred to M/s Laxmi Srinivas Engineers, Hyderabad and M/s Fractal Enterprise, Vishakhapatnam for commercialization.

Single toilet core unit

Multiple toilet core Unit

Fig.10.6.12

Indigenous 4-axis controller for multi-process micro machine:

Micro machines are to be imported from foreign countries and that leads to enhanced procurement and maintenance cost. Furthermore, it becomes difficult for small-scale industries and educational institutions / engineering colleges to procure such systems for machining and skill development respectively due to high cost of the such machines. To address the same, CSIR-CMERI has developed a low cost micro

machine test bed which houses an indigenously developed controller, software and graphical user interface that can conduct four micromachining operations i.e. micro turning/ micro milling/ micro drilling/ micro patterning in a single desktop system (60 cm X 60 cm). The developed system can be used by small and medium scale micro-machining industries such as Surgical tool industries, Jewellery making industries etc. besides skill development in engineering colleges for imparting training on CNC machine operations. Technology has been transferred to two industries on non-exclusive basis for commercialization.

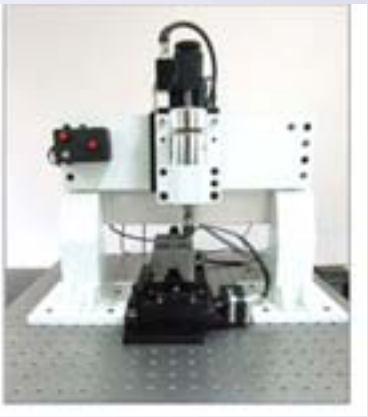


Fig.10.6.13 Prototype fo the developed system

Graphene Based Aqueous Lubricant:

Technology for production of graphene based aqueous lubricant has been developed by CSIR-CMERI to replace graphite-based imported lubricant extensively used in hot-forging industries. The developed lubricant is affordable and has minimum wastage with no nozzle clogging and almost no deposit on the shop-floor. No extra additive or preservative is required for storing the lubricant and it can be stored as solid powder and require only mixing before use. It is not affected by bacterial attack or bad odor due to temperature change. The scaled-up graphene production technology (200g/batch) has been transferred to a specialty chemical company, Auropol Pvt. Ltd., Kolkata.

Fig.10.6.14. Graphene Based Aqueous Lubricant

Micro Fuel Cell:

Micro fuel cell is a power source for electronic devices that converts chemical energy into electrical energy. The scaled down fuel cells can be used in electronic devices such as digital cameras, radios, toys and other low power applications. CSIR-CMERI has developed cost effective, simple and easy to fabricate micro fuel cell for use in low power applications. The developed micro fuel cells are light weight with high energy density, rechargeable and re-usable and can generate 1.5 V, ~1000 mAh per cell which can be stacked upon to extract more energy (~ 1W). The developed liquid based fuel cell can undergo in-situ charging-discharging process like batteries,

Fig.10.6.15.

eliminates the complexities associated with micro fuel cells and can contribute in the development of affordable and novel rechargeable batteries to meet the growing need of energy of low power applications. Technology has been transferred to M/s Victor Industries Pvt. Ltd., Sangli, Maharashtra for commercialization.

Technology for manufacturing of ADI components for mining application: In mining industry sharp digger teeth are being used for ground penetration, enabling the excavator to dig with the least possible effort. At present digger teeth are manufactured from cast steel material. The cast steel digger teeth wear out faster in comparison to indigenously developed ADI digger teeth.

Fig.10.6.16. Digger Teeth developed with ADI technology

To address the same, CSIR-CMERI has developed process technology for manufacturing of ADI components for mining application. The technology has been demonstrated on L&T CK -300 Excavator machine for more than 500 hrs of operation at Eastern Coal Field Limited. Excavator digger teeth made with developed ADI technology has superior wear resistant properties and offers good combination of low cost and a high strength to weight ratio. Durability of Digger Tooth would increase which reduces operational cost. Technology has been transferred to M/s Mahalaxmi Auto Industries, Jamshedpur, Jharkhand for commercialization.

Intelligent and Powered Wheel Chair:

Affordable, intelligent and powered wheel chairs have been designed and developed. It is a differentially driven model where two of the central wheels are used for power and rear wheels have active suspension mounted casters. The design provides enhanced mobility and stability and capability to turn full 360 degrees in any narrow corridor. It can also go up slant pavements, maintaining stability. It offers high degree of maneuverability to navigate smoothly on ups and downs. Its light weight components (main body and seating) decreases the overall weight without compromising on safety. It has fully electronic soft touch control, infrared based safety warning and safety belt, collapsible and foldable foot rest, interchangeable seating with on board charging facility and better night vision capability. The market value of the Powered Wheel Chair is ranging between Rs. 90,000/- to Rs. 3,00,000/- . The envisaged cost of the developed technology/product is approximately Rs 35,000/- to 40,000/-Simultaneously the system has immense societal value for the physically challenged people, old age population for mobility and

Fig.10.6.17. Wheel chair

rehabilitation purpose. The technology has been transferred to M/s S.S. Udyog, Kolkata.

System for detection of adulteration in milk (KSHEER-SCANNER)

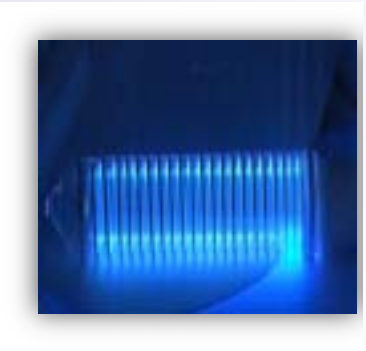
CSIR-CEERI, Pilani, a constituent laboratory of CSIR has developed an Adulteration Detection System named as "**Ksheer Scanner**". Based on electrochemical measurements involving electronic tongue, the system is capable of detecting milk samples adulterated with spurious chemicals and other adulterants such as; urea, caustic soda, hydrogen peroxide, detergent, liquid soap, boric acid and salt. It is an automated, real-time, fast and low cost instrument for detection of synthetic adulteration in milk that can be deployed at milk collection centres and can screen sample taken from every bucket / can of milk being brought by individual milk supplier in a rapid fashion thereby ensuring minimization of the problem of adulteration at the lowest point in the milk chain. The system also represents the first fully Indian 'concept to implementation' effort in the milk related instrumentation sector. The developed technology of the Ksheer Scanner has been transferred to two industries i.e. M/s Rajasthan Electronics & Instruments Limited (REIL), Jaipur & M/s Alpine Technologies, Surat.

Fig.10.6.18. Ksheer Scanner

Mercury-Free Plasma UV-Lamp

CSIR-CEERI has developed mercury-free plasma UV lamp technology: "A novel dielectric barrier discharge (DBD) based portable UV / VUV source for water disinfection" which can replace UV light sources used in household water purifier systems, storage / sewage / waste water treatment plants, municipality water treatment plants. Further, application specific systems can be developed for sterilization of food, medical equipment, surfaces, ill skin conditions, air-conditioners and air fresheners for hospitals, titanium coated toilet sterilization in trains, water supply in trains and buses, portable water purifiers for soldiers, outdoorsmen, farmers, etc. It is a much superior alternative for the presently used mercury based UV lamps

in the market. It has multiple competing features like: Filamentless light source, no end sleeves, negligible start-up time, scalable in dimensions, easily repairable, broad wavelength coverage due to dimer (or molecular) radiations, medium pressure lamp and mercury free. The Know-how of the technology has been transferred to two industries for its mass production and these are: 1) M/s YOUWE (UV) Purifiers, Jaipur; 2) M/s ARKEN Techno Pvt. Ltd., Pune.



Developed MFP-UV-Lamp of O.D. 18 mm and arc length 195 cm

Commercially available systems assembled with CSIR-CEERI made MFP-UV-Lamp

Portable water purifier system

Fig.10.6.19. Mercury-free plasma UV lamp technologies of CSIR-CEERI

Dual Energy X-Ray Image Analysis Technique for Material Discrimination

CSIR-CEERI has developed a technology using material discrimination based on atomic number of scanned items and pattern recognition techniques algorithms, threat objects in baggage can be found. Using this technology, baggage checking can be automated to a certain degree and dependence on operator can be reduced drastically. The system can alert the operator when it finds anything suspicious (auto-detection) instead of completely relying on the operator. Its multiple features including determination of atomic number and density of scanned material items; 16-bit grey scale image data acquisition; dual-energy X-ray image fusion; based on atomic number, the material items are labelled and displayed as 3-color & 6-color images; separate image processing functionalities are provided for density image, organic stripping, inorganic stripping and metal detection; display of density image; high density alarm; user-friendly graphical interface; hardware security enabled software; and two identical materials of similar thickness belonging to different categories can be segregated. The technology has been transferred and commercialized by M/s Krystal vision Image Systems Pvt. Ltd., Pune.

Dual Energy X-Ray Baggage Scanner

X-Ray Material Discrimination Software Integrated with Baggage Scanner

Fig.10.6.20. Dual Energy X-Ray Image Analysis System

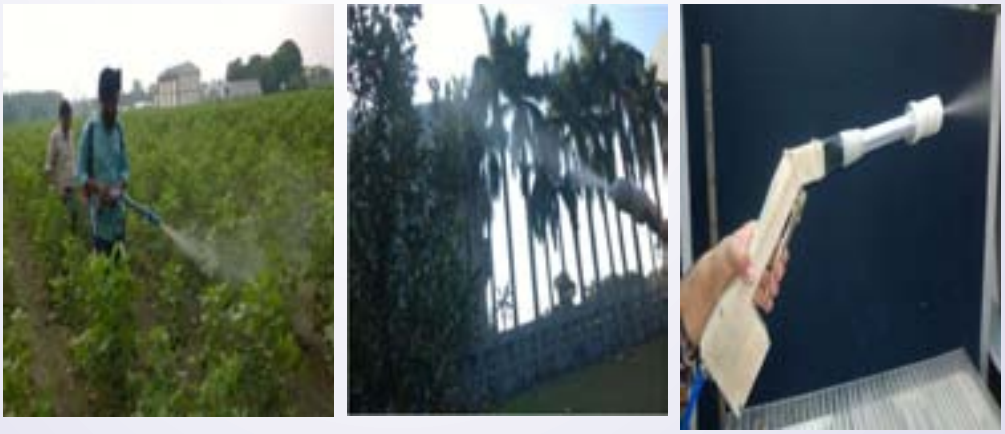
Gas Sensor System for Environmental Monitoring

Environmental pollution is a growing problem of developing nations. CSIR-CEERI has developed Gas Sensor System to detect NH_3, CO and H_2S which can be extended for other gases detection like C_2H_5OH, C_3H_7OH, etc. Sensors are realized using MEMS technologies and are based on metal-oxide semiconductors as sensing film .These sensor responds to gases in <1-2 minutes with recover to base line) up to 95 (%in <3 minutes . MEMS Gas sensor can operate at <100 mW, whereas non-MEMS)without cavity (Gas sensor, which are rugged, require power <600 mW. Sensors have excellent minimum detectable limits i.e. 10 ppm) NH3(, 100 ppm) CO(, 25 ppm) H2S(, 250 ppm) C2H5OH (and 250 ppm) C3H7OH.(Technology for “Ammonia)NH_3 (gas sensor system” has been transferred to M/s Macwin India, New Delhi.

Fig.10.6.21. Gas Sensor System to detect NH_3, CO and H_2S

Electrostatic spraying technology for societal and industrial applications

CSIR-CSIO has designed and developed a new air-assisted electrostatic nozzle for small scale farms with a specific focus on Indian agricultural and rural developing economies. This nozzle is light weight, highly efficient, reduces pesticide use and human health risks, and eco-friendly. An air-assisted electrostatic nozzle is a blend of an air-assisted nozzle and induction based electrostatic charging system. Spray droplets are electrified to more than 10 mC/kg charge-to-mass levels by charging voltage less than $2.0\ kV$, electric power consumption less than $75\ mW$. It covers all the liquid based pesticides with full charging efficiency. The product developed is totally indigenous which costs approximately Rs. 0.75 Lakhs (development cost) with all the accessories which is very cost effective comparison to imported product from the foreign competing agencies. It's also an internationally patented technology (PCT). The know-how of the developed technology has been transferred to two industries: M/s.Jagatsukh Industries, Pakhowal Road, Passi Chowk, Ludhiana and M/s. Dashmesh Industries, Alwar.



Electrostatic Sprayer for Crops Electrostatic Sprayer for Orchards

Fig.10.6.22. New air-assisted electrostatic Electrostatic Sprayer

HUD Technologies

(A) Head Up Display (HUDMk-1) for LCA Tejas:

Head-Up Display (HUD), a vital display in Fighter Aircraft Cockpit, is classified as primary flight instrument. It is a see-through display that presents flight, Aircraft & weapon data in a collimated form to enable pilot view this information superimposed on his forward view. The HUD developed by CSIR-CSIO possesses technical edge over its competitors in terms of high display brightness, which is essential in high ambient day mode flights, high contrast ratio, wide field of view of more than 25˚, no forced air cooling or internal fan to remove the heat generated in the system which results in reduction in cockpit noise and increases pilot's comfort level. With this achievement, India became one of the few nations with the capability to make Head Up Displays. CSIR-CSIO HUD has been inducted in Indian Air Force with LCA-Tejas Mk1. A total of 68 units have been produced till date by Bharat Electronics Ltd. (BEL) and CSIR-CSIO. They are powered with full day and night features and their flight record have been flawless in various LCA Aircraft versions.

Fig.10.6.23. HUD Technologies of CSIR-CSIO

(B) Head Up Display (HUD Mk1N) for LCA Navy Aircraft

CSIR-CSIO developed HUD for LCA Navy (HUD Mk1N) with enhanced field of view (FOV) of 20° in vertical direction, reduced attention tunneling, better beam combiner transmission without compromising on combiner reflectance, enhanced electromagnetic interference and electromagnetic compatibility (EMI/EMC) requirement of radiated susceptibility (RS03 test) which required that HUD MK1N should be able to withstand an electric field of 200V/m, ability to withstand arrestor landing shock and enhanced raster and electronics performance required for Navy Aviation application. The HUD units were designed to be mechanically and optically interfaced in the LCA-Navy Cockpit within the available cockpit geometry and does not interfere with the ejection clearance line (ECL) and nose clearance line (NCL) of the LCA-Navy. In addition, they are being used for integrated avionics tests at ADA and HAL, Bangalore.

Fig.10.6.24.Head up display and Ski jump of LCA with CSIR-CSIO HUD onboard

(C) Head Up Display for HJT-36 Trainer Aircraft:

HUD H-Series for Hindustan Jet Trainer Aircraft (HJT-36) has several state-of-art features. The challenge of HUD design for HJT-36 Aircraft has been huge owing to the requirement of very compact size, low weight and requirement of thermal management without forced air cooling within the available HUD geometry. The unit has been tailored for HJT-36 Cockpit with high field of view of 25°, Instantaneous field of view of 20° in elevation and 18° in azimuth. The biggest achievement has been the low weight of HUD along with mounting tray which is 12.5 Kg. The thermal management without forced air cooling has been achieved due to its excellent mechanical modelled structure and very low power consumption. The feature of electronic standby (SBS) has been built-in into the system to provide critical display to the pilot in case both the mission computers fail. SBS provides the necessary flight data to the pilot through standard graticule scale which is controlled through a knob provided on Data Entry panel (DEP). User friendly data entry panel provides the pilot interface to the mission computer while automatic brightness control maintains the comfortable contrast level of the symbology to the pilot ensuring sun light readability and good contrast at lower ambient brightness levels. The positional accuracy achieved is of order of 0.2mR against the maximum allowable limit of 3.6mR.

Fig.10.6.25. Head up display for HJT-36 Trainer Aircraft

(D) Head Up Display (HUD Mk-1-NP) for Naval LCA:

Naval LCA gets only ~150 m length of airstrip to land thus requiring arrestor landing shock resistance of 50g. It has a requirement of wide instantaneous field of view (IFOV) - Elevation 22.0° (19.0° below +3° above FRL) and Azimuth 20°. It is compatible with Naval Aircraft Carrier requirements of radiated susceptibility standard up to 200v/m along with the several features such as contrast ratio ≥ 1.2, brightness non-uniformity: 1.5:1, and multimode operations: Stroke Mode for Day flights, Stroke in Raster in low visibility & night mode. It also has feature of real time communication with Mission computer for Human Machine Interface and Extensive online built in test. Two airworthy HUDs have been delivered for flight trials after taking approval from RCMA Chandigarh. Cost of imported production units with HUD Mk1-NP features is > Rs. 200 Lakhs/Unit so FOREX saving is more Rs.3200 Lakhs which includes development cost. Funding sanctioned: Rs.787 Lakhs.

Fig.10.6.26. Head up Display (HUD Mk1-NP) for Naval LCA

Technology Development for Aluminium Composite Foams (ACFs) for Crashworthiness Applications

CSIR-AMPRI is the only institute in India which has developed the Al-foam technology in large scale and with the quality at per with those available in international market but at relatively lower price. The technology for 150 kg/day foam at a production cost of Rs 800/kg (foam billet) has been developed. Interaction has been made with DRDO and Ordinance factory for their blast resistance applications and they requested for supply of prototype foam samples. The prototypes have been fabricated and supplied to Defence Materials and Stores Research and Development Establishment (DMSRDE). Foam filled crash box and bumper strips have been designed as well as fabricated and tested. 1500 gm of foams absorb 70-80 KJ of impact energy (through tests at ARAI Pune and FEM simulation). Foam blocks were supplied to TATA Motors, Pune for crash worthiness evaluation at their end against their purchase order.

Similarly, Al and Zn foam samples have been supplied to M/s Next Motive, for testing and Evaluation. High strain rate testing, component level testing and FEM simulations demonstrated quite encouraging results. An investment of Rs. 3000/- to 4000/- may result in excellent safety of the vehicle and avoid lot of casualties and damage.

Fig.10.6.27. Prototypes of Crash Box and Bumpers

Paper-Based Ceramic Separator for Li-Ion Battery Application

Currently there is no Indian technology available for making separator for Li-ion Battery applications and there is no global presence of such product commercially either. CSIR-CGCRI has developed process for paper-based ceramic coated separator which has high porosity, low thermal shrinkage, high mechanical strength, low internal resistance and excellent wettability to electrolyte and also better electrochemical performance.

The process of making the ceramic separator can be retrofit with the paper making industry for producing ceramic separator as a paper-industry by-product. Any recycled paper can be converted to paper-based ceramic separator for Li-ion battery application.

Fig.10.6.28. Ceramic Separator for Li-Ion Battery

Electrophoretic Deposition for Industrial Application

Industrial coatings market is highly dynamic in nature owing to its varied application in several end-use industries such as automotive, buildings & construction, marine, oil & gas, metallurgy & metal forming, aerospace, electronic, mining, chemical and medical & healthcare. They all need customized coating solutions for their specific needs.
CSIR-IMMT has developed electrophoretic de position (EPD) technology which is unique in the sense that it is applicable to coating by any material such as metal, ceramic, polymer, clay, graphene, carbon nanotube and composites. Coating can be done on any type of surface whether flat, tubular or complex shapes with easy control through simple adjustment of its operating parameters. Deposition kinetics is fast often varying from 30 sec to 3 min. The system is mechanized and automated computer controlled and can be customized for specific coating needs.

Fig.10.6.29. An 8 U-bend test rig be for coating by EPD

Maximizing the recovery of iron values from lean grade iron ore by reduction roasting and pelletisation of high LOI and high Blaine number iron ore fines

Iron ores are valuable raw materials for iron and steel industries. As per the recent National Steel Policy of Govt. of India, steel production will be enhanced to 300 MTPA in 2025 from current production of 95 MTPA. For production of 300 MTPA, the country needs high quality ore around 450 MTPA. India is not endowed with high grade requisite iron ore resources. It is, therefore, imperative to achieve the best use of available low and lean grade iron ore resources through scientific methods of beneficiation and pelletisation.

CSIR-IMMT has developed an indigenous pelletisation technology to handle high LOI and high Blaine number fine concentrate. MoUs have been signed with M/s. FL Smidth, India Pvt. Ltd., Chennai to translate the reduction roasting technology in commercial level Process and with M/s. L&T Ltd., Kolkata to translate pelletisation technology in commercial level.

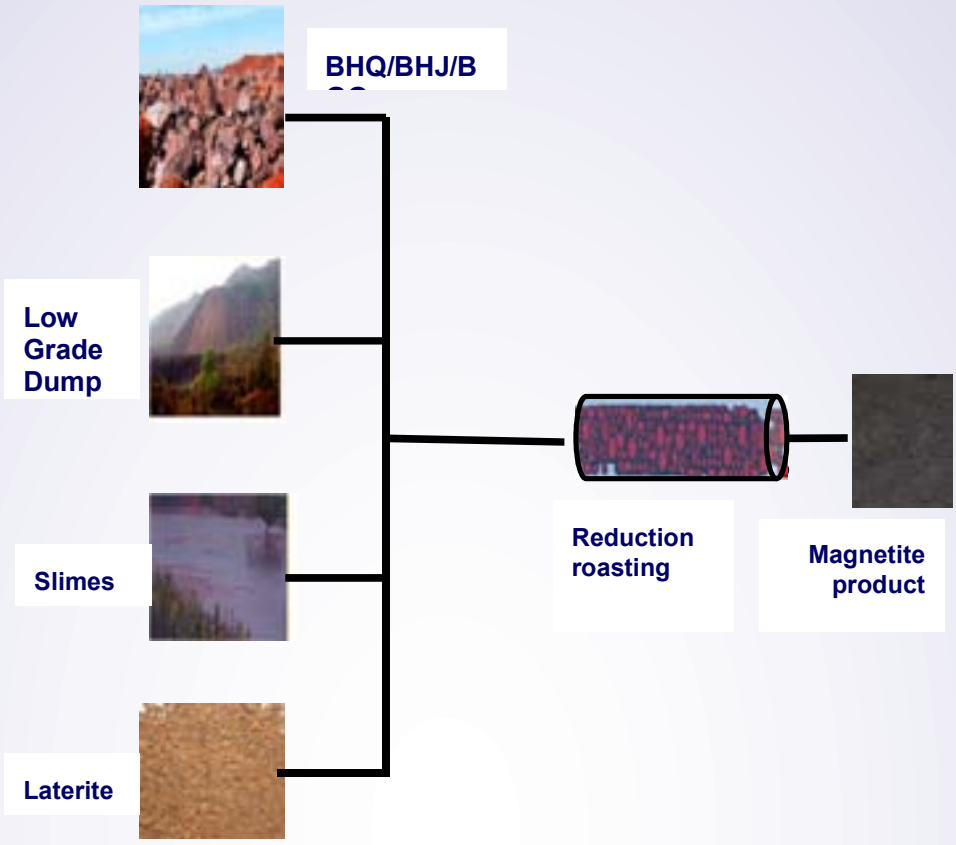


Fig.10.6.30. Flow Diagram of Process

Technology for Extraction of Tungsten from Variety of Scraps

Tungsten is an important metal; both strategically and industrially. Currently most of the Indian tungsten demand is met through imports, as India is deprived of any primary tungsten ore deposits. This technology is aimed at reducing the tungsten recycling cost, thereby encouraging indigenous tungsten powder production through recycling of available scraps.

Several batches of bench scale trials conducted under optimized condition and about 7 Kg of >99.9% pure W-powder produced and supplied to Defence Metallurgical Laboratory (DMRL), Hyderabad. Pilot plant trial run has been conducted for few unit operations (Oxidation @ 20 kg/batch, Pulverization @50 kg/batch). 500 kg/day scale W-powder production plant by M/s Wolfram MetChem Pvt. Ltd has been commissioned under the supervision of CSIR-NML.

Microbial consortium for aquaculture waste management and disease control

Aquaculture contributes a significant fraction of export income to Indian economy and support a large number of people who depends on aquaculture for food and income. Currently, only 15 % of the total coastal area (1.2 million hectares) of India has been

exploited for aquaculture. A major roadblock in extending aquaculture to other areas or making the existing ones profitable is the lack of appropriate tools for managing water quality and disease outbreaks. CSIR-NIO has designed a consortium of marine bacteria, which can degrade the organic waste generated in aquaculture ponds into nutrients and subsequently enhance the phytoplankton growth. The phytoplankton functions as a food source for the cultured animals in the pond. The regular application of consortium may protect the cultured animals from disease outbreaks via avoiding the accumulation of organic waste.

Three ponds each in Kerala and Karnataka have been validated in field conditions. The experimental ponds were stocked with *Litopenaeus vannamei* and *Penaeus monodon*. The probiotics were applied once in 10 - 15 days and the hydrographic variables were monitored regularly.

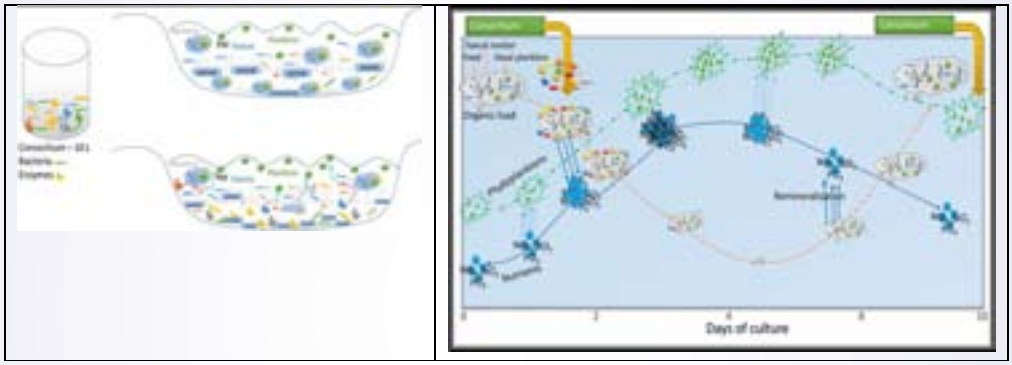


Fig.10.6.31. Process Floe Chart of Bacterial consortium for waste management in aquaculture ponds

Earthquake Hazard Assessment

CSIR has come up with the Earthquake Risk Index Map of the City of Dehradun. This can be used to prepare for facing the expected Earthquake event in its aftermath. The Salient Recommendations are:

(i) Design Spectra are proposed for three expected levels of earthquake shaking. The same may be included in the Building Bye-Laws by the Urban Development Authority for the City of Dehradun;

(ii) Earthquake Hazard Estimate is described through the amplitude of ground motion and the spectral shape; this is different from that prescribed by the Indian Seismic Code IS:1893 (Part 1) – 2016. The same may be used for Earthquake Safety Assessment of Critical and Lifeline Structures in the City of Dehradun, and suitable seismic retrofitting may be undertaken as required.

(iii) It is observed to have 13%, 41% and 59% risk for intensities VI, VIII and IX, respectively. This is due to the reason that response spectra proposed for intensity VI indicates that most of the buildings in 1-3 storey range will get damaged. Similarly, for Intensity VIII, buildings in range upto 5 storeys will

get affected severely and for intensity IX wide range of buildings get affected due to higher acceleration. Hence it is suggested to use appropriate spectra for design of buildings.

Blocks	EDRI (%)	Light Injuries (%)	Severe Injuries (%)	Life Loss (%)
1	12	0.21	0.02	1.00
2	29	8.94	2.33	1.41
3	31	5.14	2.35	4.60
4	19	3.02	0.25	0.00
5	26	0.65	0.09	0.03
6	29	0.19	0.05	0.03

Fig,10.6.32. Seismic Vulnerability map of Dehradun City

10.6.2 Mission Mode Projects:

- Aimed at enabling CSIR to cross threshold of intellectual barrier in order to deliver scientific, industrial and social goods.
- Focused around product/technology development in an area in concerted way with ultimate aim of deployment of products and technology with stakeholder support addressing an unmet need.
- A Top-Down approach has been adopted for identification of Mission Mode Projects; and
- Projects are identified by considering several factors such as National needs, ongoing National Missions, Priorities of the Govt., market/Industry needs, Strength of CSIR in the area and Leads available with the labs.

CSIR Aroma Mission

The CSIR Aroma Mission is envisaged to bring transformative change in the aroma sector through development of superior aroma crop varieties and their agro-technologies and assessment of their suitability for the large scale cultivation in specific agro-climatic regions; promotion of cultivation and processing of aromatic crops, enhancing area under selected aromatic crops along with enabling interventions including setting up of distillation units and catalysing setting up of cooperatives for marketing of the produce; value-addition of aromatic crops in the form of high-end aroma chemicals and products; and skill & entrepreneurship activities and facilitating the creation of Spin-offs.

In the second year, the work components include development of high-yielding varieties/chemotypes and region-and environment-specific genotypes agro technologies; increasing area under cultivation of aromatic crops by another 2000 hectares and ensuring availability of quality planting material for the purpose; setting up of around 130 additional distillation units; trainings for skill development among farming communities through 150 more one-day awareness programmes for farmers and progressive citizens, 30 training programmes of 2-3 days duration on cultivation and processing technologies; and 25 advanced training of 1-2 weeks on processing technologies and two hands-on practical training on fragrance quality of aromatic oils skill development as aroma tester would be conducted.

Fig.10.6.33. Superior aroma crop varieties

CSIR Phytopharmaceuticals Mission

The CSIR Phytopharmaceutical Mission is envisaged to bring transformative change in the medicinal plants sector through captive cultivation of selected medicinal plants, including rare, engendered and threatened species, production of quality planting material and development of region specific agro technologies; technology packages for production of GMP grade medicinal plant extracts; and phytopharmaceutical development from important medicinal plants.

In the first year of project implementation, mass multiplication of quality planting material and captive cultivation of target plant species has been achieved in an area of 120 hectare in different states/districts. Further, plants of 25 Rare, Engendered and Threatened (RET) species have been collected for gene bank. On site demonstration of cultivation technology has been imparted to farmers.

Sickle Cell Anemia (SCA) Mission

A Mission Mode Project on Sickle Cell Anemia has been launched and is being implemented. The cost of the project is Rs.5468.484 lakh for duration of 3 years. The project is being implemented by CSIR-IIIM, Jammu; CSIR-CCMB, Hyderabad; CSIR-IICB, Kolkata; CSIR-IMT; Chandigarh; CSIR-IGIB, Delhi; CSIR-NCL, Pune & CSIR-

URDIP, Pune. The CSIR Sickle Cell Anemia Mission aims to achieve following objectives:

(i) Managing Genetic Burden of Sickle Cell Anemia and Understanding Genetic Basis of Differential Response to Hydroxyurea Therapy. (CSIR-CCMB);

(ii) Drug discovery and development for management of SCA. (CSIR-IIIM, CSIR-NCL, CSIR-IICB, CSIR-IGIB);

(iii) Genome editing and stem cell research approach for the treatment of SCA. (CSIR-IGIB, CSIR-IICB); and

(iv) Development and on-ground implementation of an affordable, accurate and accelerated diagnostic kit. (CSIR-IMTECH).

Catalysis for Sustainable Development (CSD) Mission

The Indian Chemical Industry is the 3rd largest contributor to the overall chemical industry in Asia and the 8th largest chemicals producer worldwide with estimated size of about US$ 100 billion contributing about 6.7% of the Indian GDP. Chemical industry worldwide relies mostly on fossil feedstock. Due to geopolitical reasons, limited availability and fluctuations in price of these feedstock, it might be precarious to depend on them for our future needs. Thus, it is imperative to focus on alternative and renewable feedstock for chemicals synthesis. This mission mode program addresses this vital issue and intends to develop chemical products and processes utilizing renewable raw materials (in-edible biomass, carbon dioxide (CO2), water and shale (natural) gas) instead of the conventional fossil fuels.

CSIR Mission Mode project entitled “Catalysis for Sustainable Development (CSD)” has been launched with budgetary support amounting to Rs. 8958.30 lakh for duration of 3 years. The Mission Project is being implemented by CSIR-NCL, CSIR-IIP, CSIR-IICT, CSIR-CECRI, CSIR-CSMCRI, CSIR-NIIST& CSIR-URDIP. The Mission Project has 3 components:

1. Dimethyl Ether (DME) from Methanol or Syn Gas
2. Valorization of CO_2
3. Biomass to Value added Chemicals

Mission on ‘Safety and Security of Vital Installations’

CSIR has recently launched a mission on ‘Safety and Security of Vital Installations’ which envisages to address following issues: Earthquake Hazard quantification studies in Uttarakhand; Design and development of efficient slope stabilization measures of mitigate landslide hazards for the safety of vital installations in hilly

religions of NW Himalayan Belt; Safety of Hospitals particularly in seismic prone zones; To evolve blast and impact resistant design of Hardened Aircraft Shelter with layered configuration for a specified threat; Structural Health Monitoring (SHM) through innovative solutions consisting of smart video camera system, smart video surveillance system, Real-time system for identification of outsiders; Border security management system based on intelligent multi-sensor approach; and Active Fire Protection System for the design and development of customized fire safety and security solutions for Hospitals.

CSIR has already prepared Earthquake Risk Index Map of the City of Dehradun which can be used to prepare for facing the expected Earthquake event in its aftermath. Design Spectra were proposed for three expected levels of earthquake shaking. The same may be included in the Building Bye-Laws by the Urban Development Authority for the City of Dehradun; and Earthquake Hazard Estimate is described through the amplitude of ground motion and the spectral shape; this is different from that prescribed by the Indian Seismic Code IS:1893 (Part 1) – 2016. The same may be used for Earthquake Safety Assessment of Critical and Lifeline Structures.

Mission on 'Drone based Electromagnetic and Magnetic'

The helicopter borne time-domain electromagnetic (HTEM) methods are now well established as the most widely employed geophysical exploration tool for regional as well as detailed surveys to delineate geological targets. However, their cost increases exponentially as the size of the survey area reduces. Logistics and necessary permissions from civil aviation authorities often become cumbersome and time consuming. Also, at times, the vital subsurface information may be required over limited areas where logistic requirements for helicopter surveys are not optimal.
A drone based EM exploration system can provide an effective, fast and inexpensive option to overcome the above mentioned limitations, but the depth penetration and survey speed will be limited for the proposed Drone based EM system compared to HTEM.

CSIR has launched a Mission project which is envisaged to be very useful for exploration for earth resources such as: a) Resource mapping: Minerals and groundwater, b) Time lapse surveys: Coastal salinity, Pre and post monsoon mapping of aquifer parameters, Vadose zone, Leachate plumes, Palaeo channels, c) Earthquakes: Mapping shallow fluid filled faults in seismically active terrains, d) Defence**:** UXO location, Tunnel detection in sensitive areas and e) Near surface applications: Foundation engineering, waste disposal sites, mapping fractured zones to design tunnels in hilly terrains, etc.

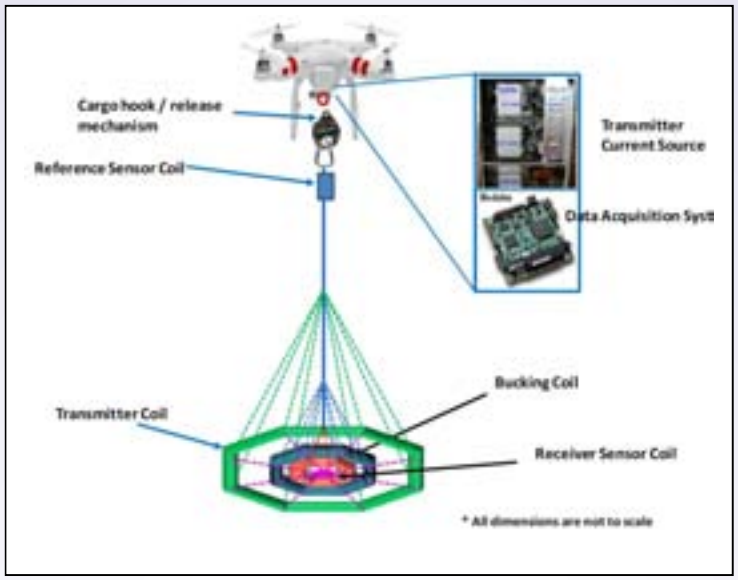


Fig.10.6.34. Proposed Schematic Diagram of the Technique

10.6.3. Other Activities:

Smart India Hackathon 2018: A non-stop 36-hour digital product development competition among Engineering/Technology Students

CSIR actively participated in Smart India Hackathon-2018-Software Edition and successfully organized 36-hour Grand Finale at CSIR-NCL, Pune. CSIR was a 'Premier Partner' in this initiative. The Smart India Hackathon is a non-stop digital product development competition conceptualized and organized by Government of India, where the identified problems (software and hardware challenges) are posed to engineering/ technology students for developing innovative solutions. In the grand finale organized by CSIR on 30 & 31 March 2018, 53 teams consisting of six team members and one-two mentors in each team participated to provide solutions to 10 problem statements posed by the CSIR scientists. Finally, 318 students and 75 mentors from various engineering colleges across the country gathered to showcase their talent, while working on the problem statements. The solutions by all the teams were rigorously reviewed by the panel of judges. After rigorous interactions with all the shortlisted teams, finally three teams received awards i.e. of Rs. 1,00,000/- (Winner), Rs. 75,000/- (1st Runner up) and Rs. 50,000/- (2nd Runner up). Additionally, three more teams were selected for the "Persistent Inspiration Award", "KPIT Award" and "Deloitte Innovation Award".

Fig.10.6.35. Participants in Smart India Hackathon

Fig.10.6.36. Winners of Smart India Hackathon 2018

10.7 Traditional Knowledge Digital Library (TKDL)

The Traditional Knowledge Digital Library (TKDL) initiative documents and preserves the country's traditional knowledge and aims to prevent the misappropriation of India's traditional medicine knowledge mainly at International Patent Offices. The TKDL acts as a bridge between India's rich traditional medicine knowledge which exists in local languages such as Sanskrit, Hindi, Arabic, Persian, Urdu, Tamil, etc. and patent examiners at the international patent offices. TKDL has removed language and format barriers by converting the available traditional Indian medical texts to structured English (and four other international languages) formulations.

During 2017-2018, TKDL has enriched its database with over 5400 transcribed formulations belonging to the Indian Systems of Medicine, namely, Ayurveda, Unani, Siddha; and Yoga. As on date, about 0.34 million formulations on Indian Traditional Medicine Knowledge (TMK) have been transcribed.

In June 2017, a TKDL Access Agreement was signed with Rospatent (intellectual office of Russia) on the sidelines of the Hon'ble PM's visit. In the same month, another TKDL Access agreement was signed with INDECOPI (intellectual property office of Peru) during the visit of a High Power delegation. Currently, the TKDL database is available to 12 patent offices worldwide.

TKDL signed an MoU with Traditional Knowledge Innovation-Kerala (TKIK) under the Directorate of Ayurveda Medical Education on 23 March 2018 in the presence of Hon'ble Chief Minister of Kerala. This MoU is the beginning of a collaboration with TKIK to digitize manuscripts of Ayurvedic medicine collected from Kerala. TKDL will also begin digitization of a new branch of traditional medicine, namely Sowa Rigpa, for which a setup is being established in Leh Ladakh.

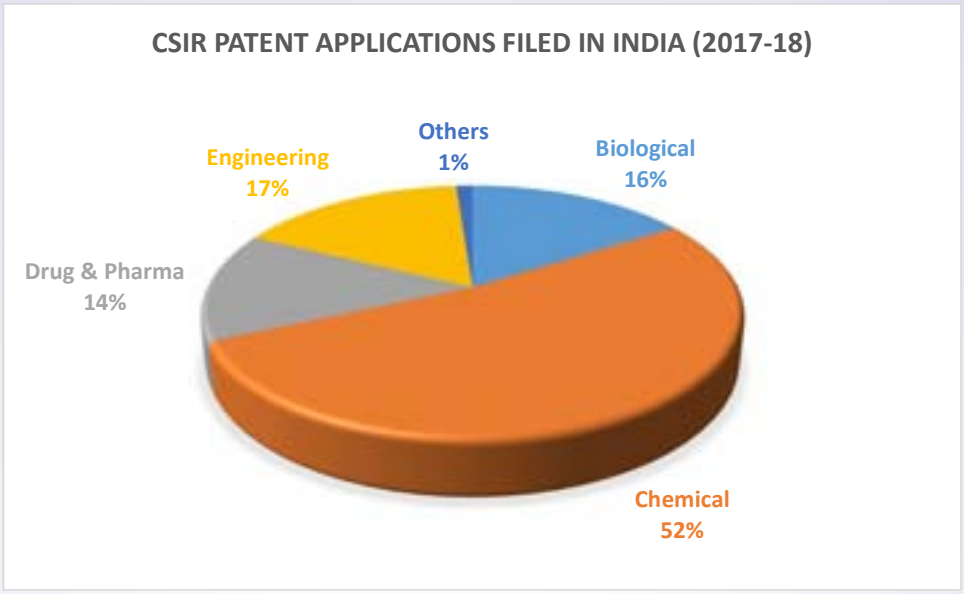
10.8 Intellectual Protection Unit (IPU)

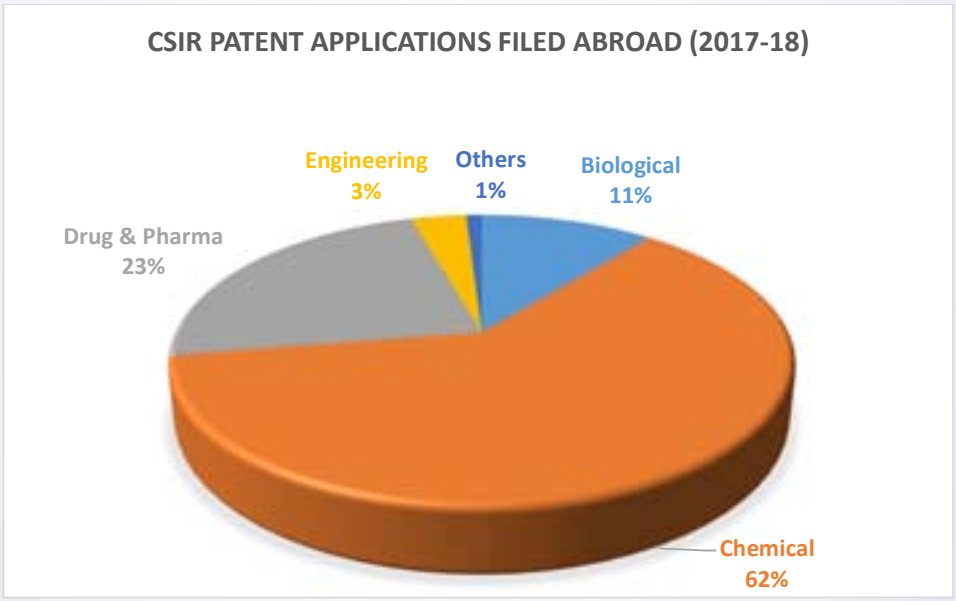
Significant Scientific and Technical Achievements (2017-2018)

CSIR's Patent Filing:

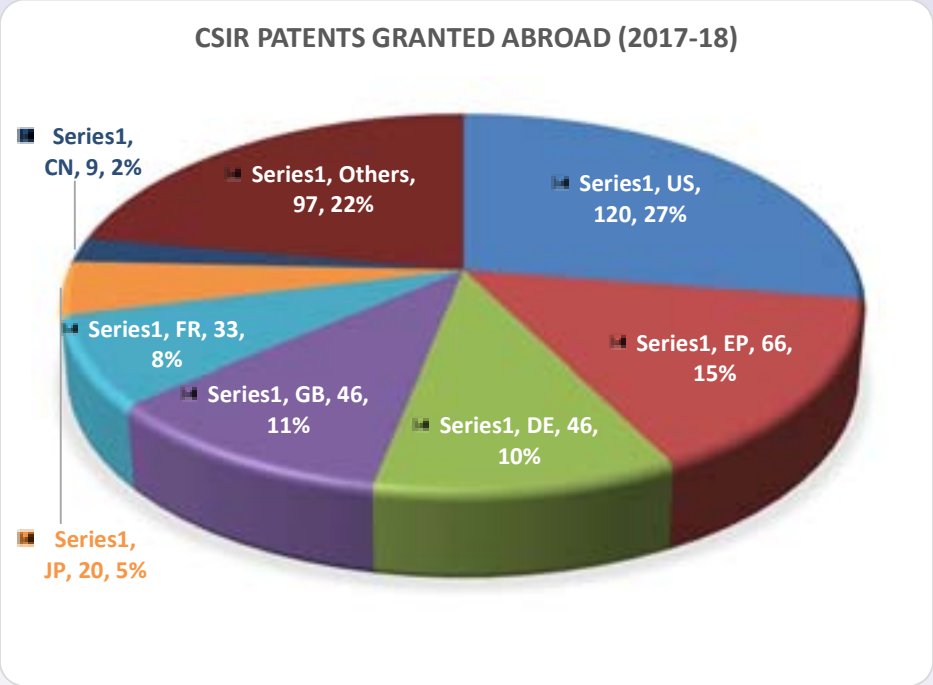
(I) CSIR Patent Applications Filing and Grant of Patents

CSIR has been actively involved in filing, prosecuting and obtaining patents in India and abroad. It has filed 203 patent applications abroad and 170 patent applications in India in various technical fields during 2017-2018.


CSIR PATENT APPLICATIONS FILED IN INDIA (2017-18)
Others
1%
Biological
16%
Engineering
17%
Drug & Pharma
14%
Chemical
52%


CSIR PATENT APPLICATIONS FILED ABROAD (2017-18)
Engineering
3%
Others
1%
Biological
11%
Drug & Pharma
23%
Chemical
62%

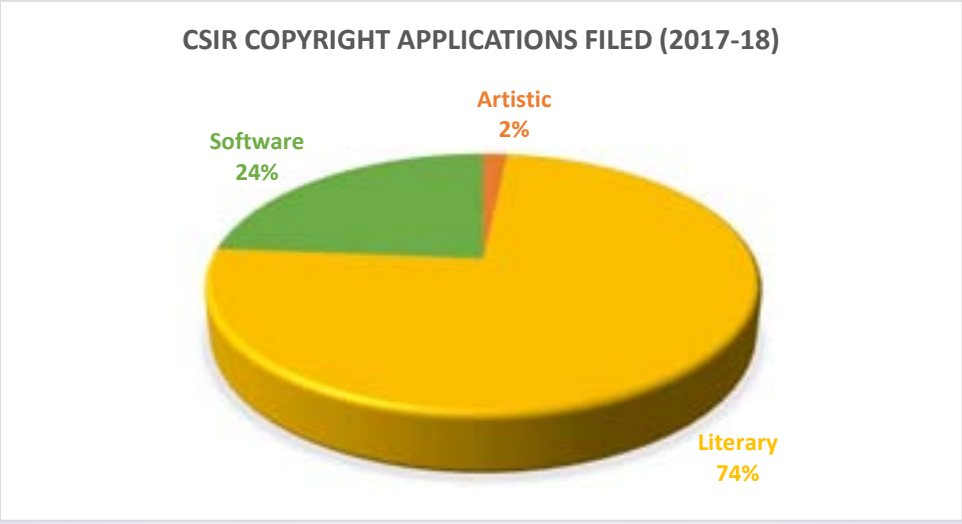
(II) CSIR Patent Applications Granted in major Jurisdictions



(III) CSIR's Copyright, Trade Mark and Design Filing

CSIR has also explored the possibility of obtaining rights over other forms of IP generated by various laboratories. CSIR has filed **59 Copyright applications, 37 Trade Mark applications and 12 Design** applications during 2017-2018.

The Copyright applications filed by CSIR subsist in different categories such as literary work, software and artistic work.



(IV) Vetting of intellectual property aspects in MoU/Agreements

CSIR-IPU has examined intellectual property aspects of more than **40 MoU/Agreements/Proposals** executed by CSIR during 2017-2018.

(V) Handling issues relating to Biological Diversity Act 2002 and Biological Diversity Rules, 2004

CSIR-IPU assessed the requirement of taking permission from the NBA in respect of patent applications of CSIR based on use of Biological Recourses from India. The applications for **permission were filed in respect of 176 patent applications** with the competent authority i.e. the National Biodiversity Authority.

Consequently, CSIR-IPU has obtained permissions from National Biodiversity Authority under the Biological Diversity Act, 2002 and the Biological Diversity Rules, 2004 by way of entering into Agreements on Access and Benefit Sharing.

CSIR-IPU is also in continuous negotiation with the NBA over the various clauses detailed in the Agreement on Access and Benefit Sharing offered by the NBA after the publication of the Benefit Sharing Regulations 2014.

(VI) CSIR Innovation Award for School Children-2017:

Four innovations were selected out of 450 applications received for **'CSIR Innovation Award for School Children-2017'.** The selected innovations are (i) Artificial Gill System for Divers and Commandos, (ii) Innovative method of raising rice seedlings by an economically viable and ecologically sustainable method, (iii) Two in One Dustbin, (iv) Self Confident Wheel for two Wheelers and Electricity Generation.

The winners of the CSIR Innovation Award for School Children-2017 were given prizes by the Vice President of CSIR and Minister of Science & Technology at Vigyan Bhavan on CSIR Foundation Day 26th September, 2017. The presentation includes cash prize, Memento and certificates to the winners.

(VII) IP Awareness Programmes organized / lectures delivered:

Seminars organized:

CSIR-IPU Organized an Interactive Session with Japan Patent Attorneys Association, at IPU Delhi on February 7, 2018.CSIR-IPU and EPO jointly organised an EPO Technical Session at CSIR-IPU on March 5, 2018 for understanding the EPO Overview on the Global Dossier, EPO laws and practices on patent filing and examination (Chemical/Pharmaceuticals//Biotech) and Drafting specification and claims as per EPO guidelines. About 16 lectures on various aspects of IP were also delivered by IPU.:

10.9 Unit for Science Dissemination (USD)

The Unit for Science Dissemination is fully responsible for furthering favourable public image of CSIR as a whole. Several image-building activities were executed to achieve the overall objective through `Team USD'.

Execution of Diverse Image Building Activities

Image Building through Print Media

Publicity Efforts

- Effective media relations helped in furthering result-oriented relationship with the key press persons covering science in their respective dailies. Appropriate logistics support was ensured to all of them to earn their confidence in this Unit; several features/ stories were published with the support of inputs provided by this Unit.
- Press coverage was successfully organized during important CSIR events.
- Press releases were prepared and disseminated on several occasions and their coverage monitored for effectiveness.

Advertising Efforts:

- Advt. in Newsletter of CSIR Pensioners Welfare Association, Lucknow News Letter No.- 24 for 2017
- Advt. for CSIR on the occasion of National Technology Day - 2017
- Advt. in Indian Women Press Corps. 2017

Image Building through Interactive Media Exhibitions, etc.

CSIR participates in various national/international exhibitions and other related events with two main objectives: (i) Creating awareness about CSIR and its achievements, and (ii) Supporting its business development efforts.

This important activity was consolidated and efforts were made to project, as far as possible, an integrated picture of CSIR overall contributions to the theme areas of each event through extensive coordination with the participating CSIR labs on one side and the organizer of the event on the other.

Exhibitions organized/participated during this year include*:*

Sl. No.	Name of the Exhibition	Theme	Place	Duration
1	Global R&D Summit 2017.	Display of CSIR Technologies in the area of Socio Economic & Industrial Development	The Lalit Ashok, Bangalore	6-7 April, 2017

2	Exhibition at the residence of Hon'ble Minister S&T and ES	CSIR showcase its technologies for awareness of school students and general public	New Delhi	28 March , 2017 onward
3	Bundelkhand Sarjan-2017.	Display of CSIR Technologies for the awareness of the general public	Tikamgarh(MP)	6-7 May, 2017
4	Rising Kashmir-2017.	Display of CSIR Technologies for the benefit of J&K State	SKICC, Srinagar(J&K)	3-6 July, 2017
5	Participation of CSIR Team in Chemeca and RACI Confeence at Melbourne	CSIR showcase its technologies in the area of Chemical Science in this event	Melbourne	23-28 July, 2017
6	Exhibition organized by Scientific Ministries/ Departments.	CSIR showcases its technologies for the awareness of Hon'ble MPs and Ministers	Parliament complex, New Delhi	23 July to11 Aug 2017
7	Participation in Indian National Exhibition cum Fair 2017	Display of CSIR technologies for the awareness of general public	Kanungo Park, Garia, Kolkata	17 -20 Aug., 2017
8	21st National Exhibition at Kolkata	Display of CSIR technologies for the awareness of general public	Agradut Krirangan, New Barrackpore, Kolkata	24-27 Aug 2017
9	Destination Himachal Pradesh-2017	Display of CSIR Technologies for the benefit of Himanchal Pradesh	Palampur,Himachal Pradesh	12-14 Sept 2017
10	Swadeshi Mela-2017	Display of CSIR Technologies in	Kahsi	8-17 Oct 2017

		the area of Ecology & Environment, Water and Agriculture for the awareness of General Masses		
11	India Water Week-2017	CSIR showcases its Technologies in the area of Water	Vigyan Bhawan, New Delhi	10-14 Oct 2017
12	4th Vibrant India & Meri Delhi Utsav-2017	CSIR showcases its technologies for the awareness of general masses	Pitampura Delhi Hat	13-15 Oct 2017
13	IISF-2017 Mega Science Technology & Industry Expo.	CSIR showcases its technologies in the area of Health, Water, Environment, Chemicals, Petrochemicals, Aerospace, Agriculture, Floriculture, Food for the awareness of general masses	Science City, Chennai	13-16 Oct 2017
14	9th Agrovision	CSIR showcases its technologies in the area of Agriculture science for the awareness of farmers and general masses	Nagpur	10-13 Nov 2017
15	Chemtech+Waterex World expo.-2018.	CSIR showcases its Technologies in the area of	Ahmedabad	23-25 Jan 2018

		Water, Chemicals & Petrochemicals for the awareness of Industries and general masses		
16	Exhibition at the residence of Hon'ble Minister S&T and ES.	CSIR showcases its technologies for the awareness of Hon'ble Ministers, MPs, Students and general masses	New Delhi	9th Jan., 2018 onward for 4 weeks
17	Vision J&K 2018	Display of CSIR Technologies for the benefit of J&K State	Udhampur	29-31 Jan 2018
18	India Pharma-2018 & India Medical Device 2018	CSIR showcases its technologies in the area of health and pharma sector	BIEC, Bangalore	15-17 Feb 2018
19	105th Indian Science Congress: Pride of India Expo-2017	CSIR showcases its technologies in the area of Health, Water, Environment, Chemicals, Petrochemicals, Aerospace, Agriculture, Floriculture, Food for the awareness of students and general masses	Manipur University, Impal	16-20 March, 2018

Other Information Dissemination Services

The Unit provides press-clipping service to the office of the Minister of Science & Technology, DGCSIR and other top management professionals of CSIR after scanning about 28 papers and 14 magazines on a regular basis. This activity was consolidated to make it more professional and timely.

Value-addition to the regular Newspaper Clipping Service of this Unit

- Special compilations were brought on the coverage by media (of important CSIR events) (both national and international) for perusal of MOS (S&T), DG,CSIR and the concerned departments;

Daily News Bulletin services: Soft copy of the news clippings on CSIR matters published in national media being forwarded to all CSIR colleagues.

Social Media Handles: USD handles social media like Facebook (CSIR India),Twitter (CSIR IND) and Youtube (CSIR INDIA).

10.10 Director General Technical Cell (DGTC)

CSIR Integrated Skill Initiative

Several CSIR labs are engaged in conducting industry oriented training/ skilling programmes that have been well accepted by users. In tune with the Government Policy on Skill Mission, CSIR in its Platinum Jubilee Year mounted a major programme on "CSIR Integrated Skill Initiative". Dr. Harsh Vardhan, Hon'ble Minister of (S&T and ES) and Vice President, CSIR had launched 'CSIR Integrated Skill Initiative' on September 23, 2016 across various CSIR labs.

Fig.10.10.1. CSIR had launched 'CSIR Integrated Skill Initiative'

Some major highlights of CSIR Integrated Skill Initiative during the FY 2017-18:

- Nearly 24,000 candidates skilled/trained at CSIR laboratories in various S&T domains.
- CSIR-IICT bagged a contract from Andhra Pradesh Skill Development Council for Biotech program for 250 candidates;
- CSIR-CSIO has received a work order in collaboration with Punjab Skill Development Mission to train 500 candidates under DAY-NULM scheme;

- CSIR-CLRI has imparted skill training to 2071 artisans in different leather trades pan India with financial support from institutions like National Scheduled Castes Finance and Development Corporation (NSFDC);
- CSIR-NEIST Integrated Skill Initiative Program has been selected under NABARD's Joint Liability Group (JLG) Promotion scheme for bank loans;
- CSIR labs established connect with various Sectoral Skill Councils (SSC): Leather Sector Skill Council (CSIR-CLRI); Life Sciences Sector Skill Council (CSIR-IICT); Capital Goods Sector Skill Council (CSIR-CSIO); Automotive Sector Skill (CSIR-CSIO); Aerospace & Aviation Sector Skill Council (CSIR-NAL); Agriculture Sector Skill Council (CSIR-NIO/ CSIR-NBRI/CSIR-IITR); Skill Council for Mining Sector (CSIR-CIMFR); Health Care Skill Council (CSIR-IICB) and Paint & Coating Skill Council (CSIR-CECRI).
- CSIR-NAL, in collaboration with Aviation Sector Skill Council (AASSC) has worked towards development of various Qualification Packs (QP) and National Occupation Standards (NOS) for Aviation sector.

CSIR & KVS Signing of MoU ; STUDENT-SCIENTIST CONNECT PROGRAMME

CSIR and Kendriya Vidyalaya Sangathan (KVS) signed an MoU on Scientist – Student Connect programme '**Jigyasa**' on **6th July, 2017**. The programme will connect 38 laboratories with **1151 KV** schools. The programme is a unique platform to bring in teachers and scientists for nurturing young minds. The programme envisages opening up the national scientific facilities to school children, enabling CSIR scientific knowledgebase and facility to be utilized by school children.

Fig.10.10.2. Scientist – Student Connect programme of KVS & CSIR

BRIEF ON JIGYASA

CSIR has been contributing to the Science Technology and Innovation ecosystem of the country which is one of the major driver of growth in this competitive world. To supplement this growth a constant supply of large quantity of talent pool is required. An enabling mechanism for this is capturing the mind space of school children to nurture their carrier in science streams. For this, the need is to create Scientific Temper which is a mechanism wherein students' capabilities to use scientific methods which include questioning, observing physical reality, testing, experimenting, hypothesizing, analyzing, and communicating are enhanced.

Jigyasa Objective:

It aims to inculcate scientific temperament among school kids, inspire young minds about scientific research, and to ignite the spirit of scientific thinking at early age through **Scientists – student Connect programme: Jigyasa**. The students will be engaged in practical activities to get a flavor of research in one the premier national laboratory by extending classroom learning to **research and laboratory-based learning**. Further, Scientists will be encouraged to visit KV schools and impart their knowledge to students as part of the **Scientific Social Responsibility** of CSIR. Teachers will also be provided with hands on experimentation at state-of-art facilities of CSIR.

Present Status:

- The Scientist – Student Connect programme '**Jigyasa**' was officially launched on **6th July, 2017** in the presence of Hon'ble Minister of Human Resources Development and Hon'ble Minister for Science & Technology and Earth Sciences.
- More than 24,500 students and 2000 teachers from Kendriya Vidyalaya visited CSIR Laboratories during the Financial Year 2017-18.
- 50,000 students and 4,000 teachers from Kendriya Vidyalaya are targeted during 2018-19.
- Some of the models of engagement include:
    i. Laboratory visit
    ii. Select hands – on research experimentation for students and teachers
    iii. Popular lectures by eminent scientists
    iv. Visit to state-of-art facilities
    v. Simple and easy scientific concepts explained with models
    vi. Field visits
    vii. Oral & Poster presentations
    viii. Quiz competitions

ix. Students as scientists programme

Highlights of some Programmes implemented:

- Sixteen CSIR laboratories participated in the **Summer Camp programme** implemented during June – August, 2017.
- CSIR-CEERI organised **innovation competition** and **Innovation Camp** among the school students to promote their innovative ideas to solve relevant social and technological problems.
- CSIR-IITR organized "**Be a Scientist" programme**" on Technology Day.
- CSIR-NGRI organised **Earth, earthquakes and essentials of safety** programme
- CSIR - AMPRI conducted a **minor research projects** programmes for students.
- CSIR-CCMB conducted **Young Investigator's Program (YIP)** wherein 15 students are shortlisted for a two week hands on experience of research activity in CCMB. These students would carry out experiments on their own, involving the preparation and analysis of their own DNA, in January.
- A two-day science **research camp 'Jigyasa-2017'** was organised during July 7-8, 2017 by CSIR-CEERI. The theme of the camp was to explore the world of electronics and allied engineering sciences for triggering and motivating the young minds towards the science through live interaction with the scientists and providing an opportunity to present their ideas.
- Two-three days **Science Teachers' Workshop** was conducted by many CSIR laboratories providing 'Hands-on' training.
- Scientific and technological achievements of CSIR was provided by CSIR-CFTRI
- **Science and Maths Club** for school children was organised by CSIR-AMPRI**.**
- CSIR-IGIB organised interactive **scientific games** and hands on research activities like how to carry out blood test.
- CSIR-IHBT organised Jigyasa programme on **"Phenological Calendar of Trees** in School Campus".
- **Faculty Development program** for K V computer science teachers was organised by CSIR-NPL.
- CSIR-NEERI participated in the **social science exhibition-cum-national integration camp** organized by Kendriya Vidyalaya, Ajni wherein students of seven Kendriya Vidyalayas of Vidarbha region participated.
- CSIR-CBRI conducted Workshop for students on **National Mathematics Day** (22 December).
- CSIR Foundation day (26 September, 2017) was celebrated by CSIR and its laboratories by inviting students to respective laboratories. Nearly 5,000 students from Kendriya Vidyalaya attended the programme across India.

- CSIR-NPL organized one day Jigyasa programme on **Van de Graaf Generator, SI units**. Nearly 200 students from Delhi region participated in the one day programme.
- CSIR's Jigyasa programme will also be implemented by **Navodaya Vidyalaya Samiti (NVS)**. Based on the Jigyasa success, Ministry of Human Resource Development directed NVS officials to be in touch with CSIR to implement Jigyasa in similar lines of KVS.

10.11 Recruitment and Assessment Board(RAB)

Recruitment & Assessment Board (RAB) established in mid 2002 with the appointment of its Chairman & establishment of RAB office, commenced its activities in January, 2003. A full-fledged Board with adequate functions and powers has been setup to overcome the operational and procedural difficulties in recruitment and assessment process and with a view to have a well-defined structure of the CSIR Recruitment and Assessment Board with specified powers and functions.

RAB facilitated recruitment of 125 scientists in CSIR Laboratories/Institutes in 2017-18. Assessment of Jr Scientists to Principal Scientists due for promotion in 2017-18 covering all the areas of CSIR numbering 600 was concluded. In addition, the Division organized assessment of 13 Senior Principal Scientists due for promotion during 2017-18.

Awards / Recognition

During the year numerous awards and recognitions have come to CSIR staff, as under:

Sun Pharma Research Award for 2016 in Medical Sciences under Basic Sciences Category	Dr. Rajan Sankar Narayanan	CSIR-CCMB
Fellow National Academy of Medical Sciences	Dr. Giriraj R Chandak	CSIR-CCMB
Young Scientist Award from Society of Indian Association of Medical Genetics.	Dr S. S. Agarwal	CSIR-CCMB
AstraZeneca Oration & Prof. N.R. Dhar Memorial Lecture Award 2017	Dr. Madhu Dikshit	CSIR-CDRI
ISCB Distinguished Women Scientist Award-2018, in Biological Sciences by Indian Society of Chemists and Biologists India	Dr Vinita Chaturvedi	CSIR-CDRI
Selected as Organizing Committee Chairman - International Conference on “International Conference on Innovative Approaches in Applied Science and Technologies” (iCiAsT) in the Nanyang Technological University, Singapore	Dr. Hemant K. Gautam	CSIR-IGIB
Member, National Academy of Sciences	Dr. Sanjay Kr. Uniyal	CSIR-IHBT
NASI - Reliance Industries Platinum Jubilee Award 2017 in Biological Sciences	Dr. Inshad Ali Khan	CSIR-IIIM
Member of the expert review panel of WHO, for formulating WHO guidelines on Protecting workers from potential risks of manufacturing nano materials	Dr. D.Kar. Chowdhuri	CSIR-IITR

Prof. K T Shetty Memorial Oration of Indian Academy of Neurosciences	Dr.A.B. Pant	CSIR-IITR
Fellow of the Academy of Environment Biology by the academy of Environment Biology	Dr.Kausar Mohammad Ansari	CSIR-IITR
Shanti Swarup Bhatnagar Award 2017	Dr. Vinay Gupta	CSIR-NPL
IEI Young Engineer Award from the Institution of Engineers	Dr. Bhnau Pratap Singh	CSIR-NPL
Fellow of Asia- Pacific Academy of Materials (APAM)- 2017, Sendai, Japan.	Dr. Bipin Kumar Gupta	CSIR-NPL
Elected as a Fellow of Indian National Science Academy	Dr. Vijayamohanan K. Pillai	CSIR-CECRI
Mascot National Award- 2017 by the Electrochemical Society of India, Bengaluru.	Dr. S. Sathiyanarayanan	CSIR-CECRI
Outstanding Scientist Award by Venus International foundation for the year 2017.	Dr. Subrata Kundu, Dr. Santosh Kumar Bhat, Chennai Unit Dr. G. Subramanian	CSIR-CECRI
ASDF (Association for Scientists, Developers and Faculties) Global Award-2017'.	Dr. Subrata Kundu	CSIR-CECRI
Best Scientific Research Award for the year 2017 by ASDF during the ASDF Global Award Ceremony in Goa.	Dr. V. Ganesh	CSIR-CECRI
CSIR Technology Award 2017	CSIR-CLRI Team	CSIR-CLRI
CSIR Diamond Jubilee Technology award (CDJTA) 2016 -foundation day, September 2017	CSIR-CLRI Team	CSIR-CLRI
INSA-DFG Visiting Scientist Fellowship	Dr N. Nishad Fathima	CSIR-CLRI

NABS- Best Women Scientist Award 2016-September 2017	Dr. A. Gnanamani	CSIR-CLRI
Professor Shantilal Oswal Young Scientist Award - Year 2017	Dr. Md. Sayem Alam	CSIR-CLRI
Ariviyal Kalanjiyam – Tamil Nadu	Dr B. Chandrasekaran	CSIR-CLRI
Skoch order of merit award by Skoch Group for developing and commercializing a high rate biomethanation technology	CSIR-IICT Team	CSIR-IICT
Gandhian Young Technological Innovation (GYTI)	CSIR-IICT Team	CSIR-IICT
SERB-IGCW 2017 Award for "Biohydrogen Technology" by DST & Green ChemisTree Foundation- year 2017	CSIR-IICT Team	CSIR-IICT
Technology Development Board (TDB) National Award for Successful Commercialization of Indigenous Technology for Wax Production at Numaligarh Refinery Limited (NRL), ASSAM	CSIR-IIP Team	CSIR-IIP
Indian Chemical Council Award-2016 on 29th September, 2017	CSIR-IIP Team	CSIR-IIP
Sun Pharma Research Award' (Pharmaceutical Sciences)	Dr. D. Srinivasa Reddy	CSIR-NCL
Fellow of the National Academy of Sciences (NASI)	Dr. D. Srinivasa Reddy	CSIR-NCL
CSIR Young Scientist Award in Chemical Sciences	Dr. Sakya S. Sen	CSIR-NCL
Young Associate of the Indian Academy of Sciences, Bangalore	Dr. Sakya S. Sen	CSIR-NCL

Electron Microscope Society of India (EMSI) Fellow Award	Dr. Pankaj Poddar	CSIR-NCL
INSA Young Scientist Award	Dr. Dinesh Jagadeesan	CSIR-NCL
World Academic Championship Award 2018	Miss Panchali Bharali Mr. Somiron Borthakur Dr. Swapnali Hazarika	CSIR-NEIST
Gold Medal, Chemical Research Society of India	Dr. G. Vijay Nair	CSIR-NIIST
State Young Scientist Award (KSYSA)	Dr. B. S. Sasidhar Kerala	CSIR-NIIST
Elected as a Fellow of Indian Institute of Ceramics, conferred on December 06, 2017.	Dr K. Muraleedharan	CSIR-CGCRI
CSIR Young Scientist Award for the Year 2017	Shri Sathravada Balaji	CSIR-CGCRI
Elected as a member to the council of Chemical Research Society of India Fellow of The Royal Society of chemistry, UK, on 7th July, 2017.	Dr P. Sujatha Devi	CSIR-CGCRI
Royal Society Newton International Fellowship Award	Ms. Indranee Das	CSIR-CGCRI
CSIR Technology Awards- 2017.	CMERI Team	CSIR-CMERI
CSIR Young Scientist Award" in Engineering Science	Dr. Prosenjit Das	CSIR-CMERI
Eminent Engineer Award from Institution of Engineers (India)	Dr. R.K. Jain	CSIR-CMERI
Awarded 'Outstanding Contribution in Reviewing' in recognition of the contributions	Dr. Priyabrata Banerjee	CSIR-CMERI

made to the quality of the journal by the Editors of the Elsevier Journals namely Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, Inorg anica Chimica Acta and Journal of Solid State Chemistry		
Excellence in Academics Award-2017 by the Institution of Engineers (I), Roorkee.	Prof. Satish Chandra	CSIR-CRRI
CSIR Technology Awards 2017 under the category “Physical and Engineering Sciences” on September 26th, 2017	Team CSIR-CRRI	CSIR-CRRI
CSIR Technology Award - 2017" for ‘Technology for Recovery of Iron Values from Low and Lean Grade Iron Ore Resources’	Team CSIR-IMMT	CSIR-IMMT
Scientific Institutional Award 2017	Team CSIR-NML	CSIR-NML
Fellow of Indian National Academy of Engineers (INAE) -2017	Dr. I. Chattoraj	CSIR-NML
Young Engineer Award by Mineral Engineering Science Association, Vishakapatnam, India (2017) Membership of National Academy of Sciences, India	Dr. Abhilash	CSIR-NML
SKOCH Order-of-Merit Award 2017	Dr. A.K. Sahu	CSIR-NML
SKOCH Order-of-Merit Award 2017	Dr. A.K. Mohanty	CSIR-NML
Elected as Editorial Board Member for Proceedings of the Indian National Science Academy (2017-18)	Prof. Santosh Kapuria	CSIR-SERC
Elected as Member, Development Council for Cement Industry, Ministry of Industry, Govt. of India, notified in the Gazette of India (June 2017-19)	Prof. Santosh Kapuria	CSIR-SERC
Ultra Tech Award 2017” for “Outstanding Young Concrete Engineer of Tamilnadu”	Dr. P.S. Ambily	CSIR-SERC

Prize in the National Level Competition "Ideas for Nav Bharat Nirman" for the concept “Easy to Build Textile Reinforced Concrete Toilet" held in the India International Science Festival (IISF-2017)	Dr. Smitha Gopinath Dr. A. Ramachandra Murthy Dr. J. Prabakar Dr. T. Hemalatha	CSIR-SERC
Raman Research Fellowship for the year 2017-18	Dr. M.B. Anoop	CSIR-SERC
Skotch Challenger Gold Award-2017	Dr. PC Panchariya	CSIR-CEERI
Young Scientist Award’-2017 in Metallurgical and Materials Engineering by Venus International Research Foundation, Chennai	Dr. Achu Chandran	CSIR-CEERI
The CSIR Young Scientist Award	Shri Amit Laddi	CSIR-CSIO
Gold-Skoch Transformational Innovation Award Skoch-Order-of-Merit-Award 2016	CSIR-CSIO Team	CSIR-CSIO
Indian Young Leadership Award" for Excellence in Skill Based Education	Mr. Narinder Singh Jassal	CSIR-CSIO
IEI Young Engineers Award 2017-2018" in Electronics & Telecommunication Engineering	Ms. Naga Vara Aparna Akula	CSIR-CSIO
Certificate of outstanding contribution of Reviewing in recognition of the contributions made in the quality of the journal from International Journal of Rock Mechanics and Mining Sciences, Elsevier, 2018	Dr. P. K. Mandal	CSIR-CIMFR
National Geoscience Award 2016	Dr. Santosh Kumar Ray	CSIR-CIMFR
Dr. M.G. Krishna Award for the highest number of copyrights in the year 2017	Dr. S.K. Bharati	CSIR-CIMFR

The IME Journal Lifetime Achievement Award"	Dr. V.K Singh	CSIR-CIMFR
Elected as Fellow of the National Academy of Sciences (FNAS)	Dr. Alok Kalra	CSIR-CIMAP
Elected as National Academy of Agricultural Sciences (NAAS)	Dr. Ajit Kumar Shasany	CSIR-CIMAP
Elected as Fellow of Academy of Sciences for Animal Welfare (ASAW)	Dr. D.U. Bawankule	CSIR-CIMAP
Raman Research Fellowship for 2017-18	Dr. Ashutosh K. Shukla	CSIR-CIMAP
Fellowship of the National Academy of Medical Sciences in this period (FAMS)	Dr. G. Suresh Kumar	CSIR-IICB
Fellow of the West Bengal Academy of Science & Technology (FAScT)	Dr. Parasuraman Jaisankar	CSIR-IICB
ICMR-Novartis Award' for the year 2016 as Gold medal for outstanding contribution in the field of Cancer	Dr. Sib Sankar Ray	CSIR-IICB
Prof. Sohail Ahmad Award, 2017 in Biomedical Sciences from the Indian Academy of Biomedical Sciences	Dr. Snehasikta Swarnakar	CSIR-IICB
1) NASI Scopus Young Scientist Awards in Medicine 2) Swarnajayanti Fellowship Award	Dr. Dipyaman Ganguly	CSIR-IICB
INSA Young Scientist Medal	Dr. Smita Kumar	CSIR-NBRI
IAPT Research Grant Award by the International Association for Plant Taxonomy, Bratislava, Slovakia	Shri M.G Prasad	CSIR-NBRI
Raman Research Fellowship	Dr. Arup Ghosh	CSIR-CSMCRI
ICCES/Outstanding Young Investigator Award in The Field of Science and Technology of	Dr. Balamati Choudhury	CSIR-NAL

Metamaterials by the USA ICCES Society on June 2017 at Madeira, Portugal.		
Gold Medal in “Electronics and Tele Communication Engineering discipline”	Dr. M Sendil Murugan	CSIR-NAL
ISAMPE Award for Outstanding Design and/or Process Development	Dr. P Pitchai & Dr. D Saji	CSIR-NAL
N M Sampat Award by The Electrochemical Society of India, Bengaluru	Dr. Meenu Srivastava	CSIR-NAL
Elected as a member of the Executive Board of the World Federation of Culture Collections- 2017	Dr. G.S. Prasad	CSIR-IMT
INSERM CRI Fellowship, France-2017	Dr. Anshu Bhardwaj	CSIR-IMT
Sun Pharma Science Foundation Award	Dr. Anil Koul	CSIR-IMT
Swarna Jayanti Fellowship Award-2017	Dr. Ashwani Kumar	CSIR-IMT
Kharaka Award from the International Association of Geochemistry,	Dr. Parthasarathi Chakraborty	CSIR-NIO
National Award of Excellence in the field of Geoscience & Technology for the year 2017	Dr. K.S. Krishna	CSIR-NIO
Indian Society of Applied Geochemists (ISAG) Medal-2017 for the best contribution in the field of “Hydrogeology and Environmental Geochemistry”	Dr. Parthasarathi Chakraborty	CSIR-NIO
Fellow of Andhra Pradesh Akademi of Sciences	Dr. S. Lakshminarayana	CSIR-NIO
SKOCH Order-of-Merit Award	Team CSIR-NIO	CSIR-NIO
Raman Research Fellowship	Dr. NG Rudraswami	CSIR-NIO
Hanse-Wissenschaftskolleg (HWK) postdoctoral fellowship	Dr. Lata Gawade Velip	CSIR-NIO

Indo-Japanese Fellowship	Dr. Firoz Badesab	CSIR-NIO
Full Bright Fellowship	Dr. Shital Godad	CSIR-NIO
Fulbright Kalam Climate Fellowship	Shri Kalyan De	CSIR-NIO
National Academy of Sciences (NASI) Springer Best Paper Award 2017	Ms. Poornima Dhawaskar	CSIR-NIO

Annexure – II

CSIR Patent Applications Filed and Patents Granted in India and abroad				
	India		Abroad*	
	Filed	Granted	Filed	Granted
CSIR-AMPRI	0	0	4	1
CSIR-CBRI	0	0	0	0
CSIR-CCMB	0	0	0	4
CSIR-CDRI	3	16	3	9
CSIR-CECRI	2	3	0	11
CSIR-CEERI	0	1	0	0
CSIR-CFTRI	5	10	1	1
CSIR-CGCRI	1	5	0	14
CSIR-CIMAP	2	1	2	1
CSIR-CIMFR	3	3	0	1
CSIR-CLRI	14	6	8	5
CSIR-CMERI	11	1	1	0
CSIR-CRRI	1	0	0	0
CSIR-CSIO	7	0	3	0
CSIR-CSIR(SCH)	3	4	2	0
CSIR-CSMCRI	13	15	10	19
CSIR-4PI	0	0	0	0
CSIR-IGIB	0	0	0	11
CSIR-IHBT	2	1	0	7
CSIR-IICB	2	1	3	2
CSIR-IICT	9	22	9	19
CSIR-IIIM	5	1	18	15
CSIR-IIP	3	11	9	13
CSIR-IITR	0	0	0	0
CSIR-IMMT	3	5	4	2
CSIR-IMT	5	1	9	13
CSIR-NAL	2	5	3	6
CSIR-NBRI	0	3	3	5
CSIR-NCL	54	22	100	209
CSIR-NEERI	2	5	0	30
CSIR-NEIST	2	8	3	4
CSIR-NGRI	0	0	0	1
CSIR-NIIST	3	8	3	14
CSIR-NIO	0	1	0	0
CSIR-NMITLI	0	0	1	11
CSIR-NML	6	8	1	0
CSIR-NPL	6	5	3	9
CSIR-SERC(M)	1	0	0	0
TOTAL	**170**	**172**	**203**	**437**
* Data may increase later, during national phase entry				

Annexure - IIA

Foreign Patents Granted to CSIR

CSIR-AMPRI				
S.No	**Country**	**Patent No**	**Title Of Invention**	**Inventors**
1	United States Of America	9890081	Functionalized Brine Sludge Material And A Process For The Preparation Thereof	Amritphale Sudhir Sitaram, Verma Sarika, Das Satyabrata
CSIR-CCMB				
S.No	**Country**	**Patent No**	**Title Of Invention**	**Inventors**
2	Switzerland	Ep2706840	Wdr13 As A Novel Biomarker Useful For Treating Diabetes And Cancer	Satish Kumar, Vijay Pratap Singh
3	Germany	Ep2706840	Wdr13 As A Novel Biomarker Useful For Treating Diabetes And Cancer	Satish Kumar, Vijay Pratap Singh
4	European Patent Office	Ep2706840	Wdr13 As A Novel Biomarker Useful For Treating Diabetes And Cancer.	Satish Kumar, Vijay Pratap Singh
5	France	Ep2706840	Wdr13 As A Novel Biomarker Useful For Treating Diabetes And Cancer	Satish Kumar, Vijay Pratap Singh
CSIR-CDRI				
S.No	**Country**	**Patent No**	**Title Of Invention**	**Inventors**
6	African Regional Intellectual Property Organization	Ap 4321	Carbodithioates And Process For Preparation Thereof	Vishanu Lal Sharma, Nand Lal, Amit Sarswat, Santosh Jangir, Veenu Bala, Lalit Kumar, Tara Rawat, Ashish Jain, Lokesh Kumar, Jagdamba Prasad Maikhuri, Gopal Gupta
7	Australia	2014208337	Antidiabetic And Antidyslipidemic Activities Of Pregnane-Oximino-Aminoalkylethers	Prem Chandra Verma, Jyoti Gupta, Dharmendra Pratap Singh, Varsha Gupta, Hari Narayan Kushwaha, Anamika Misra, Neha Rahuja, Rohit

				Srivastava, Natasha Jaiswal, Ashok Kumar Khanna, Akhilesh Kumar Tamrakar, Shio Kumar Singh, Anil Kumar Dwivedi, Arvind Kumar Srivastava, Ram Pratap
8	Canada	2720038	Novel Donor-Acceptor Flurene Scaffolds:A Process And Uses Thereof	Atul Goel, Sumit Chaurasia, Vijay Kumar, Sundar Manoharan, Rs Anand
9	Canada	2753993	Polymeric Nanomatrix Associated Delivery Of Kaempferol In Rats To Improve Its Osteogenic Action	Prabhat Ranjan Mishra, Ritu Trivedi, Girish Kumar Gupta, Avinash Kumar, Varsha Gupta, Srikanta Kumar Rath, Kamini Srivastava, Naibedya Chattopadhyay, Anil Kumar Dwivedi
10	European Patent Office	3039010	Novel Aryl Naphthyl Methanone Oxime Derivatives For The Treatment Of Hematological Malignancies And Solid Tumors	Sabyasachi Sanyal, Atul Kumar, Naibedya Chattopadhyay, Jawahar Lal, Arun Kumar Trivedi, Dipak Datta, Srikanta Kumar Rath, Tahseen Akhtar, Shailendra Kumar Dhar Dwivedi, Manisha Yadav, Bandana Chakravarti, Abhishek Kumar Singh, Jay Sharan Mishra, Nidhi Singh, Anil Kumar Tripathi
11	Ghana	Ap 4321	Carbodithioates And Process For Preparation Thereof	Vishanu Lal Sharma, Nand Lal, Amit Sarswat, Santosh Jangir, Veenu Bala, Lalit Kumar, Tara Rawat, Ashish Jain, Lokesh Kumar, Jagdamba Prasad Maikhuri, Gopal Gupta
12	United States Of America	9820968	An Anti-Leukemic Agent Useful For Inducing Differentiation In Myeloid Leukemia Cells	Pooja Pal, Savita Lochab, Jitendra Kumar Kanuajiya, Sabyasachi Sanyal, Arun Kumar Trivedi
13	United States Of America	9687480	Chiral 3-Aminomethylpiperidine Derivative As Inhibitors Of Collagen Induced Platelet Activation And Adhesion	Dinesh Kumar Dikshit, Madhu Dikshit, Tanveer Irshad Siddiqui, Anil Kumar, Rabi Sankar Bhatta, Girish Kumar Jain, Manoj Kumar Barthwal, Ankita Misra, Vivek Khanna, Prem Prakash, Manish Jain, Vishal Singh, Varsha Gupta, Anil Kumar Dwivedy

14	Zimbabwe	Ap 4321	Carbodithioates And Process For Preparation Thereof	Vishanu Lal Sharma, Nand Lal, Amit Sarswat, Santosh Jangir, Veenu Bala, Lalit Kumar, Tara Rawat, Ashish Jain, Lokesh Kumar, Jagdamba Prasad Maikhuri, Gopal Gupta
CSIR-CECRI				
S.No	**Country**	**Patent No**	**Title Of Invention**	**Inventors**
15	Canada	2717354	New Types Of Self-Supported Polymeric Hybrid-Membranes For Air Humidification In Polymer Electrolyte Fuel Cell Stacks	Ashok Kumar Shukla, Sethuraman Pitchumani, Parthasarathi Sridhar, Santoshkumar Dattatray Bhat, Ayyappan Manokaran, Akhila Kumar Sahu
16	Germany	2630685	Process For The Preparation Of High Voltage Nano Composite Cathode (4.9v) For Lithium Ion Batteries	Sukumaran Gopukumar, Chandrasekaran Nithya, Ramasamy Thirunakaran, Arumugam Sivashanmugam
17	European Patent Office	2675758	An Improved Electrochemical Coagulation Process For The Removal Of Nitrate From Drinking Water	Subramanyan Vasudevan, Epron Florence, Subbiah Ravichandran, Ganapathy Sozhan, Swaminathan Mohan, Jothinathan Lakshmi
18	European Patent Office	2630685	Process For The Preparation Of High Voltage Nano Composite Cathode (4.9v) For Lithium Ion Batteries	Sukumaran Gopukumar, Chandrasekaran Nithya, Ramasamy Thirunakaran, Arumugam Sivashanmugam
10	Spain	2675758	An Improved Electrochemical Coagulation Process For The Removal Of Nitrate From Drinking Water	Subramanyan Vasudevan, Epron Florence, Subbiah Ravichandran, Ganapathy Sozhan, Swaminathan Mohan, Jothinathan Lakshmi
20	France	2675758	An Improved Electrochemical Coagulation Process For The Removal Of Nitrate From Drinking Water	Subramanyan Vasudevan, Epron Florence, Subbiah Ravichandran, Ganapathy Sozhan, Swaminathan Mohan, Jothinathan Lakshmi
21	France	2630685	Process For The Preparation Of High Voltage Nano Composite Cathode (4.9v) For Lithium Ion Batteries	Sukumaran Gopukumar, Chandrasekaran Nithya, Ramasamy Thirunakaran, Arumugam Sivashanmugam

22	United Kingdom	2675758	An Improved Electrochemical Coagulation Process For The Removal Of Nitrate From Drinking Water	Subramanyan Vasudevan, Epron Florence, Subbiah Ravichandran, Ganapathy Sozhan, Swaminathan Mohan, Jothinathan Lakshmi
23	United Kingdom	2630685	Process For The Preparation Of High Voltage Nano Composite Cathode (4.9v) For Lithium Ion Batteries	Sukumaran Gopukumar, Chandrasekaran Nithya, Ramasamy Thirunakaran, Arumugam Sivashanmugam
24	United States Of America	9882206	Cathode Material And Lithium Ion Battery Therefrom	Sukumaran Gopukumar, Chandrasekaran Nithya, Ramasamy Thirunakaran, Arumugam Sivashanmugam
25	United States Of America	9863045	An Electrochemical Process For The Preparation Of Metallic Lead Foam	Manikka Venkatachalapathi Thulasiram Dhananjeyan, Kopula Kesavan Jagadesh, Giri Nagasamy Kuppusamy Ramesh Babu, Somasundaram Ambalavanan, Ramachandran Sekar
CSIR-CFTRI				
S.No	**Country**	**Patent No**	**Title Of Invention**	**Inventors**
26	Philippines	1-2006-501270	Bael Fruit Powder And Method For The Preparation Of Same	Navin Kumar Rastogi, Hangalore Umesh Hebbar, Rangaswamy Subramanian, Shankramthadathil Gangadharan Jayaprakash, Mahadeva
CSIR-CGCRI				
S.No	**Country**	**Patent No**	**Title Of Invention**	**Inventors**
27	Switzerland	2845009	An Improved Sensor Composition For Acetone Detection In Breath For Diabetic Diagnostics	Amarnath Sen, Subhasis Rana
28	Czech Republic	3001834	A Process For Fabrication Of Rare Earth Doped Optical Fiber Through Vapor Phase Doping Technique	Ranjan Sen, Maitreyee Saha
29	Germany	2845009	An Improved Sensor Composition For Acetone	Amarnath Sen, Subhasis Rana

			Detection In Breath For Diabetic Diagnostics	
30	Germany	3001834	A Process For Fabrication Of Rare Earth Doped Optical Fiber Through Vapor Phase Doping Technique	Ranjan Sen, Maitreyee Saha
31	Denmark	3001834	A Process For Fabrication Of Rare Earth Doped Optical Fiber Through Vapor Phase Doping Technique	Ranjan Sen, Maitreyee Saha
32	European Patent Office	2845009	An Improved Sensor Composition For Acetone Detection In Breath For Diabetic Diagnostics	Ranjan Sen, Maitreyee Saha
33	European Patent Office	3001834	A Process For Fabrication Of Rare Earth Doped Optical Fiber Through Vapor Phase Doping Technique	Ranjan Sen, Maitreyee Saha
34	Finland	3001834	A Process For Fabrication Of Rare Earth Doped Optical Fiber Through Vapor Phase Doping Technique	Ranjan Sen, Maitreyee Saha
35	France	3001834	A Process For Fabrication Of Rare Earth Doped Optical Fiber Through Vapor Phase Doping Technique	Ranjan Sen, Maitreyee Saha
36	United Kingdom	2845009	An Improved Sensor Composition For Acetone Detection In Breath For Diabetic Diagnostics	Amarnath Sen, Subhasis Rana
37	United Kingdom	3001834	A Process For Fabrication Of Rare Earth Doped Optical Fiber Through Vapor Phase Doping Technique	Amarnath Sen, Subhasis Rana
38	Italy	2845009	An Improved Sensor Composition For Acetone Detection In Breath For Diabetic Diagnostics	Amarnath Sen, Subhasis Rana
39	Slovenia	3001834	A Process For Fabrication Of Rare Earth Doped Optical Fiber Through Vapor Phase Doping Technique	Ranjan Sen, Maitreyee Saha
40	Taiwan	I596339	An Improved Sensor Composition For Acetone	Amarnath Sen, Subhasis Rana

			Detection In Breath For Diabetic Diagnostics	
CSIR-CIMAP				
S.No	**Country**	**Patent No**	**Title Of Invention**	**Inventors**
41	United States Of America	Pp28388	Vetiver Plant Named `Cimap-Khusinolika`	Harmesh Singh Chauhan, Hemendra Pratap Singh, Chandan Singh Chanotiya, Ajit Kumar Shasany, Umesh Chandra Lavania, Virendra Kumar Singh Tomar, Alok Kalra, Ashok Kumar Singh
CSIR-CIMFR				
S.No	**Country**	**Patent No**	**Title Of Invention**	**Inventors**
42	United Kingdom	Gb2481940	Tracking And Monitoring System For Opencast Mines	Lakshmi Kanta Bandyopadhyay, Swades Kumar Chaulya, Pankaj Kumar Mishra
CSIR-CLRI				
S.No	**Country**	**Patent No**	**Title Of Invention**	**Inventors**
43	Germany	3094754	A Novel Composition For Water Free, Pickle Free Chrome Tanning Without Medium And A Chrome Tanning Process Thereof	Chellappa Muralidharan
44	European Patent Office	3094754	A Novel Composition For Water Free, Pickle Free Chrome Tanning Without Medium And A Chrome Tanning Process Thereof	Chellappa Muralidharan
45	France	3094754	A Novel Composition For Water Free, Pickle Free Chrome Tanning Without Medium And A Chrome Tanning Process Thereof	Chellappa Muralidharan
46	Italy	3094754	A Novel Composition For Water Free, Pickle Free Chrome Tanning Without Medium And A Chrome Tanning Process Thereof	Chellappa Muralidharan
47	Turkey	3094754	A Novel Composition For Water Free, Pickle Free Chrome Tanning Without	Chellappa Muralidharan

			Medium And A Chrome Tanning Process Thereof	
CSIR-CSMCRI				
S.No	**Country**	**Patent No**	**Title Of Invention**	**Inventors**
48	African Regional Intellectual Property Organization	Ap4180	Production Of Potable Water From Highly Saline Sub-Soil Brine In Salt Works Using Exhaust Waste Heat Form Diesel Engine Employed Round The Clock During The Salt Manufacturing Season To Charge The Salt Pans With Susoil Brine	Pushpito Kumar Ghosh, Girish Rajanikant Desale, Bhavin Hasmukhlal Khatri, Rajeshkumar Naranbhai Patel, Sanatkumar Natavarlal Patel, Gajjar Mahesh Ramjibhai, Borle Niitin Ganesh
49	African Regional Intellectual Property Organization	3854	An Enviornment Friendly Cycle Process For The Production Of High Purity Soda Ash With Reduced Fluoride Content From Mineral Trona	Maheshkumar Ramniklal Gandhi, Jatin Rameshchandra Chunawala, Pratyush Maiti, Kiritkumar Mangaldas Popat
50	Australia	2013328229	Biodegradable Hydrophobic Composite Materials And Process For The Preparation Thereof	Meena Ramavatar, Ghosh Pushpito Kumar, Chejara Dharmesh, Eswaran Karuppanan, Siddhanta Arup Kumar, Prasad Kamalesh, Chaudhary Jai Prakash
51	Australia	2013234427	Method Of Recycling Of By-Products For The Production Of Soda Ash And Ammonium Sulphate	Pushpito Kumar Ghosh, Haresh Mahipatlal Mody, Rajesh Shantilal Somani, Pratyush Maiti, Maheshkumar Ramniklal Gandhi, Hari Chand Bajaj, Jatin Rameshchandra Chunawala, Sumesh Chandra Upadhyay
52	Brazil	Pi0205773-5	Preparation Of Nutriant Rich Salt Of Plant Origin	Kumar P, Reddy Mp, Pandya Jb, Shambhubhai J, Vaghela Sm, Gandhi Mr, Sanghvi Rj, Kumar Vgs, Shan Mt
53	Canada	2756520	Improved Process For The Preparation Of Agarose Polymer From Seaweed Extractive	Ramavatar Meena, Kamalesh Prasad, Arup Kumar Siddhanta, Pushpito Kumar Ghosh, Gauravkumar Kishor Mehta, Bharatkumar Kalidas Ramavat, Meenakshi Sundaram Ganesan, Bhavanath Jha, Avinash Mishra, Mahesh Ramniklal Gandhi, Pradeep Kumar

				Agarwal, Karuppanan Eswaran
54	Germany	2834193	Production Of High Purity Salt With Reduced Levels Of Impurities	Pushpito Kumar Ghosh, Sumesh Chandra Upadhyay, Vadakke Puthoor Mohandas, Rahul Jasvantrai Sanghavi, Babulal Rebary
55	European Patent Office	2544995	Preparation Of Inorganic Hydrogels With Alkali Halides	Ajeet Singh, Bishwajit Ganguly
56	European Patent Office	2791095	An Improved Process For The Preparation Of 2-Phenyl Ethanol By Catalytic Hydrogenation Of Styrene Oxide	Hari Chand Bajaj, Sayed Hasan Razi Abdi, Rukhsana Ilyas Kureshy, Noor-Ul Hasan Khan, Aasif Asharafbhai Dabbawala, Tamal Roy
57	European Patent Office	2834193	Production Of High Purity Salt With Reduced Levels Of Impurities	Pushpito Kumar Ghosh, Sumesh Chandra Upadhyay, Vadakke Puthoor Mohandas, Rahul Jasvantrai Sanghavi, Babulal Rebary
58	United Kingdom	2544995	Preparation Of Inorganic Hydrogels With Alkali Halides	Ajeet Singh, Bishwajit Ganguly
59	United Kingdom	2834193	Production Of High Purity Salt With Reduced Levels Of Impurities	Pushpito Kumar Ghosh, Sumesh Chandra Upadhyay, Vadakke Puthoor Mohandas, Rahul Jasvantrai Sanghavi, Babulal Rebary
60	United Kingdom	2791095	An Improved Process For The Preparation Of 2-Phenyl Ethanol By Catalytic Hydrogenation Of Styrene Oxide	Hari Chand Bajaj, Sayed Hasan Razi Abdi, Rukhsana Ilyas Kureshy, Noor-Ul Hasan Khan, Aasif Asharafbhai Dabbawala, Tamal Roy
61	Jordan	3125	Process For Production Of Sulphate Of Potash From Bittern Through Selective Extraction Of Pottasium	Pratyush Maiti, Pushpito Kumar Ghosh, Mahesh Ramniklal Gandhi, Jignesh Solanki, Harshad Raman Rahmbhatt
62	Philippines	1-2011501869	Improved Process For The Preparation Of Agarose Polymer From Seaweed Extractive	Ramavatar Meena, Kamalesh Prasad, Arup Kumar Siddhanta, Pushpito Kumar Ghosh, Gauravkumar Kishor Mehta, Bharatkumar Kalidas Ramavat, Meenakshi Sundaram Ganesan,

				Bhavanath Jha, Avinash Mishra, Mahesh Ramniklal Gandhi, Pradeep Kumar Agarwal, Karuppanan Eswaran
63	United States Of America	9745432	Novel Ion Exchange Membrane And The Process Of Preparation Thereof	Uma Chatterjee, Suresh Kumar Jewrajka, Sreekumaran Thampy
64	United States Of America	9908790	Improved Household Solar Still With Easy Operation And Maintenance And Enhanced Output	Subarna Maiti, Pankaj Arvindbhai Patel, Chitangi Bhatt, Jitendra Narsinhbhai Bharadia, Mahesh Ramjibhai Gajjar, Pratap Sashikant Bapat, Pushpito Kumar Ghosh
65	United States Of America	9675098	Double Fortified Salt Composition Containing Iron And Iodine And Process Of Preparation Thereof	Jatin Rameshchandra Chunawala, Pushpito Kumar Ghosh, Maheshkumar Ramniklal Gandhi, Satish Hariray Mehta, Mrunalben Vinodray Sheth
66	United States Of America	9736984	A Device For Efficient And Cost-Effective Seaweed Harvesting For Large-Scale Commercial Application	Pushpito Kumar Ghosh, Vaibhav Ajit Mantri, Jayanta Kumar Pothal, Veeraprakasam Veeragurunathan, Sangaiya Thiruppathi
CSIR-IGIB				
S.No	**Country**	**Patent No**	**Title Of Invention**	**Inventors**
67	Germany	2709727	Method To Modulate Pigmentation Process In The Melanocytes Of Skin	Gokhale Rajesh Sudhir, Natarajan Vivek Turunelveli, Ganju Parul
68	Denmark	2709727	Method To Modulate Pigmentation Process In The Melanocytes Of Skin	Gokhale Rajesh Sudhir, Natarajan Vivek Turunelveli, Ganju Parul
69	European Patent Office	2916873	Novel Amphipathic Mgpe Peptides For Efficient Transfection Of Biomolecules	Ganguli Munia, Rajpal, Shivpuri Shivangi
70	European Patent Office	2709727	Method To Modulate Pigmentation Process In The Melanocytes Of Skin	Gokhale Rajesh Sudhir, Natarajan Vivek Turunelveli, Ganju Parul

71	Spain	2709727	Method To Modulate Pigmentation Process In The Melanocytes Of Skin	Gokhale Rajesh Sudhir, Natarajan Vivek Turunelveli, Ganju Parul
72	Finland	2709727	Method To Modulate Pigmentation Process In The Melanocytes Of Skin	Gokhale Rajesh Sudhir, Natarajan Vivek Turunelveli, Ganju Parul
73	France	2709727	Method To Modulate Pigmentation Process In The Melanocytes Of Skin	Gokhale Rajesh Sudhir, Natarajan Vivek Turunelveli, Ganju Parul
74	United Kingdom	2916873	Novel Amphipathic Mgpe Peptides For Efficient Transfection Of Biomolecules	Ganguli Munia, Rajpal, Shivpuri Shivangi
75	Italy	2709727	Method To Modulate Pigmentation Process In The Melanocytes Of Skin	Gokhale Rajesh Sudhir, Natarajan Vivek Turunelveli, Ganju Parul
76	United States Of America	9738684	N-Terminally Modified Linear And Branched Polyamine Conjugated Peptidomimetics As Antimicrobials Agents	Pasha Santosh, Dewangan Rikeshwer Prasad, Joshi Seema
77	United States Of America	9669104	Novel Amphipathic Mgpe Peptides For Efficient Transfection Of Biomolecules	Ganguli Munia, Rajpal, Shivpuri Shivangi
CSIR-IHBT				
S.No	**Country**	**Patent No**	**Title Of Invention**	**Inventors**
78	European Patent Office	2268661	A Method For Cloning Functional Gene Of Copper/Zinc Superoxide Dismutases Using Oligonucleotide Primers	Bhardwaj Pardeep Kumar, Kumar Arun, Kishore Amit, Ghawana Sanjay, Rani Arti, Singh Kashmir, Singh Harsharan, Singh Ravi Shankar, Kumar Hitesh, Sood Payal, Dutt Som, Kumar Sanjay, Ahuja Paramvir Singh
79	United Kingdom	2268661	A Method For Cloning Functional Gene Of Copper/Zinc Superoxide Dismutases Using Oligonucleotide Primers	Bhardwaj Pardeep Kumar, Kumar Arun, Kishore Amit, Ghawana Sanjay, Rani Arti, Singh Kashmir, Singh Harsharan, Singh Ravi Shankar, Kumar Hitesh, Sood Payal, Dutt Som, Kumar Sanjay, Ahuja Paramvir Singh

80	Japan	6186379	An Economical Process For Purification Of Bio Amino Acids	Harsh Pratap Singh, Ajay Rana
81	Mexico	346985	A Method For Enhancing Status Of Carbon, Nitrogen, Biomass And Yield Of Plants	Anish Kaachra, Surender Kumar Vats, Paramvir Singh Ahuja, Sanjay Kumar
82	Philippines	1/2013/502175	A Method For Enhancing Status Of Carbon, Nitrogen, Biomass And Yield Of Plants	Anish Kaachra, Surender Kumar Vats, Paramvir Singh Ahuja, Sanjay Kumar
83	United States Of America	9872448	A Bioreactor Vessel For Large Scale Growing Of Plants Under Aseptic Conditions	Rajesh Thakur, Anil Sood, Paramvir Singh Ahuja
84	Vietnam	18153	A Field Convenient Jacketed Leaf Inactivator For Green Tea Processing	Garikapati Dyva Kiran Babu, Ravindranath Srigiripuram Desikachar
CSIR-IICB				
S.No	**Country**	**Patent No**	**Title Of Invention**	**Inventors**
85	Australia	2012213070	A Synthetic Peptide Formulation Against Melanoma And Other Cancers Over-Expressing S100b	Amlanjyoti Dhar, Shampa Mallick, Israr Ahmed, Aditya Konar, Santu Bandyopadhyay, Siddhartha Roy
86	United States Of America	9642854	Development Of A Bifunctional Molecule 5-Hydroxy-2-Phenyl-7-(6-Piperidin-1-Yl-Hexyloxy)-4h-Benzpyran-4-One As Anti Helicobacter Pylori And Gastric Antisecretory Agent	Pratap Kumar Das, Suchandra Goswami, Annalakshmi Chinniah, Janaswamy Madhusudana Rao, Katragadda Suresh Babu
CSIR-IICT				
S.No	**Country**	**Patent No**	**Title Of Invention**	**Inventors**
87	Australia	2013288213	A Process For The Preparation Of Karanja Oil-Based Epoxy And Acyloxy Compounds As Lubricant Basestocks	Korlipara Venkata Padmaja, Mallampalli Sri Lakshmi Karuna, Krishnasamy Saravanan, Rachapudi Badari Narayana Prasad
88	Canada	2779656	Electrodialysis-Distillation Hybrid Process For The Recovery Of Dimethylsulfoxide (Dmso) Solvent From Pharmaceutical Industrial Effluent	Yerrapragada Venkata Lakshmi Ravikumar, Kunduvelil Sreedhara Menon Raghunandanan, Mannava Giridhara Venkata Chalapathi Rao, Kammara Sunitha, Boinee Vishwanadham, Sundergopal Sridhar,

				Cheerkapally Potulapally Ramulu
89	Germany	11 2007 003 607	Preparation Of Solid Heterogeneous Acid Catalyst From Crude Glycerol And Other Organic Compounds And Their Application In The Esterification Of Fatty Acids For The Preparation Of Biodiesel(Alkyl Esters Of Fatty Acids)	Bethala Lakshmi Anu Prabhavathi Devi, Katkam Nadpi Gangadhar, Potharaju Seetharamanjaneya Sai Prasad, Rachapudi Badari N
90	Germany	2942345	Novel 3,4,5-Trimethoxystyrylarylaminopropenones As Potential Anticancer Agents	Ahmed Kamal, Gajjela Bharath Kumar, Anver Basha. Shaik, Vangala Santhosh Reddy, Mahesh Rasala
91	Germany	De 11 2012 000807	Pyrrolo[2,1-C][1,4]Naphthodiazepine Linked Substituted Piperazine Conjugates As Potential Antitumour Agents And Process For The Preparation Thereof	Ahmed Kamal, Jayanti Naga Srirama Chandra Murty, Arutla Viswanath
92	European Patent Office	2942345	Novel 3,4,5-Trimethoxystyrylarylaminopropenones As Potential Anticancer Agents	Ahmed Kamal, Gajjela Bharath Kumar, Anver Basha. Shaik, Vangala Santhosh Reddy, Mahesh Rasala
93	European Patent Office	1986670	New Intestinal Alpha-Glucosidase Inhibitors From Natural Source Adn Use Thereof	Janaswamy Madhusudana Rao, Katragadda Suresh Babu, Ashok Kumar Tiwari, Tatipaka Hari Babu, Pullela Venkata Srinivas, Suryadeva Praveen Kumar, Boggavarapu Subrahmanya Sastry, Jhillu Singh Yadav
94	France	2942345	Novel 3,4,5-Trimethoxystyrylarylaminopropenones As Potential Anticancer Agents	Ahmed Kamal, Gajjela Bharath Kumar, Anver Basha. Shaik, Vangala Santhosh Reddy, Mahesh Rasala
95	United Kingdom	2942345	Novel 3,4,5-Trimethoxystyrylarylaminopropenones As Potential Anticancer Agents	Ahmed Kamal, Gajjela Bharath Kumar, Anver Basha. Shaik, Vangala Santhosh Reddy, Mahesh Rasala
96	United Kingdom	Gb2501403	3-Arylethynyl Substituted Quinazolinone Compounds	Ahmed Kamal, Farheen Sultana, Erla Vijaya Bharathi, Yellamelli Valli Venkata Srikanth, Arutla Viswanath, Ponnampalli Swapna
97	United Kingdom	2499154	Pyrrolo[2,1-C][1,4]Naphthodiazepine Linked Substituted	Ahmed Kamal, Jayanti Naga Srirama Chandra Murty, Arutla Viswanath

			Piperazine Conjugates As Potential Antitumour Agents And Process For The Preparation Thereof	
98	United States Of America	9925298	Porous Polymer Scaffold Useful For Tissue Engineering In Stem Cell Transplantation	Amitava Das, Pratyay Basak, Ramasatyaveni Geesala, Nimai Bar, Neha Raghuvir Dhoke, Komal Kaushik
99	United States Of America	9783537	Synthesis And Biological Evaluation Of 3-(4-Ethynylphenyl) Pyridopyrimidinone Compounds As Potential Anticancer Agents	Ahmed Kamal, Ranjita Nayak, Farheen Sultana
100	United States Of America	9840530	Process For Synthesis Of Novel Mannose - Receptor Selective Lysinylated Cationic Amphiphile For Invivo Delivery Of Dna Vaccines	Arup Garu, Gopikrishna Moku, Sachin Barad Agawane, Arabinda Chaudhuri
101	United States Of America	9776162	Cuo -Tio2 Nanocomposite Photocatalyst For Hydrogen Production, Process For The Preparation Thereof	Valluri Durga Kumari, Machiraju Subrahmanyam, Basavaraju Srinivas, Gullapelli Sadanandam, Muthukonda Venkatakrishnan Shankar, Bethanabhatla Syama Sundar, Murikinati Mamatha Kumari, Dharani Praveen Kumar
102	United States Of America	9763881	Rice Bran-Lipids Based Formulation And Process For Preparation Thereof For Selective Delivery Of Genes To Cancer Cells	Roy Sayantani, Banerjee Rajkumar, Chakrabarti Pradosh Prasad, Rachapudi Badari Narayana Prasad
103	United States Of America	9611255	A Process For Total Synthesis Of Flavonoid Compounds And Isomers Thereof	Batchu Venkateswara Rao, Macha Lingamurthy, Gurrapu Raju, Vanka Umamaheswara Sarma
104	United States Of America	9878977	N-((3,4,5-Trimethoxystyryl)Aryl)Cinnamide Compounds As Potential Anticancer Agents And Process For The Preparation Thereof	Ahmed Kamal, Shaik Bajee, Challa Ratna Reddy, Mohammed Shaheer Malik, Vadithe Lakshma Nayak
105	United States Of America	9861653	Anticancer Gene-Associated Cationic Lipid And Estrogenic Drug Formulation For The Treatment Of Aggressive Pancreatic Cancer And Breast Cancer Stem Cell (Csc)-Like Cells	Rajkumar Banerjee, Debabrata Mukhopadhyay

CSIR-IIIM				
S.No	**Country**	**Patent No**	**Title Of Invention**	**Inventors**
106	European Patent Office	3004116	Tetrahydro-2h-Pyrano [3,2-C] Isochromene-6-Ones And Analogs For The Treatment Of Inflammatory Disorders	Jain Shreyans Kumar, Sidiq Tabasum, Meena Samdarshi, Khajuria Anamika, Vishwakarma Ram Asrey, Bharate Sandip Bibishan
107	European Patent Office	2986605	Rohitukine Analogs As Cyclin-Dependent Kinase Inhibitors And A Process For The Preparation Thereof	Vishwakarma Ram Asrey, Bharate Sandip Bibishan, Bhushan Shashi, Mondhe Dilip Manikrao, Jain Shreyans Kumar, Meena Samdarshi, Guru Santosh Kumar, Pathania Anup Singh, Kumar Suresh, Behl Akanksha, Mintoo Mubashir Javed, Bharate Sonali Sandip, Joshi Prashant
108	European Patent Office	3039031	Brachiatin D And Process For Their Production Thereof	Deepika Singh, Jai Prakash Sharma, Sundeep Jaglan, Abid Hamid Dar, Anamika Khajuria, Varun Pratap Singh, Ram Asrey Vishwakarma
109	European Patent Office	2984078	New Chromone Alkaloid Dysoline For The Treatment Of Cancer And Inflammatory Disorders	Vishwakarma Ram Asrey, Jain Shreyans Kumar, Bharate Sandip Bibishan, Dar Abid Hamid, Khajuria Anamika, Meena Samdarshi, Bhola Sunil Kumar, Qazi Asif Khurdhid, Hussain Aashiq, Sidiq Tabasum, Uma Shaanker Ramanan, Ravikanth Gudasalamani, Vasudeva Ramesh, Mohana Kumara Patel, Ganeshaiah Kotiganahalli
110	United Kingdom	3039031	Brachiatin D And Process For Their Production Thereof	Deepika Singh, Jai Prakash Sharma, Sundeep Jaglan, Abid Hamid Dar, Anamika Khajuria, Varun Pratap Singh, Ram Asrey Vishwakarma
111	United Kingdom	2984078	New Chromone Alkaloid Dysoline For The Treatment Of Cancer And Inflammatory Disorders	Vishwakarma Ram Asrey, Jain Shreyans Kumar, Bharate Sandip Bibishan, Dar Abid Hamid, Khajuria Anamika, Meena Samdarshi, Bhola Sunil Kumar, Qazi Asif Khurdhid, Hussain Aashiq, Sidiq Tabasum, Uma Shaanker Ramanan, Ravikanth Gudasalamani, Vasudeva Ramesh, Mohana Kumara

				Patel, Ganeshaiah Kotiganahalli
112	United Kingdom	2986605	Rohitukine Analogs As Cyclin-Dependent Kinase Inhibitors And A Process For The Preparation Thereof	Vishwakarma Ram Asrey, Bharate Sandip Bibishan, Bhushan Shashi, Mondhe Dilip Manikrao, Jain Shreyans Kumar, Meena Samdarshi, Guru Santosh Kumar, Pathania Anup Singh, Kumar Suresh, Behl Akanksha, Mintoo Mubashir Javed, Bharate Sonali Sandip, Joshi Prashant
113	Japan	6126197	Design, Synthesis And Biological Evaluation Of Isoform Selective Analogs Of Liphagane Scaffold As Anticancer Agents: P13k-Alpha/Beta Inhibitors	Ram A Vishwakarma, Sanghapal Damodhar Sawant, Parvinder Pal Singh, Abid Hamid Dar, Parduman Raj Sharma, Ajit Kumar Saxena, Amit Nargotra, Kolluru Anjaneya Aravind Kumar, Mudududdla Ramesh, Asif Khurshid Qazi, Aashiq Hussain, Nayan Chanauria
114	Taiwan	I577687	Boronic Acid Bearing Liphagane Compounds As Inhibitors Of Pi3k-A And/Or ß	Ram A Vishwakarma, Sanghapal Damodhar Sawant, Parvinder Pal Singh, Abid Hamid Dar, Parduman Raj Sharma, Ajit Kumar Saxena, Amit Nargotra, Kolluru Anjaneya Aravind Kumar, Mudududdla Ramesh, Asif Khurshid Qazi, Aashiq Hussain, Nayan Chanauria
115	United States Of America	9777014	Tetrahydro-2h-Pyrano [3,2-C] Isochromene-6-Ones And Analogs For The Treatment Of Inflammatory Disorders	Jain Shreyans Kumar, Sidiq Tabasum, Meena Samdarshi, Khajuria Anamika, Vishwakarma Ram Asrey, Bharate Sandip Bibishan
116	United States Of America	9776989	New Chromone Alkaloid Dysoline For The Treatment Of Cancer And Inflammatory Disorders	Vishwakarma Ram Asrey, Jain Shreyans Kumar, Bharate Sandip Bibishan, Dar Abid Hamid, Khajuria Anamika, Meena Samdarshi, Bhola Sunil Kumar, Qazi Asif Khurdhid, Hussain Aashiq, Sidiq Tabasum, Uma Shaanker Ramanan, Ravikanth Gudasalamani, Vasudeva Ramesh, Mohana Kumara Patel, Ganeshaiah Kotiganahalli

117	United States Of America	9624266	Brachiatin D And Process For Their Production Thereof	Deepika Singh, Jai Prakash Sharma, Sundeep Jaglan, Abid Hamid Dar, Anamika Khajuria, Varun Pratap Singh, Ram Asrey Vishwakarma
118	United States Of America	9845330	6-Notro-2,3-Dihydroimidazo[2,1-B] Oxazoles And A Process For The Preparation Thereof	Parvinder Pal Singh, Gurunadham Munagala, Kushalava Reddy Yempalla, Inshad Ali Khan, Nitin Pal Kalia, Vikrant Singh Rajput, Amit Nargotra, Sanghapal Damodhar Sawant, Ram Asrey Vishwakarma
119	United States Of America	9868695	10-Substituted Colchicinoids As Potent Anticancer Agents	Vishwakarma Ram, Bharate Sandip Bibishan, Kumar Ajay, Singh Baljinder, Kumar Ashok, Bhushan Shashi, Hamid Abid, Joshi Prashant, Guru Santosh Kumar, Kumar Suresh, Hussain Aashiq, Qazi Asif Khurshid, Bharate Sonali Sandip, Sharma Parduman, Saxena Ajit Kumar, Mondhe Dilip Manikrao, Mahajan Girish, Wani Zahoor
120	United States Of America	9822126	Substituted 1,2,3-Triazol-1-Yl-Methyl-2,3-Dihydro-2-Methyl-6-Nitroimidazo[2,1-B]Oxazoles As Anti-Mycobacterial Agents And A Process For The Preparation Thereof	Yempalla Kushalava Reddy, Munagala Gurunadham, Singh Samsher, Sharma Sumit, Khan Inshad Ali, Vishwakarma Ram Asrey, Singh Parvinder Pal
CSIR-IIP				
S.No	**Country**	**Patent No**	**Title Of Invention**	**Inventors**
121	China	Cn104718276b	A Process For Production Of Benzene Lean Gasoline By Recovery Of High Purity Benzene From Unprocessed Cracked Gasoline Fraction Containing Organic Peroxides	Garg Madhukar Onkarnath, Nanoti Shrikant Madhusudan, Nautiyal Bhagat Ram, Sunil Kumar, Ghosh Prasenjit, Nisha, Yadav Pooja, Jagdish Kumar, Tiwari Manish, Rao Meka Raja Gopala, Murthy Nagarathinam Shenbaga
122	European Patent Office	2882830	A Process For Production Of Benzene Lean Gasoline By Recovery Of High Purity Benzene From Unprocessed Cracked Gasoline Fraction Containing Organic Peroxides	Garg Madhukar Onkarnath, Nanoti Shrikant Madhusudan, Nautiyal Bhagat Ram, Sunil Kumar, Ghosh Prasenjit, Nisha, Yadav Pooja, Jagdish Kumar, Tiwari Manish, Rao Meka Raja Gopala, Murthy Nagarathinam Shenbaga

123	Japan	6138938	A Process For Production Of Benzene Lean Gasoline By Recovery Of High Purity Benzene From Unprocessed Cracked Gasoline Fraction Containing Organic Peroxides	Garg Madhukar Onkarnath, Nanoti Shrikant Madhusudan, Nautiyal Bhagat Ram, Sunil Kumar, Ghosh Prasenjit, Nisha, Yadav Pooja, Jagdish Kumar, Tiwari Manish, Rao Meka Raja Gopala, Murthy Nagarathinam Shenbaga
124	Russia	2635923	A Process For Production Of Benzene Lean Gasoline By Recovery Of High Purity Benzene From Unprocessed Cracked Gasoline Fraction Containing Organic Peroxides	Garg Madhukar Onkarnath, Nanoti Shrikant Madhusudan, Nautiyal Bhagat Ram, Sunil Kumar, Ghosh Prasenjit, Nisha, Yadav Pooja, Jagdish Kumar, Tiwari Manish, Rao Meka Raja Gopala, Murthy Nagarathinam Shenbaga
125	Russia	2648239	A Single Step Catalytic Process For The Conversion Of Naphtha To Diesel Range Hydrocarbons	Nagabhatla Viswanadham, Peta Sreenivasulu, Saxena Sandeep Kumar, Panwar Rajiv, Nandan Devaki, Jadgish Kumar
126	United States Of America	9630167	Ni Nano-Cluster Supported On Mgo -Ceo2-Zro2 Catalyst For Tri-Reforming Of Methane And A Process For Preparation Thereof	Bordoloi Ankur, Singha Rajib Kumar, Bal Rajaram, Manoj Kumar, Pendem Chandrashekar
127	United States Of America	9714385	A Process For The Conversion Of Low Polymer Wax (A Byproduct Of Hdpe Plant) To Paraffin Wax, Microcrystalline Wax, Lube And Grease Base Stocks Using Organic Peroxides Or Hydro Peroxides And Metal Oxides	Khan Hayat Ullah, Sahai Manisha, Kumar Sanat, Kumar Ajay, Thakre Gananath Doulat, Kaul Savita, Nanoti Shrikant Madhusudan, Shukla Bal Mukund, Garg Madhukar Onkarnath, Thrissokaran Paulose Antony, Chaturvedi Ajit Kumar
128	United States Of America	9889434	Ni-Pt-Zro2 Nanocrystalline Oxide Catalyst And Process Thereof Useful For The Production Of Syngas By Combining Oxy- Dry Reforming Of Natural Gas	Bal Rajaram, Sarkar Bipul, Goyal Reena, Bordoloi Ankur, Pendem Chandrashekar, Konathala Laxmi Narayan Sivakumar
129	United States Of America	9908101	An Improved Process And Catalyst For The Selective Dehydrogenation / Oxidative Dehydrogenation Of Ethane To Ethylene	Bal Rajaram, Sarkar Bipul, Singha Rajib Kumar, Pendem Chandrashekar, Shankha Shubhra Acharyya, Ghosh Shilpi
130	United States Of America	9856500	Consolidated Bio Processing For Production Of L (+) - Lactic Acid And/Or Lactate.	Adhikari Dilip Kumar, Trivedi Jayati, Agrawal Deepti

131	United States Of America	9758460	Process For Recovery Of Pure Components From Product Mixture Of One Step Dimethyl Ether Synthesis Reactor	Sunil Kumar, Nanoti Shrikant Madhusudan, Garg Madhukar Onkarnath
132	United States Of America	9610569	A Process For The Preparation Of Ni-Cemgal2o4 Catalyst For Dry Reforming Of Methane With Carbon Dioxide	Bordoloi Ankur, Das Subhasis, Goyal Reena, Singha Rajib Kumar, Pendem Chandrashekar, Konathala Laxmi Narayan Sivakumar, Bal Rajaram, Vemulapalli Venkata Durga Nagendra Prasad, Botcha Neelam Naidu, Manoj Kumar
133	United States Of America	9638680	An Improved Method For The Colorimetric Detection Of Water In Hydrocarbon Fuels	Khatri Praveen Kumar, Jain Suman Lata, Ghosh Indrajit Kumar, Umesh Kumar, Chatterjee Alok Kumar, Garg Madhukar Onkarnath
CSIR-IMMT				
S.No	**Country**	**Patent No**	**Title Of Invention**	**Inventors**
134	United States Of America	9879331	A Green Process For The Preparation Of Pure Iron	Bhagyadhar Bhoi, Barada Kanta Mishra, Chinmaya Kumar Sarangi, Pravas Ranjan Behera, Priyanka Rajput, Partha Sarathi Mukherjee, Snigdha Priyadarshini
135	United States Of America	9630844	Hydrometallurgical Process For The Recovery Of Tellurium From High Lead Bearing Copper Refinery Anode Slime	Tondepu Subbaiah, Barada Kanta Mishra, Malay Kumar Ghosh, Kali Sanjay, Indra Narayan Bhattacharya, Chinmaya Kumar Sarangi, Barsha Dash, Abdul Rauf Sheik
CSIR-IMT				
S.No	**Country**	**Patent No**	**Title Of Invention**	**Inventors**
136	Germany	2859100	An Expression Vetor Containing A Strong Promoter Useful For High Level Expression Heterologous Gene In Schizosaccharomyces Pombe And Method For Production Of Desired Proteins Thereof	Jagmohan Singh, Hemant Kumar Verma
137	European Patent Office	2600891	Protein Fusion Constructs Possessing Thrombolytic And Anticoagulant Properties	Neeraj Maheshwari, Girish Sahni

138	European Patent Office	2986720	Novel Uricase Mutant	Prasad Gandham Satyanarayana, Yelchuri Ravikumar
139	European Patent Office	2859100	An Expression Vetor Containing A Strong Promoter Useful For High Level Expression Heterologous Gene In Schizosaccharomyces Pombe And Method For Production Of Desired Proteins Thereof	Jagmohan Singh, Hemant Kumar Verma
140	France	2859100	An Expression Vetor Containing A Strong Promoter Useful For High Level Expression Heterologous Gene In Schizosaccharomyces Pombe And Method For Production Of Desired Proteins Thereof	Jagmohan Singh, Hemant Kumar Verma
141	France	2986720	Novel Uricase Mutant	Prasad Gandham Satyanarayana, Yelchuri Ravikumar
142	United Kingdom	2859100	An Expression Vetor Containing A Strong Promoter Useful For High Level Expression Heterologous Gene In Schizosaccharomyces Pombe And Method For Production Of Desired Proteins Thereof	Jagmohan Singh, Hemant Kumar Verma
143	United Kingdom	2986720	Novel Uricase Mutant	Prasad Gandham Satyanarayana, Yelchuri Ravikumar
144	Nigeria	005258	Aptamers For Purifying And Quantifying Gelsolin And Its Variants	Ashish, Renu Garg, Nagesh Peddada
145	Russia	2644191	Aptamers For Purifying And Quantifying Gelsolin And Its Variants	Ashish, Renu Garg, Nagesh Peddada
146	United States Of America	9790524	Designer Cells for Enantio-Selective Reduction Of Ketones And Use Thereof In Efficient Production Of Enantioenriched Alcohols.	Srivastava Gautam, Kaur Suneet, Jolly Ravinder Singh

147	United States Of America	9663773	Cretion Of A Meso-Active Thermo-Stable Chimera Through Transplantation Of The Entire Active Surface Of A Mesophile Enzyme Onto Its Thermophile Homolog	Divya Kapoor, Sanjeev Kumar, Shubbir Ahmed, Swati Sharma, Manish Dutt, Balvinder Singh, Karthikeyan Subramanian, Purnananda Guptasarma
148	United States Of America	9695408	Mutants Of Streptokinase And Their Covalently Modified Forms	Shekhar Kumar, Neeraj Maheshwari, Girish Sahni

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149	Australia	2012354063	An Improved Solar Selective Coating Having High Thermal Stability And A Process For The Preparation Thereof	Barshilia Harish Chandra
150	Germany	2954265	A Hybrid Multilayer Solar Selective Coating For High Temperature Solar Thermal Applications And A Process For The Preparation Thereof	Barshilia Harish Chandra, Bharathibai Jyothi Basu, Ramachandrappa Vara Lakshmi
151	European Patent Office	2954265	A Hybrid Multilayer Solar Selective Coating For High Temperature Solar Thermal Applications And A Process For The Preparation Thereof	Barshilia Harish Chandra, Bharathibai Jyothi Basu, Ramachandrappa Vara Lakshmi
152	Spain	2954265	A Hybrid Multilayer Solar Selective Coating For High Temperature Solar Thermal Applications And A Process For The Preparation Thereof	Barshilia Harish Chandra, Bharathibai Jyothi Basu, Ramachandrappa Vara Lakshmi
153	United States Of America	9726402	A Hybrid Multilayer Solar Selective Coating For High Temperature Solar Thermal Applications And A Process For The Preparation Thereof	Barshilia Harish Chandra, Bharathibai Jyothi Basu, Ramachandrappa Vara Lakshmi
154	United States Of America	9803891	An Improved Solar Selective Coating Having High Thermal Stability And A Process For The Preparation Thereof	Barshilia Harish Chandra

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155	Australia	2014333405	A Method For Production Of Transgenic Cotton Plant.	Sawant Samir Viswanath, Tripathi Rajiv Kumar, Idris Asif

156	China	104302769	Allium Fistulosum Leaf Agglutinin Protein, Its Encoding Gene, Primer And Process For Prepation Thereof	Singh Pradhyumna Kumar, Rai Preeti, Singh Rahul, Upadhyay Santosh Kumar, Saurabh Sharad, Singh Harpal, Verma Praveen Chandra, Krishnappa Chandrashekar, Tuli Rakesh
157	European Patent Office	2798061	A Process For Preparation Of A Novel Insecticidal Chitinase Toxic Against Whiteflies, It"S Encoding Nucleotides And Application There Off	Singh Pradhyumna Kumar, Upadhyay Santosh Kumar, Krishnappa Chandrashekar, Saurabh Sharad, Singh Rahul, Rai Preeti, Singh Harpal, Mishra Manisha, Singh Ajit Pratap, Verma Praveen Chandra, Nair Kuttan Pillai Narayanan, Tuli Rakesh
158	United Kingdom	2798061	A Process For Preparation Of A Novel Insecticidal Chitinase Toxic Against Whiteflies, It"S Encoding Nucleotides And Application There Off	Singh Pradhyumna Kumar, Upadhyay Santosh Kumar, Krishnappa Chandrashekar, Saurabh Sharad, Singh Rahul, Rai Preeti, Singh Harpal, Mishra Manisha, Singh Ajit Pratap, Verma Praveen Chandra, Nair Kuttan Pillai Narayanan, Tuli Rakesh
159	Mexico	351264	A Process For Preparation Of A Novel Insecticidal Chitinase Toxic Against Whiteflies, It"S Encoding Nucleotides And Application There Off	Singh Pradhyumna Kumar, Upadhyay Santosh Kumar, Krishnappa Chandrashekar, Saurabh Sharad, Singh Rahul, Rai Preeti, Singh Harpal, Mishra Manisha, Singh Ajit Pratap, Verma Praveen Chandra, Nair Kuttan Pillai Narayanan, Tuli Rakesh
CSIR-NCL				
S. No	**Country**	**Patent No**	**Title Of Invention**	**Inventors**
160	Austria	2938667	Nucleating Agents	Mohan Raj Mani, Ramesh Chellaswamy, Vijayamohanan Kunjikrishnan Pillai
161	Belgium	3033171	Water Splitting Activity Of Layered Oxides	Nandini Devi, Soumya Bharathi Narendranath
162	Belgium	3027605	Novel Indazole Compounds, Preparation And Uses Thereof	Dumbala Srinivasa Reddy, Chaitanya Saxena, Kashinath Komirishetty
163	Belgium	2844719	Novel Organic Materials And Their Application In Charge Transport	Kothandam Krishnamoorthy, Arulraj Arulkashmir, Bhan Prakash Jain
164	Belgium	2692004	An Improved Process For The Preparation Of	Vijayamohanan Kunju Krishna, Ulhas Kanhaiyalal Kharul,

			Membrane Electrode Assemblies (Meas)	Sreekumar Kurungot, Harshal Dilip Chaudhari, Sreekuttan Maraveedu Unni, Bipinlal Unni, Husain Noman Kagalwala
165	Canada	2792474	Surface Modified Porous Polymers For Enhanced Cell Growth	Prasad Lv Bhagavatula, Virginia D Britto
166	Canada	2773301	Novel Process For The Preparation Of Pure Methyl Lactate From Alkali Metal Lactate Using Carbon Dioxide And Methanol	Prashant Purushottam Barve, Bhaskar Dattatraya Kulkarni, Milind Yashwant Gupte, Sanjay Narayan Nene, Ravindra William Shinde, Sanjay Pandurang Kamble
167	Switzerland	Ep2766340	Aminoacrylic Acid Derivatives And Synthesis Thereof	Dumbala Srinivasa Reddy, Kashinath Komirishetty, Siva Swaroop Pandrangi
168	Switzerland	3027605	Novel Indazole Compounds, Preparation And Uses Thereof	Dumbala Srinivasa Reddy, Chaitanya Saxena, Kashinath Komirishetty
169	Switzerland	3079805	Tube In Tube Continuous Glass Lined Reactors	Amol Arvind Kulkarni, Vivek Vinayak Ranade
170	China	Zl200980150549.6	Self Standing Nanoparticle Networks/Scaffolds With Controllable Void Dimensions	Guruswamy Kumaraswamy, Kamendra Prakash Sharma
171	Germany	2819994	Process For Producing Amide Compounds	Darbha Srinivas, Anuj Kumar, Nepak Devadutta
172	Germany	3027605	Novel Indazole Compounds, Preparation And Uses Thereof	Dumbala Srinivasa Reddy, Chaitanya Saxena, Kashinath Komirishetty
173	Germany	2956184	Silk Based Porous Scaffolds	Anuya Nisal, Premnath Venugopalan, Nairiti Sinha
174	Germany	2539057	Abpbi Based Porous Membranes	Ulhas Kanhaiyalal Kharul, Harshada Ramesh Lohokare
175	Germany	2844719	Novel Organic Materials And Their Application In Charge Transport	Kothandam Krishnamoorthy, Arulraj Arulkashmir, Bhan Prakash Jain
176	Germany	2938667	Nucleating Agents	Mohan Raj Mani, Ramesh Chellaswamy, Vijayamohanan Kunjikrishnan Pillai
177	Germany	3110874	Novel Poly-Benzimidazole With Pyrene And Anthraceneflourophore	Sayali Vinayak Shaligram, Ulhas Kanhaiyalal Kharul, Prakash Purushottam Wadgaonkar
178	Germany	Ep2994494	Renewable And Degradable Polyacetals	Samir Hujur Chikkali, Bhausaheb Shivaji Rajput

179	Germany	3041941	Enzyme Composition And Process Of Preperation Theroff	Jayant Malhar Khire, Pradnya Deepak Gujar
180	Germany	2951165	Single Step Process For Conversion Of Furfural To Tetrahydrofuran	Chandrasekhar Vasant Rode, Narayan Shamrao Biradar, Amol Mahalingappa Hengne
181	Germany	3055312	Novel Ligand For Detection Of Chromium (Iii)	Amitava Das, Firoj Ali, Sukdeb Saha
182	Germany	2365948	Self Standing Nanoparticle Networks/Scaffolds With Controllable Void Dimensions	Guruswamy Kumaraswamy, Kamendra Prakash Sharma
183	Germany	3041790	Novel Carbon Electro-Catalyst For Oxygen Reduction Reaction	Rohan Gokhale, Sreekuttan Maraveedu Unni, Kurungot Sreekumar, Satishchandra Balkrishna Ogale
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185	Germany	2948454	A Method To Synthesize Triazines	Pradeep Kumar, Anand Harbindu, Brijesh Sharma
186	Germany	3052473	Stereospecific And Proficient Synthesis Of Seven Membered Sulfide: Its Application For Tamiflu Synthesis	Subhash Prataprao Chavan, Prakash Narsing Chavan
187	Germany	2529036	Hydrolysis Of Hemicellulose By Heterogeneous Catalysts	Dhepe Paresh, Sahu Ramakanta
188	Germany	3097087	Efficient Production Of Renewable Liquid Fuels And Chemicals From Biomass Over Ruthenium Supported Catalysts	Satyanarayana Vera Venkata Chilukuri, Atul Sopan Nagpure, Nishita Satyendra Lucas
189	Germany	2788319	Cross Linking Catalyst From Cashew Nut Shell Liquid	Prakash Purushottam Wadgaonkar, Bhimrao Dhondiba Sarwade, Bhausaheb Vilas Tawade
190	Germany	2800764	Polypropylene Compositions For Reduced Necking In Extrusion Film Casting Or Extrusion Coating Processes	Kalyani Suresh Chikhalikar, Ashish Kishore Lele, Harshwardhan Vinayak Pol, Kishor Shankar Jadhav, Sunil Janardan Mahajan, Zubair Ahmad
191	Germany	2976644	One Pot Process For The Preparation Of Gold Quantum Clusters	Puneet Khandelwal, Dheeraj Kumar Singh, Pankaj Poddar

192	Germany	3035945	A Probiotic Composition Comprising The Novel Isolated Bacterial Strain Of Brevebacterium Casei Ap9	Hrishikesh Vinayak Mungi, Pooja Vijay Ghushe, Avinash Vellore Sunder, Archana Vishnu Pundle
193	Germany	3079805	Tube In Tube Continuous Glass Lined Reactors	Amol Arvind Kulkarni, Vivek Vinayak Ranade
194	Germany	2892877	Ew Method For The Preparation Of Highly Enantiopure (S)-2-Ethyl-N-(1-Methoxypropan-2-Yl)-6-Methyl Aniline, A Precursor Of (S)-Metolachlor	Muthukrishnan Murugan, Prashant Pramod Mujumdar
195	Germany	3014504	Simulated Carbon And Proton Nmr Chemical Shift Based Binary Fingerprints For Virtual Screening	Muthukumarasamy Karthikeyan, Renu Vyas, Pattuparambil Ramanpillai Rajamohanan
196	Germany	2692004	An Improved Process For The Preparation Of Membrane Electrode Assemblies (Meas)	Vijayamohanan Kunju Krishna, Ulhas Kanhaiyalal Kharul, Sreekumar Kurungot, Harshal Dilip Chaudhari, Sreekuttan Maraveedu Unni, Bipinlal Unni, Husain Noman Kagalwala
197	Germany	Ep2401066	A Process For Deacidification Using Membranes	Ulhas Kanhaiyalal Kharul, Ramchandra Vitthal Gadre, Vithal Venkatrao Jogdand, Yogesh Jayasing Chendake
198	Germany	3013787	Transition-Metal-Free N-Arylation Of Tertiary Amines Using Arynes	Akkattu Thankappan Biju, Sachin Suresh Bhojgude, Trinadh Kaicharla
199	Denmark	3035945	A Probiotic Composition Comprising The Novel Isolated Bacterial Strain Of Brevebacterium Casei Ap9	Hrishikesh Vinayak Mungi, Pooja Vijay Ghushe, Avinash Vellore Sunder, Archana Vishnu Pundle
200	Denmark	3027605	Novel Indazole Compounds, Preparation And Uses Thereof	Dumbala Srinivasa Reddy, Chaitanya Saxena, Kashinath Komirishetty
201	European Patent Office	3063091	Biocompatible Graphene Quantum Dots For Drug Delivery And Bioimaging Applications	Neetu Singh, Anil Chandra
202	European Patent Office	2956184	Silk Based Porous Scaffolds	Anuya Nisal, Premnath Venugopalan, Nairiti Sinha
203	European Patent Office	3041941	Enzyme Composition And Process Of Preperation Theroff	Jayant Malhar Khire, Pradnya Deepak Gujar

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209	European Patent Office	Ep2994494	Renewable And Degradable Polyacetals	Samir Hujur Chikkali, Bhausaheb Shivaji Rajput
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224	European Patent Office	2994505	Acidic Ionic Liquids Catalyzed Depolymerization Of Lignin	Dhepe Paresh Laxmikant, Ashutosh Anant Kelkar, Babasaheb Mansub Matsagar, Sandip Kumar Singh
225	European Patent Office	2948454	A Method To Synthesize Triazines	Pradeep Kumar, Anand Harbindu, Brijesh Sharma
226	European Patent Office	2976644	One Pot Process For The Preparation Of Gold Quantum Clusters	Puneet Khandelwal, Dheeraj Kumar Singh, Pankaj Poddar
227	European Patent Office	2844304	Novel Uv-Laser Synthesized Fluoresent, Spherical And Magnetic Nanoparticles Loaded Sophorolipid Mesostructures For Imaging And Therapeutic Applications	Asmita Ashutosh Prabhune, Pradeep Kumar Singh, Ruchira Arup Mukherji, Satishchandra Balkrishna Ogale

228	European Patent Office	2692004	An Improved Process For The Preparation Of Membrane Electrode Assemblies (Meas)	Vijayamohanan Kunju Krishna, Ulhas Kanhaiyalal Kharul, Sreekumar Kurungot, Harshal Dilip Chaudhari, Sreekuttan Maraveedu Unni, Bipinlal Unni, Husain Noman Kagalwala
229	European Patent Office	2702035	Methodology For The Continuous Flow Manufacturing Of Beta - Amino Crotonate	Amol Arvind Kulkarni, Ramesh Anna Joshi, Rohini Ramesh Joshi
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277	Indonesia	Idp000050315	Aminoacrylic Acid Derivatives And Synthesis Thereof	Dumbala Srinivasa Reddy, Kashinath Komirishetty, Siva Swaroop Pandrangi
278	Indonesia	Idp000045709	Pyrroloquinoline Alkaloids And Process For The Preparation Thereof	Santosh B.Mhaske, Jyoti R. Lande
279	Ireland	3027605	Novel Indazole Compounds, Preparation And Uses Thereof	Dumbala Srinivasa Reddy, Chaitanya Saxena, Kashinath Komirishetty

280	Italy	3027605	Novel Indazole Compounds, Preparation And Uses Thereof	Dumbala Srinivasa Reddy, Chaitanya Saxena, Kashinath Komirishetty
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282	Japan	6158166	Stable Oxide Encapsulated Metal Clusters And Nanoparticles	Nandini R Devi, Anupam Samanta
283	Japan	6162704	Sila Analogs Of Oxazolidine Derivatives And Synthesis Thereof	Dumbala Srinivasa Reddy, Seetharam Singh Balamkundu, Remya Ramesh
284	Japan	6289630	Nitrogen Doped Caron Nanohorns As Enhanced Electro Catalysts	Sreekumar Kurungot, Sreekuttan Maraveedu Unni, Sarath Ramadas
285	Japan	6211687	Process For Preparation Of Nanoporous Graphene& Graphene Quantum Dots	Sreekumar Kurungot, Thangavelu Palaniselvam
286	Japan	6223474	Silk Based Porous Scaffolds	Anuya Nisal, Premnath Venugopalan, Nairiti Sinha
287	Japan	6305989	Process For Making Di-Methyl Carbonate	Darbha Srinivas, Pulikkeel Unnikrishnan
288	Japan	6174130	Process For Preparing Biodegradable Lubricant Base Oils	Darbha Srinivas, Mehejabeen Kotwal
289	Japan	6211182	Simulated Carbon And Proton Nmr Chemical Shift Based Binary Fingerprints For Virtual Screening	Muthukumarasamy Karthikeyan, Renu Vyas, Pattuparambil Ramanpillai Rajamohanan
290	Japan	6174790	N-Doped Porous Carbon Derived From Graphitic C3n4-Mof Composite As Efficient Non-Metal Electrocatalyst	Sreekumar Kurungot, Rahul Banerjee, Sekar Pandiaraj, Harshitha Barike Aiyappa
291	Japan	6148663	An Improved Process For The Preparation Of Membrane Electrode Assemblies (Meas)	Vijayamohanan Kunju Krishna, Ulhas Kanhaiyalal Kharul, Sreekumar Kurungot, Harshal Dilip Chaudhari, Sreekuttan Maraveedu Unni, Bipinlal Unni, Husain Noman Kagalwala
292	Japan	6211003	Energy Level Modulated Conjugated Polymers For Oxidation Resistance	K.Krishnamoorthy

293	Japan	6251691	Process For Producing Amide Compounds	Darbha Srinivas, Anuj Kumar, Nepak Devadutta
294	South Korea	10-1835879	Process For Preparation Of Nanoporous Graphene& Graphene Quantum Dots	Sreekumar Kurungot, Thangavelu Palaniselvam
295	South Korea	10-1776977	Surface Modified Porous Polymers For Enhanced Cell Growth	Prasad Lv Bhagavatula, Virginia D Britto
296	South Korea	10-1845108	Polymeric Form Of Ionic Liquids	Ulhas Kanhaiyalal Kharul, Santosh Chandrakant Kumbharkar, Rupesh Sudhakar Bhavsar, Rahul Hanumant Shevate
297	South Korea	10-1784904	Dna Loaded Supported Gold Nanoparticles, Process For The Preparation And Use Thereof	Prasad Lv Bhagavatula, Periyasamy Shanmugham Vijayakumar, Othalathara Ushar Raj Abhilash, Bashir Mohammad Khan
298	Malaysia	My-162898-A	Method For The Preparation Of Biofuels From Glycerol	Dharbha Srinivas, Lakshmi Saikia, Paul Ratnasamy
299	Netherlands	3027605	Novel Indazole Compounds, Preparation And Uses Thereof	Dumbala Srinivasa Reddy, Chaitanya Saxena, Kashinath Komirishetty
300	Netherlands	2539057	Abpbi Based Porous Membranes	Ulhas Kanhaiyalal Kharul, Harshada Ramesh Lohokare
301	Netherlands	2844719	Novel Organic Materials And Their Application In Charge Transport	Kothandam Krishnamoorthy, Arulraj Arulkashmir, Bhan Prakash Jain
302	Netherlands	3079805	Tube In Tube Continuous Glass Lined Reactors	Amol Arvind Kulkarni, Vivek Vinayak Ranade
303	Sweden	2956184	Silk Based Porous Scaffolds	Anuya Nisal, Premnath Venugopalan, Nairiti Sinha
304	Sweden	3097087	Efficient Production Of Renewable Liquid Fuels And Chemicals From Biomass Over Ruthenium Supported Catalysts	Satyanarayana Vera Venkata Chilukuri, Atul Sopan Nagpure, Nishita Satyendra Lucas
305	Sweden	2994505	Acidic Ionic Liquids Catalyzed Depolymerization Of Lignin	Dhepe Paresh Laxmikant, Ashutosh Anant Kelkar, Babasaheb Mansub Matsagar, Sandip Kumar Singh
306	United States Of America	9915669	Water Soluble Polyfluorene Functionalized With Glucuronic Acid Useful In Sensing Bilirubin In Aqueous Medium	Asha Syamakumari, Senthil Kumar

307	United States Of America	9657037	Novel Pyrrole Derivatives With Silicon Incorporation	Dumbala Srinivasa Reddy, Natarajan Vasudevan, Sachin Bhausaheb Wagh, Remya Ramesh
308	United States Of America	9677046	In Situ Ph Management Using Hydrogel And Applications Thereof	Mugdha Chetan Gadgil
309	United States Of America	9650329	Transition-Metal-Free N-Arylation Of Tertiary Amines Using Arynes	Akkattu Thankappan Biju, Sachin Suresh Bhojgude, Trinadh Kaicharla
310	United States Of America	9899687	Novel Carbon Electro-Catalyst For Oxygen Reduction Reaction	Rohan Gokhale, Sreekuttan Maraveedu Unni, Kurungot Sreekumar, Satishchandra Balkrishna Ogale
311	United States Of America	9802909	An Enantioselective Process For Synthesis Of (+)-Petromyroxol And Its Diastereomers	Chepuri Venkata Ramana, Venkannababu Mullapudi
312	United States Of America	9823232	Novel Ligand For Detection Of Chromium (Iii)	Amitava Das, Firoj Ali, Sukdeb Saha
313	United States Of America	9642815	Biocompatible Graphene Quantum Dots For Drug Delivery And Bioimaging Applications	Neetu Singh, Anil Chandra
314	United States Of America	9656927	Copper Catalyzed Carbonylation Of Halides With Cyanide: New Process For The Production Of Carboxylic Acid Derivatives	Pragati Kishore Prasad, Arumugam Sudalai
315	United States Of America	9631066	Highly Fluorescent Monodisperse, Cross-Linked Polymer Microbeads	Asha Syamakumari, Swapnil Laxman Sonawane
316	United States Of America	9902746	Novel Benzoxaphosphole Derivatives And Its Preparation Thereof	Akkattu Thankappan Biju, Anup Bhunia, Trinadh Kaicharla
317	United States Of America	9737510	Novel Indazole Compounds, Preparation And Uses Thereof	Dumbala Srinivasa Reddy, Chaitanya Saxena, Kashinath Komirishetty
318	United States Of America	9745240	Metal Free Allylic Oxidation Process	Subhash Prataprao Chavan, Pradeep Bhaskarrao Lasonkar
319	United States Of America	9790526	A Nucleotide Sequence Encoding Enone Oxidoreductase From Mango	Vidya Shrikant Gupta, Ram Shridhar Kulkarni, Ashok Prabhakar Giri, Keshav H Pujari

320	United States Of America	9822113	Hunanamycin A And Its Analogs: Synthesis And Uses Thereof	Dumbala Srinivasa Reddy, Rahul Dilip Shingare, Velayudham Ramdoss
321	United States Of America	9617280	Spiro-Oxazines, Indolinones And Preparation Thereof	Akkattu Thankappan Biju, Anup Bhunia, Tony Roy
322	United States Of America	9783496	Oxindole Compounds, Solvent-Free Synthesis And Use Thereof	Akkattu Thankappan Biju, Trinadh Kaicharla, Santhivardhana Reddy Yetra, Tony Roy
323	United States Of America	9718773	Novel One-Pot Synthesis Of Kainoid Derivatives	Ravindra Dattatray Aher, Boopathi Senthil Kumar, Arumugam Sudalai
324	United States Of America	9758493	Phosphoric Acid Loaded Covalent Organic Framework And A Process For The Preparation Thereof	Rahul Banerjee, Suman Chandra, Tanay Kundu, Sharath Kandambeth
325	United States Of America	9891200	Novel Metal Coordination Complex For Multi-Action Naked Eye Colorimetric Anion Sensor	Vedavati Gururaj Puranik, Rajesh Ghanshyam Gonnade, Rupesh Liladhar Gawade
326	United States Of America	9651491	Novel Assay For Detection Of Fluoride Ions	Debanjan Guin, Satishchandra Balkrishna Ogale, Pooja Singh
327	United States Of America	9650354	Process For Producing Furan And Its Derivatives	Darbha Srinivas, Bhogeswararao Seemala
328	United States Of America	9834515	Novel Process For Synthesis Of Piperidine Alkaloids	Asish Kumar Bhattacharya, Hemender Rami Chand
329	United States Of America	9771325	Novel Tricyclic Compounds And Preparation Thereof	Dumbala Srinivasa Reddy, Kashinath Komirishetty, Prakash Daulat Jadhav
330	United States Of America	9757713	Process For The Preparation Of 2, 5-Dimethylefuran And Furfuryl Alcohol Over Ruthenium Supported Catalysts	Satyanarayana Vera Venkata Chilukuri, Atul Sopan Nagpure, Nishita Satyendra Lucas
331	United States Of America	9663624	Blend Membranes Based On Polybenzimidazole (Pbi) And Polymeric Ionic Liquids (Pils)	Ulhas Kanhaiyalal Kharul, Sreekumar Kurungot, Anita Sanwarmal Rewar, Harshal Dilip Chaudhari
332	United States Of America	9751911	Solomonamide Analogue Compounds, Pharmaceuticals Containing Solomonamide Analogue Compounds, And Processes	Dumabala Srinivasa Reddy, Kashinath Kormirishetty, Vasudevan Natrajan

			For The Preparation Thereof	
333	United States Of America	9650330	A Mild And General Process For The Synthesis Of Aryl Sulfones	Santosh Baburao Mhaske, Virat Pandya
334	United States Of America	9713796	Mof's-Porous Polymeric Membrane Composites	Ulhas Kanhaiyalal Kharul, Rahul Banerjee, Divya Nagaraju
335	United States Of America	9637388	Process For Preparation Of Nanoporous Graphene& Graphene Quantum Dots	Sreekumar Kurungot, Thangavelu Palaniselvam
336	United States Of America	9914928	A Non-Genetic Guanine Rich 2'-5' Linked Iso Dna/Rna Oligomers And Preparation Thereof	Vaijayanti Anil Kumar, Anita Dinkar Gunjal, Moneesha Fernandes
337	United States Of America	9624381	Reversible Switching Between Super Hydrophobic And Super Hydrophilic States	K Krishnamoorthy
338	United States Of America	9688686	Novel Porphyrin Containing Covalent Organic Frameworks And Their Synthesis	Rahul Banerjee, Sharath Kandambeth
339	United States Of America	9890132	A Novel Process For The Preparation Of Anti-Inflammatory Compounds	Chepuri Venkata Ramana, Yadagiri Kommagalla, Kolluru Srinivas
340	United States Of America	9879354	Porous Co3o4 Nanorods For Photoelectrochemical Water Splitting	Pattayil Alias Joy, Vijayamohanan Kunjikrishnan Pillai, Ramsundar Mohan Rani, Joyashish Debgupta
341	United States Of America	9815934	Renewable And Degradable Polyacetals	Samir Hujur Chikkali, Bhausaheb Shivaji Rajput
342	United States Of America	9611450	A Process For The Removal Of Polymer Thermosets From The Specific Substrate	Kothandam Krishnamoorthy
343	United States Of America	9661855	Novel Sila Analogs Of Deet As Insect Repellants	Dumbala Srinivasa Reddy, Remya Ramesh, Seetharam Singh Balamkundu
344	United States Of America	9920319	[R/S-(2-Amino-3-Methoxy)Propyl] (R-Amp And S-Amp) Nucleic Acids	Vaijayanti Anil Kumar, Venubabu Kotikam, Souvik Maiti, Smita Nahar
345	United States Of America	9659759	Quantitation Of Structural Isomers Using Maldi Ms/Ms	Venkateswarlu Panchagnula, Nivedita Bhattacharya, Avinash Dattatraya Ghanate

346	United States Of America	9862712	Novel Benzimidazole Based Egfr Inhibitors	Pradeep Kumar, Jignesh Kantilal Parikh, Eeshwaraiah Begari
347	United States Of America	9920000	Synthesis Of Dimethyl Carbonate (Dmc) From Methanol And Urea In Presence Of Stripping With Inert Gas	Vivek Vinayak Ranade, Ashutosh Anant Kelkar, Vilas Hari Rane, Anil Kisan Kinage, Savita Kiran Shingote, Lalita Sanjib Roy
348	United States Of America	9809706	Racemic Drug Resolution Using Polymer Supported Chiral Selector	Sachin Tanaji Mane, Siona Virgil Daniels, Deokar Sarika Babasaheb, Mule Smita Atmaram, Surendra Ponrathnam, Nayaku Nivrati Chavan
349	United States Of America	9695431	A Process Of Transformation In Withania Somnifera Plants To Increase Secondary Metabolite Content	Bashir Mohammad Khan, Neha Gupta, Parth Sanjaykumar Patel, Poonam Sharma, Shuchishweta Vinay Kendurkar
350	United States Of America	9845302	Peribysin E Analogues Synthesis And Uses Thereof	Dumbala Srinivasa Reddy, Kishor Laxman Handore
351	United States Of America	9869595	Flow Device For Thermokinetic Property Measurement	Amol Arvind Kulkarni, Yachita Sharma, Vikash Kumar, Vinay Gulab Bhaya
352	United States Of America	9758476	Novel O-Alkynyl Anilines And Their Preparation Thereof	Gurunath Mallappa Suryavanshi, Anil Maruti Shelke
353	United States Of America	9650683	A Nucleotide Sequence Encoding Farnesyl Pyrophosphate Synthase From Mango	Vidya Shrikant Gupta, Ram Shridhar Kulkarni, Sagar Subhash Pandit, Ashok Prabhakar Giri, Keshav H Pujari
354	United States Of America	9757481	Fluorescent, Spherical Sophorolipid Mesostructures For Imaging And Therapeutic Applications	Asmita Ashutosh Prabhune, Pradeep Kumar Singh, Ruchira Arup Mukherji, Satishchandra Balkrishna Ogale
355	United States Of America	9850337	Comb-Coil Supramolecular Crosslinked Polymer	Asha Syamakumari, Rekha Narayan

356	United States Of America	9888690	Insecticidal Enriched Extract (Biopesticide) From Nothapodites Foetida (Wight.) Sleumer	Swati Pramod Joshi, John Pereira, Phool Kumar Patanjali, Sunita Sharad Kunte, Kiran Babasaheb Sonawane, Suresh Gurappa Mummigatti, Sumithra Devi Sanna, Krishnaiah Eraiah Hullukere, Seema Chaudhary
357	United States Of America	9663548	Synthesis Of 10-?/?-D-Arabinofuranosyl-Undecenes As Potential Anti-Mycobacterial Agents	Ramana Venkata Chepuri, Dhiman Sarkar, Rahul Shivaji Patil, Sampa Sarkar
358	United States Of America	9834570	One Step Process For Regioselective Synthesis Of ?-Acyloxy Carbonyls	Arumugam Sudalai, Rambabu Reddi, Pushpa Malekar
359	United States Of America	9857376	One Pot Process For The Preparation Of Gold Quantum Clusters	Puneet Khandelwal, Dheeraj Kumar Singh, Pankaj Poddar
360	United States Of America	9905371	A Novel Approach In The Design Of All-Solid-State-Supercapacitor	Sreekumar Kurungot, Manohar Virupax Badiger, Bihag Anothumakkool, Arun Torris
361	United States Of America	9670523	Nitrite Reductase As A Drug Target/Biomarker For Mycobacterium Tuberculosis Detection.	Dhiman Sarkar
362	United States Of America	9765048	Organocatalytic Process For Asymmetric Synthesis Of Decanolides	Varun Rawat, Soumen Dey, Anil Maruti Shelke, Gurunath Mallapa Suryavanshi, Arumugam Sudalai
363	United States Of America	9757696	Porous Abpbi [Poly (2, 5-Benzimidazole)] Membrane And Process Of Preparing The Same	Ulhas Kharul, Harshada Lohokare
364	United States Of America	9775919	Curcumin Coated Superparamagnetic Iron Oxide Nanoparticles For Biomedical Applications	Pattayil Alias Joy, Jayaprabha Kunnoth Naduvilidam
365	United States Of America	9801918	Methods Of Treatment Using Extracts Of Anisomeles Heyneana	Swati Pramod Joshi, Roshan Rajan Kulkarni, Ketaki Dilip Shurpali, Sampa Sarkar, Dhiman Sarkar

366	United States Of America	9920070	Spiro-Oxazines, Indolinones And Preparation Thereof	Akkattu Thankappan Biju, Anup Bhunia, Tony Roy
367	United States Of America	9725338	Vortex Diodes As Reactors And Effluent Treatment Devices	Vivek Vinayak Ranade, Amol Arvind Kulkarni, Vinay Manoharrao Bhandari
368	United States Of America	9809566	Organocatalytic Process For Asymmetric Synthesis Of Decanolides	Varun Rawat, Soumen Dey, Anil Maruti Shelke, Gurunath Mallapa Suryavanshi, Arumugam Sudalai
CSIR-NEERI				
S. No	**Country**	**Patent No**	**Title Of Invention**	**Inventors**
369	Belgium	2598434	Catalysts For Dehydrogenation Of Hydrogenated Liquid Organic Compounds For Hydrogen Storage And Supply	Biniwale Rajesh Bhaskar, Pande Jayshri Vijay, Shukla Anshu Ajit
370	Belgium	2598434	Catalysts For Dehydrogenation Of Hydrogenated Liquid Organic Compounds For Hydrogen Storage And Supply	Biniwale Rajesh Bhaskar, Pande Jayshri Vijay, Shukla Anshu Ajit
371	Switzerland	2598434	Catalysts For Dehydrogenation Of Hydrogenated Liquid Organic Compounds For Hydrogen Storage And Supply	Biniwale Rajesh Bhaskar, Pande Jayshri Vijay, Shukla Anshu Ajit
372	Switzerland	2649014	Carbon Bed Electrolyser For Treatment Of Liquid Effluents And A Process Thereof	Nageswara Rao Neti, Tapas Nandy
373	Switzerland	2620410	Catalysts For Dehydrogenation Of Hydrogenated Liquid Organic Compounds For Hydrogen Storage And Supply	Biniwale Rajesh Bhaskar, Pande Jayshri Vijay, Shukla Anshu Ajit
374	China	Cn104169216	Solar Fuels And A Hybrid Process Thereof Based On Biomimetic Carbonation And Photocatalysis	Rayalu Sadhana Suresh, Chakrabarti Tapan, Joshi Meenal Vivek, Mangrulkar Priti Ashok, Labhsetwar Nitin Kumar, Yadav Renu Mahendra Singh, Prabhu Chandan, Wate Satish Ramchandra
375	Germany	2649014	Carbon Bed Electrolyser For Treatment Of Liquid Effluents And A Process Thereof	Nageswara Rao Neti, Tapas Nandy

376	Germany	2751026	Solar Fuels And A Hybrid Process Thereof Based On Biomimetic Carbonation And Photocatalysis	Rayalu Sadhana Suresh, Chakrabarti Tapan, Joshi Meenal Vivek, Mangrulkar Priti Ashok, Labhsetwar Nitin Kumar, Yadav Renu Mahendra Singh, Prabhu Chandan, Wate Satish Ramchandra
377	Germany	2598434	Catalysts For Dehydrogenation Of Hydrogenated Liquid Organic Compounds For Hydrogen Storage And Supply	Biniwale Rajesh Bhaskar, Pande Jayshri Vijay, Shukla Anshu Ajit
378	Germany	2598434	Catalysts For Dehydrogenation Of Hydrogenated Liquid Organic Compounds For Hydrogen Storage And Supply	Biniwale Rajesh Bhaskar, Pande Jayshri Vijay, Shukla Anshu Ajit
379	European Patent Office	2649014	Carbon Bed Electrolyser For Treatment Of Liquid Effluents And A Process Thereof	Nageswara Rao Neti, Tapas Nandy
380	European Patent Office	2751026	Solar Fuels And A Hybrid Process Thereof Based On Biomimetic Carbonation And Photocatalysis	Rayalu Sadhana Suresh, Chakrabarti Tapan, Joshi Meenal Vivek, Mangrulkar Priti Ashok, Labhsetwar Nitin Kumar, Yadav Renu Mahendra Singh, Prabhu Chandan, Wate Satish Ramchandra
381	European Patent Office	2598434	Catalysts For Dehydrogenation Of Hydrogenated Liquid Organic Compounds For Hydrogen Storage And Supply	Biniwale Rajesh Bhaskar, Pande Jayshri Vijay, Shukla Anshu Ajit
382	European Patent Office	2620410	Catalysts For Dehydrogenation Of Hydrogenated Liquid Organic Compounds For Hydrogen Storage And Supply	Biniwale Rajesh Bhaskar, Pande Jayshri Vijay, Shukla Anshu Ajit
383	Spain	2649014	Carbon Bed Electrolyser For Treatment Of Liquid Effluents And A Process Thereof	Nageswara Rao Neti, Tapas Nandy
384	France	2649014	Carbon Bed Electrolyser For Treatment Of Liquid Effluents And A Process Thereof	Nageswara Rao Neti, Tapas Nandy
385	France	2598434	Catalysts For Dehydrogenation Of Hydrogenated Liquid Organic Compounds For Hydrogen Storage And Supply	Biniwale Rajesh Bhaskar, Pande Jayshri Vijay, Shukla Anshu Ajit

386	France	2751026	Solar Fuels And A Hybrid Process Thereof Based On Biomimetic Carbonation And Photocatalysis	Rayalu Sadhana Suresh, Chakrabarti Tapan, Joshi Meenal Vivek, Mangrulkar Priti Ashok, Labhsetwar Nitin Kumar, Yadav Renu Mahendra Singh, Prabhu Chandan, Wate Satish Ramchandra
387	France	2620410	Catalysts For Dehydrogenation Of Hydrogenated Liquid Organic Compounds For Hydrogen Storage And Supply	Biniwale Rajesh Bhaskar, Pande Jayshri Vijay, Shukla Anshu Ajit
388	United Kingdom	2751026	Solar Fuels And A Hybrid Process Thereof Based On Biomimetic Carbonation And Photocatalysis	Rayalu Sadhana Suresh, Chakrabarti Tapan, Joshi Meenal Vivek, Mangrulkar Priti Ashok, Labhsetwar Nitin Kumar, Yadav Renu Mahendra Singh, Prabhu Chandan, Wate Satish Ramchandra
389	United Kingdom	2598434	Catalysts For Dehydrogenation Of Hydrogenated Liquid Organic Compounds For Hydrogen Storage And Supply	Biniwale Rajesh Bhaskar, Pande Jayshri Vijay, Shukla Anshu Ajit
390	United Kingdom	2620410	Catalysts For Dehydrogenation Of Hydrogenated Liquid Organic Compounds For Hydrogen Storage And Supply	Biniwale Rajesh Bhaskar, Pande Jayshri Vijay, Shukla Anshu Ajit
391	Italy	2649014	Carbon Bed Electrolyser For Treatment Of Liquid Effluents And A Process Thereof	Nageswara Rao Neti, Tapas Nandy
392	Italy	2598434	Catalysts For Dehydrogenation Of Hydrogenated Liquid Organic Compounds For Hydrogen Storage And Supply	Biniwale Rajesh Bhaskar, Pande Jayshri Vijay, Shukla Anshu Ajit
393	Italy	2598434	Catalysts For Dehydrogenation Of Hydrogenated Liquid Organic Compounds For Hydrogen Storage And Supply	Biniwale Rajesh Bhaskar, Pande Jayshri Vijay, Shukla Anshu Ajit
394	Norway	2598434	Catalysts For Dehydrogenation Of Hydrogenated Liquid Organic Compounds For Hydrogen Storage And Supply	Biniwale Rajesh Bhaskar, Pande Jayshri Vijay, Shukla Anshu Ajit

395	Norway	2620410	Catalysts For Dehydrogenation Of Hydrogenated Liquid Organic Compounds For Hydrogen Storage And Supply	Biniwale Rajesh Bhaskar, Pande Jayshri Vijay, Shukla Anshu Ajit
396	United States Of America	9803349	A Mechanical Automatic Urinal-Toilet Flusher, And Its Mechanism Thereof	Wath Sushant Babarao, Dutt Pallampati Subrahmanya, Wate Satish Ramchandra
397	United States Of America	9890063	Carbon Bed Electrolyser For Treatment Of Liquid Effluents And A Process Thereof	Nageswara Rao Neti, Tapas Nandy
398	South Africa	2016/00020	A Mechanical Automatic Urinal-Toilet Flusher, And Its Mechanism Thereof	Wath Sushant Babarao, Dutt Pallampati Subrahmanya, Wate Satish Ramchandra
CSIR-NEIST				
S. No	**Country**	**Patent No**	**Title Of Invention**	**Inventors**
399	China	ZI 201280074294.1	A Synergistic Pharmaceutical Composition Useful For The Treatment Of Lung Cancer	Mantu Bhuyan, Pranab Ram Bhattacharyya, Pranab Kumar Baruah, Nabin Chandra Barua, Paruchuri Gangadhar Rao, Sushmita Bhattacharya, Rakesh Kundu, Priyajit Chatterjee, Soma Seal, Sandeep Mukherjee, Suman Dasgupta, Sudipta Moitra, Shelley Bhattacharya, Samir Bhattacharya
400	United Kingdom	2489641b	A New Series Of Artemisinin Derivatives With Potent Anticancer Activities	Gakul Baishya, Nabin Chandra Barua, Abhishek Goswami, Partha Pratim Saikia, Paruchuri Gangadhar Rao, Ajit Kumar Saxena, Nitasha Suri, Madhunika Sharma
401	United States Of America	9622987	A Synergistic Pharmaceutical Composition Useful For The Treatment Of Lung Cancer	Mantu Bhuyan, Pranab Ram Bhattacharyya, Pranab Kumar Baruah, Nabin Chandra Barua, Paruchuri Gangadhar Rao, Sushmita Bhattacharya, Rakesh Kundu, Priyajit Chatterjee, Soma Seal, Sandeep Mukherjee, Suman Dasgupta, Sudipta Moitra, Shelley Bhattacharya, Samir Bhattacharya
402	United States Of America	9616412	A Process For The Preparation Of Oxidic Nano Sheets Coated Monolithic	Rajib Lochan Goswamee, Mridusmita Mishra, Anil Kumar Sarma Baruah

			Catalysts Useful For The Treatment Of Toxic N2o Gas	
CSIR-NGRI				
S. No	**Country**	**Patent No**	**Title Of Invention**	**Inventors**
403	Canada	2674377	Technique And A Device For Measurement Of Spectral Induced Polarization Response Using Pseuedo Random Binary Sequence (Prbs) Current Source	Tadepalli Rammohan Prasad, Boppana Dasaradha Ramayya, Yelamanchili Purnachandra Rao
CSIR-NIIST				
S. No	**Country**	**Patent No**	**Title Of Invention**	**Inventors**
404	Australia	2013303756	A Process For Decomposition Of Organic Synthetic Dyes Using Semiconductor-Oxides Nanotubes Via Dark Catalysis.	Shukla Satyajit Vishnu, Warrier Krishna Gopakumar, Babu Babitha Kunnathuparambil
405	China	Cn 104736485 B	A Process For Decomposition Of Organic Synthetic Dyes Using Semiconductor-Oxides Nanotubes Via Dark Catalysis.	Shukla Satyajit Vishnu, Warrier Krishna Gopakumar, Babu Babitha Kunnathuparambil
406	China	Zl20138000719 5.6	A Novel Method Of Developing Nano-Structured Silver Oxide Film Based Aqueous Voltammetric Pesticide Sensor	Panampillil Vijayammma Subha, Varghese Saumya, Talasila Prasada Rao
407	China	201480002356. 7	Semiconductor-Oxides Nanotubes-Based Composite Particles Useful For Dye-Removal And Process Thereof	Shukla Satyajit Vishnu, Padinhattayil Hareesh, Narayani Harsha, Jose Manu, Karunakaran Remya
408	Germany	3039082	A Squaraine Based Fluorescent Probe For Selective Labeling And Sensing Of Serum Albumin Proteins, Ph Monitoring And Thiol Imaging In Cells And A Process For The Preparation Thereof	Ayyappanpillai Ajayaghosh, Palappuravan Anees
409	European Patent Office	3039082	A Squaraine Based Fluorescent Probe For Selective Labeling And	Ayyappanpillai Ajayaghosh, Palappuravan Anees

			Sensing Of Serum Albumin Proteins, Ph Monitoring And Thiol Imaging In Cells And A Process For The Preparation Thereof	
410	France	3039082	A Squaraine Based Fluorescent Probe For Selective Labeling And Sensing Of Serum Albumin Proteins, Ph Monitoring And Thiol Imaging In Cells And A Process For The Preparation Thereof	Ayyappanpillai Ajayaghosh, Palappuravan Anees
411	United Kingdom	3039082	A Squaraine Based Fluorescent Probe For Selective Labeling And Sensing Of Serum Albumin Proteins, Ph Monitoring And Thiol Imaging In Cells And A Process For The Preparation Thereof	Ayyappanpillai Ajayaghosh, Palappuravan Anees
412	Japan	6246938	Self Healing Silica Based Low K Dielectric Ink For Printed Electronic Applications	Kuzhichalil Peethambharan Surendran, Mailadil Thomas Sebastian, Jobin Varghese
413	Japan	6178851	A Process For Decomposition Of Organic Synthetic Dyes Using Semiconductor-Oxides Nanotubes Via Dark Catalysis.	Shukla Satyajit Vishnu, Warrier Krishna Gopakumar, Babu Babitha Kunnathuparambil
414	Japan	6258355	A Novel Aza Bodipy Derivative For The Selective Detection Of Nitrite Ions In Water: A Process Thereof And Its Application In Waste Water Management	Danaboyina Ramaiah, Nagappanpillai Adarsh, Madhesh Shanmugasundaram
415	Japan	6167114	A Novel Method Of Developing Nano-Structured Silver Oxide Film Based Aqueous Voltammetric Pesticide Sensor	Panampillil Vijayammma Subha, Varghese Saumya, Talasila Prasada Rao
416	United States Of America	9803063	Blue Colored Inorganic Pigments, Having Near Infrared Reflectance, Based On Mixtures Of Lanthanum, Strontium, Copper And Lithium Silicate And Process Thereof	Mundlapudi Lakshmipathi Reddy, Sheethu Jose

417	United States Of America	9791451	A Squaraine Based Fluorescent Probe For Selective Labeling And Sensing Of Serum Albumin Proteins, Ph Monitoring And Thiol Imaging In Cells And A Process For The Preparation Thereof	Ayyappanpillai Ajayaghosh, Palappuravan Anees
CSIR-NMITLI				
S. No	**Country**	**Patent No**	**Title Of Invention**	**Inventors**
418	China	ZI201410521073.5	Detection Of Pathogens Using Dna Macroarrays	Chintalagiri Mohan Rao, Kunchala Sridhar Rao, Puppala Venkat Ramchander, Hajib Naraharirao Madhavan, Savitri Sharma, Gita Satpathy, Ravi Kumar Venkata Banda
419	Germany	2155909	Detection Of Pathogens Using Dna Macroarrays	Chintalagiri Mohan Rao, Kunchala Sridhar Rao, Puppala Venkat Ramchander, Hajib Naraharirao Madhavan, Savitri Sharma, Gita Satpathy, Ravi Kumar Venkata Banda
420	European Patent Office	2155909	Detection Of Pathogens Using Dna Macroarrays	Chintalagiri Mohan Rao, Kunchala Sridhar Rao, Puppala Venkat Ramchander, Hajib Naraharirao Madhavan, Savitri Sharma, Gita Satpathy, Ravi Kumar Venkata Banda
421	European Patent Office	2619328	Top2a Inhibition By Temozolomide And Its Predictive Value Of Gbm Patient's Survival	Kumaravel Somasundaram, Arivazhagan A, Kandavel Thennarasu, Alangar Sathyaranjandas Hegde, Ashwathnarayana Rao Chandramouli, Vani Santosh, Paturu Kondaiah, Manchanahalli Rangaswamy Satyanarayana Rao
422	France	2155909	Detection Of Pathogens Using Dna Macroarrays	Chintalagiri Mohan Rao, Kunchala Sridhar Rao, Puppala Venkat Ramchander, Hajib Naraharirao Madhavan, Savitri Sharma, Gita Satpathy, Ravi Kumar Venkata Banda
423	United Kingdom	2155909	Detection Of Pathogens Using Dna Macroarrays	Chintalagiri Mohan Rao, Kunchala Sridhar Rao, Puppala Venkat Ramchander, Hajib Naraharirao Madhavan, Savitri Sharma, Gita Satpathy, Ravi Kumar Venkata Banda

424	Indonesia	Idp000048158	Detection Of Pathogens Using Dna Macroarrays	Chintalagiri Mohan Rao, Kunchala Sridhar Rao, Puppala Venkat Ramchander, Hajib Naraharirao Madhavan, Savitri Sharma, Gita Satpathy, Ravi Kumar Venkata Banda
425	United States Of America	9833300	Dental Implant System	Mahesh Verma, Naresh Bhatnagar, Abhinav Sood, Farukh Faraz, Kshitij Sharma, G Venugpala Rao, P Selva Kumar
426	United States Of America	9863952	Secreted And Plasma Membrane Associated Biomarkers For The Diagnosis Of Higher- And Lower-Grade Astrocytoma	Manchanahalli Rangaswamy Satyanarayana, Paturu Kondaiah, Kumaravel Somasundaram, Sridevi Hegde, Alangar Sathyaranjandas Hegde, Vani Santosh
427	United States Of America	9777339	Detection Of Pathogens Using Dna Macroarrays	Chintalagiri Mohan Rao, Kunchala Sridhar Rao, Puppala Venkat Ramchander, Hajib Naraharirao Madhavan, Savitri Sharma, Gita Satpathy, Ravi Kumar Venkata Banda
428	Vietnam	1-0018274	Detection Of Pathogens Using Dna Macroarrays	Chintalagiri Mohan Rao, Kunchala Sridhar Rao, Puppala Venkat Ramchander, Hajib Naraharirao Madhavan, Savitri Sharma, Gita Satpathy, Ravi Kumar Venkata Banda
CSIR-NPL				
S. No	**Country**	**Patent No**	**Title Of Invention**	**Inventors**
429	Czech Republic	306776	Improved Process For The Development Of High Temperature Superconducting Bulk Current Leads	Sn Ekbote,Gk Padam, Nk Arora, Mukul Sharma, Ramesh Sethi, Mk Banjerjee
430	United Kingdom	Gb2519912	Improvement In Power Conversion Efficiency In Conjugated Polymer Modified Ptb7- Pc60bm Based Bulk Heterojunction Solar Cells	Gupta Vinay, Bharti Vishal, Chaudhary Neeraj, Chand Suresh
431	Japan	6120816	Resistive Type Porous Magnesium Ferrite Humidity Sensor	Ravinder Kumar Kotnala, Jyoti Shah, Hari Kishan, Bhikham Singh

432	Malaysia	My-161215-A	A Compact Ecg Monitoring Device With A Filter For Impulse And Channel Switching Adc Noise And Error Correction For Sequential Sampling Of Ecg Leads	Mehrotra Ravi, Mohd. Ansari Imran, Ranjan Ashish, Chadha Deepti, Sharma Anjali
433	United States Of America	9676707	A Process For The Synthesis Of [6,6]Phenyl(C61)Butyric Acid Pentyl Ester (Pc61bp)	Rachana Kumar, Samya Naqvi, Neha Gupta, Suresh Chand
434	United States Of America	9683109	Smart Coatings Of Conducting Polymer Composites For Corrosion Protection In Marine Environment	Dhawan Sundeep Kumar, Anoop Kumar Sasidharan, Bhandari Hema, Ruhi Gazala, Sharma Brijesh
435	United States Of America	9865791	Nanostructured Copper-Selenide (Cu2se) With High Thermoelectric Figure-Of-Merit And Process For The Preparation Thereof	Gahtori Bhasker, Bathula Sivaiah, Tyagi Kriti, Srivastava Avanish Kumar, Dhar Ajay, Budhani Ramesh Chandra
436	United States Of America	9704628	A Ferrofluid - Mwcnt Hybrid Nanocomposite In Liquid State	Rajendra Prasad Pant, Ajay Shankar, Komal Jain, Sonia, Mahesh Chand
437	United States Of America	9671359	Resistive Type Porous Magnesium Ferrite Humidity Sensor	Ravinder Kumar Kotnala, Jyoti Shah, Hari Kishan, Bhikham Singh

Area-wise Research Publications (TOP 25 Papers) by CSIR Labs.				
BIOLOGICAL SCIENCES				
BASED ON IMPACT FACTOR OF THE JOURNALS				
S.No.	**LAB**	**First Author**	**Journals**	**IF-2017**
1	IITR	Afshin, A	NEW ENGLAND JOURNAL OF MEDICINE, 2017, Vol. 377, Iss. 1, pp. 13 27	79.258
2	IITR	Reitsma, MB	LANCET, 2017, Vol. 389, Iss. 10082, pp. 1885 1906	53.254
3	IGIB	Dandona, L	LANCET, 2017, Vol. 390, Iss. 10111, pp. 2437 2460	53.254
4	IITR, IGIB	Barber, RM	LANCET, 2017, Vol. 390, Iss. 10091, pp. 231 266	53.254
5	IITR, IGIB	Wang, HD	LANCET, 2017, Vol. 390, Iss. 10100, pp. 1084 1150	53.254
6	IITR, IGIB	Naghavi, M	LANCET, 2017, Vol. 390, Iss. 10100, pp. 1151 1210	53.254
7	IITR, IGIB	Vos, T	LANCET, 2017, Vol. 390, Iss. 10100, pp. 1211 1259	53.254
8	IITR, IGIB	Hay, SI	LANCET, 2017, Vol. 390, Iss. 10100, pp. 1260 1344	53.254
9	IITR, IGIB	Gakidou, E	LANCET, 2017, Vol. 390, Iss. 10100, pp. 1345 1422	53.254
10	IITR, IGIB	Fullman, NTY	LANCET, 2017, Vol. 390, Iss. 10100, pp. 1423 1459	53.254
11	IGIB	Erwin, GS	SCIENCE, 2017, Vol. 358, Iss. 6370, pp. 1617 1621	41.058
12	CDRI	Ghosh, E	NATURE NANOTECHNOLOGY, 2017, Vol. 12, Iss. 12, pp. 1190 +	37.490
13	IGIB	Wang, Y	CELL, 2017, Vol. 171, Iss. 2, pp. 331 +	31.398
14	CCMB	Nakatsuka, N	NATURE GENETICS, 2017, Vol. 49, Iss. 9, pp. 1403 +	27.125
15	IGIB	Soriano, JB	LANCET RESPIRATORY MEDICINE, 2017, Vol. 5, Iss. 9, pp. 691 706	21.466

16	CDRI	Muthusamy, N	NATURE NEUROSCIENCE, 2017, Vol. 20, Iss. 1, pp. 20 23	19.912
17	IITR	Das, M	LANCET GLOBAL HEALTH, 2017, Vol. 5, Iss. 9, pp. E859 E860	18.705
18	IMTech	Albert, SK	JOURNAL OF THE AMERICAN CHEMICAL SOCIETY, 2017, Vol. 139, Iss. 49, pp. 17799 17802	14.357
19	IITR	Klein, JEMN	JOURNAL OF THE AMERICAN CHEMICAL SOCIETY, 2017, Vol. 139, Iss. 51, pp. 18705 18713	14.357
20	CDRI	Troger, J	PROGRESS IN NEUROBIOLOGY, 2017, Vol. 154, Iss., pp. 37 61	14.163
21	NBRI	Tibpromma, S	FUNGAL DIVERSITY, 2017, Vol. 83, Iss. 1, pp. 1 261	14.078
22	NBRI	Singh, BN	TRENDS IN BIOTECHNOLOGY, 2017, Vol. 35, Iss. 9, pp. 808 813	13.578
23	NBRI	Singh, BN	TRENDS IN BIOTECHNOLOGY, 2017, Vol. 35, Iss. 12, pp. 1121 1124	13.578
24	IGIB	Mabalirajan, U	JOURNAL OF ALLERGY AND CLINICAL IMMUNOLOGY 2017 139, Iss. 2, pp. 712 712	13.258
25	IGIB	Rehman, R	JOURNAL OF ALLERGY AND CLINICAL IMMUNOLOGY 2017 139, Iss. 2, pp. 713 714	13.258

Area-wise Research Publications (TOP 25 Papers) by CSIR Labs.				
CHEMICAL SCIENCES				
BASED ON IMPACT FACTOR OF THE JOURNALS				
S.No.	**LAB**	**First Author**	**Journals**	**IF-2017**
1	NIIST	Preethalayam, P	CHEMICAL REVIEWS, 2017, Vol. 117 Iss. 5 pp. 3930-3989	52.613
2	CECRI	Laskowski, FAL	ENERGY & ENVIRONMENTAL SCIENCE, 2017, Vol. 10 Iss. 2 pp. 570-579	30.067
3	NCL	Kandambeth, S	ADVANCED MATERIALS, 2017, Vol. 29 Iss. 2 pp. 1603945	21.950
4	NIIST	Ghosh, S	ADVANCED MATERIALS, 2017, Vol. 29 Iss. 10 pp. UNSP 1605408	21.950
5	NIIST	Ghosh, S	ADVANCED MATERIALS, 2017, Vol. 29 Iss. 46 pp. 1703783	21.950
6	NIIST	SeethaLekshmi, S	JOURNAL OF PHOTOCHEMISTRY AND PHOTOBIOLOGY C-PHOTOCHEMISTRY REVIEWS, 2017, Vol. 33 Iss. pp. 109-131	15.325
7	IICT	Seddigi, ZS	COORDINATION CHEMISTRY REVIEWS, 2017, Vol. 348 Iss. pp. 54-70	14.499
8	NCL	Karak, S	JOURNAL OF THE AMERICAN CHEMICAL SOCIETY, 2017, Vol. 139 Iss. 5 pp. 1856-1862	14.357
9	NCL	Mitra, S	JOURNAL OF THE AMERICAN CHEMICAL SOCIETY, 2017, Vol. 139 Iss. 12 pp. 4513-4520	14.357
10	NIIST	Dov, NE	JOURNAL OF THE AMERICAN CHEMICAL SOCIETY, 2017, Vol. 139 Iss. 33 pp. 11471-11481	14.357
11	NCL	Dey, K	JOURNAL OF THE AMERICAN CHEMICAL SOCIETY, 2017, Vol. 139 Iss. 37 pp. 13083-13091	14.357
12	NCL	Jha, PK	CHEM, 2017, Vol. 3 Iss. 5 pp. 846-860	14.104

13	NCL	Biswas, B	ACS NANO, 2017, Vol. 11 Iss. 10 pp. 10025-10031	13.709
14	CECRI	Krishnan, K	ADVANCED FUNCTIONAL MATERIALS, 2017, Vol. 27 Iss. 10 pp. 1605104	13.325
15	NPL, IICT	Suman	ADVANCED FUNCTIONAL MATERIALS, 2017, Vol. 27 Iss. 2 pp. 1603820	13.325
16	CECRI	Anantharaj, S	NANO ENERGY, 2017, Vol. 39 Iss. pp. 30-43	13.120
17	IICT	Vishwakarma, NK	NATURE COMMUNICATIONS, 2017, Vol. 8 Iss. pp. 14676	12.353
18	NCL	Jaiswal, G	NATURE COMMUNICATIONS, 2017, Vol. 8 Iss. pp. 2147	12.353
19	NCL	Shanker, GS	ACS ENERGY LETTERS, 2017, Vol. 2 Iss. 10 pp. 2251-2256	12.277
20	IICT	Bonam, SR	TRENDS IN PHARMACOLOGICAL SCIENCES, 2017, Vol. 38 Iss. 9 pp. 771-793	12.108
21	NCL	Shaikh, AC	ANGEWANDTE CHEMIE-INTERNATIONAL EDITION, 2017, Vol. 56 Iss. 3 pp. 757-761	12.102
22	NIIST	Nair, VC	ANGEWANDTE CHEMIE-INTERNATIONAL EDITION, 2017, Vol. 56 Iss. 5 pp. 1214-1218	12.102
23	NCL	Patra, A	ANGEWANDTE CHEMIE-INTERNATIONAL EDITION, 2017, Vol. 56 Iss. 10 pp. 2730-2734	12.102
24	NCL	Bera, S	ANGEWANDTE CHEMIE-INTERNATIONAL EDITION, 2017, Vol. 56 Iss. 8 pp. 2123-2126	12.102
25	NIIST	Panda, MK	ANGEWANDTE CHEMIE-INTERNATIONAL EDITION, 2017, Vol. 56 Iss. 28 pp. 8104-8109	12.102

Area-wise Research Publications (TOP 25 Papers) by CSIR Labs.				
ENGINEERING SCIENCES				
BASED ON IMPACT FACTOR OF THE JOURNALS				
S.No.	**LAB**	**First Author**	**Journals**	**IF-2017**
1	CMERI	Chatterjee, D	COORDINATION CHEMISTRY REVIEWS, 2017, Vol. 349 Iss. pp. 129 -138	14.499
2	IMMT	Bonisch, M	NATURE COMMUNICATIONS, 2017, Vol. 8 Iss. pp. 1429	12.353
3	CGCRI, NCL	Das, PP	APPLIED CATALYSIS B-ENVIRONMENTAL, 2017, Vol. 203 Iss. pp. 692 -703	11.698
4	CMERI	Jana, M	JOURNAL OF MATERIALS CHEMISTRY A, 2017, Vol. 5 Iss. 25, pp. 12863 -12872	9.931
5	CGCRI	Chattopadhyay, S	JOURNAL OF MATERIALS CHEMISTRY A, 2017, Vol. 5 Iss. 33, pp. 17341 -17351	9.931
6	CGCRI	Mondal, S	CHEMISTRY OF MATERIALS, 2017, Vol. 29 Iss. 15, pp. 6191 -6194	9.890
7	NAL	Aruna, ST	RENEWABLE & SUSTAINABLE ENERGY REVIEWS, 2017, Vol. 67 Iss. pp. 673 -682	9.184
8	CMERI	Verma, M	RENEWABLE & SUSTAINABLE ENERGY REVIEWS, 2017, Vol. 71 Iss. pp. 732 -741	9.184
9	CMERI	Sah, RP	RENEWABLE & SUSTAINABLE ENERGY REVIEWS, 2017, Vol. 74 Iss., pp. 364 -376	9.184
10	NAL	Dan, A	RENEWABLE & SUSTAINABLE ENERGY REVIEWS, 2017, Vol. 79 Iss. pp. 1050 -1077	9.184
11	CGCRI	Saha, A	ACS APPLIED MATERIALS & INTERFACES, 2017, Vol. 9 Iss. 4, pp. 4126 -4141	8.097

12	CGCRI	Bera, S	ACS APPLIED MATERIALS & INTERFACES, 2017, Vol. 9 Iss. 5, pp. 4420 -4424	8.097
13	IMMT	Ratha, S	ACS APPLIED MATERIALS & INTERFACES, 2017, Vol. 9 Iss. 11, pp. 9640 -9653	8.097
14	CGCRI	Ghosh, S	ACS APPLIED MATERIALS & INTERFACES, 2017, Vol. 9 Iss. 39, pp. 33775 -33790	8.097
15	CGCRI, IICB	Das, S	ACS APPLIED MATERIALS & INTERFACES, 2017, Vol. 9 Iss. 1, pp. 644 -657	8.097
16	NEERI	Etchie, TO	ENVIRONMENT INTERNATIONAL, 2017, Vol. 102 Iss., pp. 145 -156	7.297
17	CMERI	De, B	CARBON, 2017, Vol. 122 Iss. pp. 247 - 257	7.082
18	CMERI	Giri, SK	IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS, 2017, Vol. 64 Iss. 3, pp. 1873 -1883	7.050
19	CMERI	Jana, M	JOURNAL OF POWER SOURCES, 2017, Vol. 340 Iss. pp. 380 -392	6.945
20	CGCRI	Pramanik, A	CHEMICAL ENGINEERING JOURNAL, 2017, Vol. 307 Iss. pp. 239 -248	6.735
21	CGCRI	Ramrakhiani, L	CHEMICAL ENGINEERING JOURNAL, 2017, Vol. 308 Iss. pp. 1048 -1064	6.735
22	CMERI	Bandyopadhyay, P	CHEMICAL ENGINEERING JOURNAL, 2017, Vol. 308 Iss. pp. 1174 -1184	6.735
23	CMERI	Jana, M	CHEMICAL ENGINEERING JOURNAL, 2017, Vol. 330 Iss. pp. 914 -925	6.735
24	CGCRI	Raja, MW	JOURNAL OF MEMBRANE SCIENCE, 2017, Vol. 522 Iss. pp. 168 -174	6.578
25	NEERI	Dhoble, RM	JOURNAL OF HAZARDOUS MATERIALS, 2017, Vol. 322 Iss., pp. 469 -478	6.434

Area-wise Research Publications (TOP 25 Papers) by CSIR Labs.				
INFORMATION SCIENCES				
BASED ON IMPACT FACTOR OF THE JOURNALS				
S.No.	**LAB**	**First Author**	**Journals**	**IF-2017**
1	URDIP	Deshpande, N	NATURE BIOTECHNOLOGY, 2017, Vol. 35, Iss. 6, pp. 514 - 516	35.724
2	URDIP	Khan, NM	FREE RADICAL BIOLOGY AND MEDICINE, 2017, Vol. 106, Iss., pp. 288 - 301	6.020
3	NISCAIR	Choudhary, S	ELECTROCHIMICA ACTA, 2017, Vol. 247, Iss., pp. 924 - 941	5.116
4	NISCAIR	Sengwa, RJ	JOURNAL OF MOLECULAR LIQUIDS, 2017, Vol. 225, Iss., pp. 42 - 49	4.513
5	NISCAIR	Choudhary, S	JOURNAL OF MOLECULAR LIQUIDS, 2017, Vol. 231, Iss., pp. 491 - 498	4.513
6	NISTADS	Garg, KC	TRAVEL MEDICINE AND INFECTIOUS DISEASE, 2017, Vol. 16, Iss., pp. 64 - 65	4.450
7	CSIR-4PI	Mukul, M	SCIENTIFIC REPORTS, 2017, Vol. 7, Iss., pp. 41672	4.122
8	CSIR-4PI	Jade, S	SCIENTIFIC REPORTS, 2017, Vol. 7, Iss., pp. 11439	4.122
9	CSIR-4PI	Mohapatra, GN	QUARTERLY JOURNAL OF THE ROYAL METEOROLOGICAL SOCIETY, 2017, Vol. 143, Iss. 707, pp. 2340 - 2351	2.978
10	CSIR-4PI	Sant, DA	JOURNAL OF ASIAN EARTH SCIENCES, 2017, Vol. 146, Iss., pp. 326 - 336	2.866
11	NISCAIR	Mahesh, G	JOURNAL OF THE ASSOCIATION FOR INFORMATION SCIENCE AND TECHNOLOGY, 2017, Vol. 68, Iss. 6, pp. 1596 - 1596	2.835
12	NISTADS	Bhati, M	ENVIRONMENTAL SCIENCE AND POLLUTION RESEARCH, 2017, Vol. 24, Iss. 30, pp. 23423 - 23435	2.800
13	URDIP	Ali, Y	BIOORGANIC & MEDICINAL CHEMISTRY LETTERS, 2017, Vol. 27, Iss. 4, pp. 1017 - 1025	2.442

14	CSIR-4PI, NISTADS	Goswami, P	METEOROLOGICAL APPLICATIONS, 2017, Vol. 24, Iss. 3, pp. 360 - 375	2.391
15	CSIR-4PI	Mir, RR	BULLETIN OF THE SEISMOLOGICAL SOCIETY OF AMERICA, 2017, Vol. 107, Iss. 5, pp. 2443 - 2458	2.343
16	URDIP	Tantray, MA	ARCHIV DER PHARMAZIE, 2017, Vol. 350, Iss. 8, pp. e1700022	2.288
17	CSIR-4PI	Barman, P	INTERNATIONAL JOURNAL OF EARTH SCIENCES, 2017, Vol. 106, Iss. 6, pp. 2025 - 2038	2.276
18	URDIP	Dapurkar, D	WORLD JOURNAL OF MICROBIOLOGY & BIOTECHNOLOGY, 2017, Vol. 33, Iss. 7, pp. 138-	2.100
19	CSIR-4PI	Barman, P	INTERNATIONAL JOURNAL OF REMOTE SENSING, 2017, Vol. 38, Iss. 2, pp. 391 - 411	1.782
20	CSIR-4PI	Rakesh, V	PURE AND APPLIED GEOPHYSICS, 2017, Vol. 174, Iss. 3, pp. 1385 - 1398	1.652
21	CSIR-4PI	Parvez, IA	PURE AND APPLIED GEOPHYSICS, 2017, Vol. 174, Iss. 3, pp. 1441 - 1452	1.652
22	CSIR-4PI, NISTADS	Sarkar, S	PURE AND APPLIED GEOPHYSICS, 2017, Vol. 174, Iss. 7, pp. 2827 - 2845	1.652
23	CSIR-4PI	Sen, S	KONA POWDER AND PARTICLE JOURNAL, 2017, Vol., Iss. 34, pp. 248 - 257	1.638
24	NISCAIR	Choudhary, S	PHYSICA B-CONDENSED MATTER, 2017, Vol. 522, Iss., pp. 48 - 56	1.453
25	NISCAIR	Choudhary, S	JOURNAL OF POLYMER RESEARCH, 2017, Vol. 24, Iss. 3, pp. 54 -	1.434

Area-wise Research Publications (TOP 25 Papers) by CSIR Labs.				
PHYSICAL SCIENCES				
BASED ON IMPACT FACTOR OF THE JOURNALS				
S.No.	**LAB**	**First Author**	**Journals**	**IF-2017**
1	NPL	Vilan, A	CHEMICAL REVIEWS, 2017, Vol. 117, Iss. 5 pp. 4248 - 4286	52.613
2	NPL	Ramanujam, J	ENERGY & ENVIRONMENTAL SCIENCE, 2017, Vol. 10, Iss. 6 pp. 1306 - 1319	30.067
3	CSIO	Kumar, P	COORDINATION CHEMISTRY REVIEWS, 2017, Vol. 353,, Iss. pp. 113 - 141	14.499
4	NIO	Bristow, LA	NATURE GEOSCIENCE, 2017, Vol. 10, Iss. 1 pp. 24 - 29	14.391
5	NPL, CEERI	Prakash, J	REPORTS ON PROGRESS IN PHYSICS, 2017, Vol. 80, Iss. 1 pp. 16601 -	14.257
6	NIO	Wijayawardene, NN	FUNGAL DIVERSITY, 2017, Vol. 86, Iss. 1 pp. 1 - 594	14.078
7	NIO	Khodri, M	NATURE COMMUNICATIONS, 2017, Vol. 8, Iss. pp. 778 -	12.353
8	CSIO	Neelapu, BC	SLEEP MEDICINE REVIEWS, 2017, Vol. 31, Iss. pp. 79 - 90	10.602
9	NIO	Choi, CJ	CURRENT BIOLOGY, 2017, Vol. 27, Iss. 1 pp. R15 - R16	9.251
10	NGRI	Manju, S	RENEWABLE & SUSTAINABLE ENERGY REVIEWS, 2017, Vol. 70, Iss. pp. 298 - 313	9.184
11	NGRI	Manju, S	RENEWABLE & SUSTAINABLE ENERGY REVIEWS, 2017, Vol. 73, Iss. pp. 594 - 609	9.184
12	CSIO	Kumar, S	RENEWABLE & SUSTAINABLE ENERGY REVIEWS, 2017, Vol. 73, Iss. pp. 821 - 839	9.184

13	CSIO	Elsawy, MA	RENEWABLE & SUSTAINABLE ENERGY REVIEWS, 2017, Vol. 79, Iss. pp. 1346 - 1352	9.184
14	NPL	Kumar, A	NPJ COMPUTATIONAL MATERIALS, 2017, Vol. 3, Iss. pp. UNSP 2	8.941
15	NPL	Ahmad, R	JOURNAL OF PHYSICAL CHEMISTRY LETTERS, 2017, Vol. 8, Iss. 8 pp. 1729 - 1738	8.709
16	CSIO	Bansod, B	BIOSENSORS & BIOELECTRONICS, 2017, Vol. 94, Iss. pp. 443 - 455	8.173
17	CSIO	Kempahanumakkagari, S	BIOSENSORS & BIOELECTRONICS, 2017, Vol. 95, Iss. pp. 106 - 116	8.173
18	NPL	Kumar, P	ACS APPLIED MATERIALS & INTERFACES, 2017, Vol. 9, Iss. 16 pp. 14301 - 14308	8.097
19	CSIO	Kumar, V	ACS APPLIED MATERIALS & INTERFACES, 2017, Vol. 9, Iss. 20 pp. 16814 - 16824	8.097
20	NPL	Kumar, PN	ACS APPLIED MATERIALS & INTERFACES, 2017, Vol. 9, Iss. 30 pp. 25278 - 25290	8.097
21	NPL	Verma, S	ACS APPLIED MATERIALS & INTERFACES, 2017, Vol. 9, Iss. 33 pp. 27462 - 27474	8.097
22	CSIO	Bhardwaj, N	ACS APPLIED MATERIALS & INTERFACES, 2017, Vol. 9, Iss. 39 pp. 33589 - 33598	8.097
23	NPL	Ahmad, R	ACS APPLIED MATERIALS & INTERFACES, 2017, Vol. 9, Iss. 39 pp. 34111 - 34121	8.097
24	NPL, CSIO	Devi, P	ACS APPLIED MATERIALS & INTERFACES, 2017, Vol. 9, Iss. 15 pp. 13448 - 13456	8.097
25	CSIO	Ansari, A	AGING CELL, 2017, Vol. 16, Iss. 1 pp. 4 - 16	7.627

Annexure -IV

Summary of important audit observations

(Position as on 31.3.2018)

Sl. No.	No. & Year of the Report	Number of Paras /PA Reports on which ATNs have been submitted to Monitoring Cell, Ministry of Finance	Details of the Paras/ PAC Reports on which ATNs are pending		
			Number of ATNs not sent by the Ministry even for the first time	Number of ATNs sent but returned with observations and Audit is awaiting their resubmission by the Ministry	Number of ATNs which have been finally vetted by Audit but have not been submitted by the Ministry
1	Report No 5 of 1998 (1 Para)	NIL	NIL	NIL	1
2	Report No 5 of 2000 (1 Para)	NIL	NIL	NIL	1
3	Report No 22 of 2012-13 (1 Para)	NIL	NIL	NIL	1
4	Report No 29 of 2013 (1 Para)	NIL	NIL	1	NIL
5	Report No 30 of 2015 (1* Para)	NIL	NIL	NIL	NIL
	Total= 5 Paras			1	3
Note:*- ATN was pending with the Office of PDA(SD) as on 31.3.2018 for their vetting comments					

Annexure-V

List of the Governing Body Members

1.	Director General Dr. Shekhar C. Mande Council of Scienific and Industrial Research (CSIR) 2, Rafi Marg, New Delhi-110001	Chairman (ex-officio)
2.	Secretary (Expenditure) Shri Ajay Narayan Jha Ministry of Finance North Block New Delhi-110001	Member Finance (ex – officio)
3.	Dr. Ram A. Vishwakarma Director CSIR-Indian Institute of Integrative Medicine Canal Road Jammu – 180 001	Member
4.	Dr. Rakesh K. Mishra Director CSIR-Centre for Cellular and Molecular Biology Uppal Road Hyderabad – 560 007	Member
5.	Shri Dilip Shanghvi Managing Director Sun Pharmaceutical Industrial Limited SUN House, CTS No. 201-B/1 Western Express Highway, Goregaon E Mumbai – 400 063	Member
6.	Shri Dinesh K. Sarraf Chairperson Petroleum and Natural Gas Regulatory Board 1st Floor, World Trade Centre, Babar Road New Delhi – 110 001 Flat No. 804, C- Bock CLEO County, GH-05, Sector-121 Noida – 201 301 (UP)	Member

7.	Prof. M.R. Satyanarayana Rao Professor Chromatin Biology Laboratory Molecular Biology and Genetics Unit (MBGU) Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Jakkur Bengaluru – 560 064	Member
8.	Prof. Srikumar Banerjee Homi Bhabha Chair Professor Bhabha Atomic Research Centre, (BARC) and (Chancellor, Central University of Kashmir Srinagar, J&K), Anusaktinagar Mumbai – 400 094	Member
9.	Dr. Arun Kumar Grover, Honorary Emeritus Professor Department of Applied Sciences Punjab Engineering College (Deemed to be University), Sector-12 Chandigarh – 160 012 House No. 157, First Floor, Sector 16 A Chandigarh – 160 015	Member
10.	Secretary (Pfof. Ashutosh Sharma) Department of Science and Technology (DST) Technology Bhawan New Mehrauli Road New Delhi – 110 016	Member
11.	Secretary (Dr. G. Satheesh Reddy) Department of Defence Research and Development (DDRD) and Chairman, Defence Research and Development Organisation (DRDO) Ministry of Defence New Delhi – 110 001	Member

Annexure -VI

Cluster-wise list of FTT Projects

A. Biological Science Cluster (Total No. of Projects: 35)	
S. No.	**Project Title**
CSIR-CCMB	
1.	Paper based affordable microfluidic kit for early pregnancy detection in cattle and buffaloes
2.	Development of simple and affordable diagnostic protocols and diagonstic kit for genetic diagnosis of musculipathies and hemoglobinopthies
CSIR-CDRI	
3.	Clinical development of Candidate Drug 99/373 (Anti-osteoporotic)
4.	Clinical development of candidate drug 97/78 (anti-malarial)
CSIR-CFTRI	
5.	Know-how of the isolation of arabinoxylans from defatted cereal brans
6.	Development and production of anti-obesity DAG Oil
7.	Non-thermal processing of liquid foods
8.	Technology for carbonated fruit juice beverages from selected fruit crops
CSIR-CIMAP	
9.	Development of a high yielding variety of *Artemisia annua*
10.	Development of improved variety for high root yield with better quality of Yellow Satawar (*Asparagus adscendensRoxb.*)
11.	Development of a linalool rich cold tolerant *Ocimum chemotype*
12.	Development of withanolide rich, quality root & early maturing advance breeding line with a novel ideotype
13.	Calliterpenone for enhancing crop yields
CSIR-IGIB	
14.	Go-Med
15.	NGS based high resolution HLA typing kits
16.	NGS for mitochondrial diagnosis
17.	PulmoScan

CSIR-IHBT	
18.	Developing *L-Asparaginase* with Low Glutaminase Activity for Therapeutic Applications
19.	Process for substituted cyclohexane-1-3-dione synthesis
CSIR-IICB	
20.	Rapid Assay System and Clinical Validation of Biomarker for Rheumatic Heart Disease
21.	Serum and urine-based kits for dianosis (VL) and post kala-azar dermal leishmaniasis (PKDL) in the field setting
CSIR-IIIM	
22.	Mupirocin + IIIM-1133/06: A topical formulation for improved bioefficacy
23.	Agrotechnology transfer and thymol crystal from Jammu Monarda
24.	IND filling of anti-cancer lead IIIM (N)-290/13 (Cdk inhibitor)
CSIR-IITR	
25.	Development of biosensors (*Indicator-eye Test Range*) for detection of adulterants in food products
26.	Development of a new real time PCR based system for the quantification of small RNAs and circular RNA and development of a new kit for absolute quantification of miRNAs
27.	An electric device for online drinking water disinfection
CSIR-IMTECH	
28.	Technology for Recombinant Streptokinase
29.	For market-gelsolin estimation kit and gelsolin(s)
30.	A universal expression platform for low cost production of biothrerapeutic proteins in S.prmbe
31.	Technology Development for production of pullulan
32.	Production of a biomedically important glycolipid bio-surfactant sophorolipid
CSIR-NBRI	
33.	Thebaine rich opium poppy lines for suitable cultivation through narcotics department
34.	Low grain arsenic rice variety for safer human consumption
35.	Anacardic acid: A potential molecule to increate cotton fibre yield and quality

B. Chemical Sciences Cluster (Total No. of Projects: 32)	
CSIR-CECRI	
36.	Development of Zinc Bromine redox flow battery (500 W)
37.	Electrochemical remediation of industrial effluents and recovery of chromium
38.	Development of accurate, reliable and cost effective sensor for the electrochemical detection of multiple analytes
39.	Development of High temperature ceramic Thermal barrier coatings for Missile components
CSIR-IICT	
40.	Development of multipurpose thermal insulation coatings for different substrates
41.	Development of novel processes towards Eribulin, Nicotine, Bedaquiline
42.	Discovery of Novel Anticancer Agent (HDAC Inhibitor)
43.	Polymeric excipients for pharmaceutical applications
CSIR-NEIST	
44.	*In-situ* bioremediation technology
45.	Herbal product for management of pain
46.	Membrane Based Process Technology for Commercial Production of Biomolecules
47.	Modular Bricks from Brahmaputra River Bed Sand
CSIR-NIIST	
48.	IR reflecting rare earth blue pigment for solar heat control cool-roof applications
49.	Scaled up process for the upgradation of Low grade of Ilmenites
50.	Development of process for large scale production of β-glucosidase (BGL) enzyme for blending in biomass hydrolyzing cocktails to be used in Lignocellulosic Biorefineries
CSIR-NCL	
51.	Synthesis of 5-Hydroxymethyl furfural from sacharides
52.	Continuous Dinitration for Manufacturing of Pendimethalin
53.	Development of penicillin V acylase system for industrial production of semi-synthetic antibiotics
54.	Non-vascular self-expandable stents

CSIR-IIP	
55.	Setting up 1 TPD pilot plant for converting waste plastics to diesel
56.	Technology demonstration and process flexibility for production of Bio-Aviation fuels
57.	Demonstration and Process Validation of Laboratory scale Vacuum Swing Adsorption (VSA) Process for Biogas Up-gradation to Pipeline Quality Fuel from Raw Biogas
58.	Development of Adsorption Based Technology for the Production of Ultra Low Sulfur Diesel meeting BS IV /BS VI specification Development Positioning
CSIR-CSMCRI	
59.	Technology for double fortified salt composition containing iron and iodine to control both deficiencies
60.	Hollow fiber membrane based high flux domestic filter for water clarification and disinfection
61.	Novel cost effective process for high purity solar salt production with reduced contents of carbon, iodine, suspended solids and sulfate content directly in solar salt fields from high sulfate containing brines (particularly for Rajasthan inland/lake brines)
62.	A consolidated biomass process for integrated production of multiple products from fresh marine macroalgae
CSIR-CIMFR	
63.	Coal dust collecting and briquetting system
CSIR-CLRI	
64.	Waterless chrome tanning
65.	High grade gelatine and protein hydrolysate from trimmings
66.	Zero Wastewater Discharge Technology
67.	Cocktail of carbohydrases for rapid fiber opening
C. Engineering Sciences Cluster (Total No. of Projects: 41)	
CSIR-AMPRI	
68.	Aluminium Composite Foams (ACFs) for Crashworthiness Applications
69.	Fibre and particulate reinforced hybrid polymeric composite as architectural interior for building construction material
CSIR-CBRI	
70.	Building products using Kota stone cutting and slurry waste

71.	Foundation system for light structures
72.	Development of a boring machine based on trenchless technology
CSIR-CGCRI	
73.	Paper-based Ceramic Separator for Li-ion Battery Application
74.	Packaged Fiber Laser Modules for Industrial and Medical Applications
75.	Development of Reaction Bonded Silicon Nitride Ceramic Radome
76.	Superior Refractory for Induction Furnace to enable Refining of Steel
77.	SiAION Insert for High Speed cutting of hard materials
78.	Fast Recovery Trace moisture sensor and meter for detection of trace moisture present in transformer oil
79.	Development of novel Ion doped Hydrxyapatite (HAp) by spray drying method and its utilization for plasma spray coating on medical implants with/without ion doping
CSIR-CMERI	
80.	Field deployment of indigenous 4-axis controller for multi-process micro machine
81.	Graphene based Aqueous lubricants
82.	Development of Domestic Iron Removal Filter
83.	Micro Fuel Cell
84.	Design and Development of different prototypes of Solar Power Tree for independent area electrification
85.	Intelligent and Powered Wheel Chair
86.	Process technology for manufacturing of ADI components for minning application
CSIR-CRRI	
87.	Design of Noise Barrier based on different Frequencies
88.	Development and evaluation of "Soil Nailing Technique" for stabilisation of soil slope for the construction of underpass below Road traffic
89.	Design & Performance of Cement Grouted Bituminous Mix (CGBM) for Urban Roads
CSIR-IMMT	
90.	Electrophoretic Deposition (EPD) for Industrial Application

91.	Maximize the recovery of iron values from lean grade iron ore by reduction roasting and pelletisation of high LOI and high Blaine number iron ore fines
92.	Process Development for production of flaky graphite, high purity graphite and graphite from natural graphite
93.	Recovery of Alumina from fly ash
CSIR-NAL	
94.	Design and Development of Cost Effective and Advanced Polymer Composite Processing Equipment
95.	Fully Autonomous fixed wing mini UAVs under 5.0 kg class - Enhancement of existing UAV models
96.	Design, development and certification of Avionics Video and Data FPGA based IP Core
97.	Vertical take-off and landing (VTOL) based MAV using indigenously developed electrically driven co-axial motor
98.	Development of Medium Wind-Solar Hybrid (WiSH) Systems of 7–10 kW class for Agricultural and other rural applications
CSIR-NEERI	
99.	Solar Disinfection Systems for potable water
CSIR-NML	
100.	Technology for extraction of tungsten (yellow tungsten oxide or ammonium paratungstate or metallic W-powder) from a variety of scraps
101.	Development of Hydrogen standard in Steel
102.	Low Phosphorus steel through furnace route using DRI as major ferruginous raw material-an industrial assessment
CSIR-SERC	
103.	Glass Textile Reinforced Concrete Crash Barrier System
104.	Design of Emergency Restoration System for Power Lines
105.	"अहल्या (AHALYA)" RFID based Battery less Wireless Embedded Sensor for Structural Health Monitoring of Reinforced Concrete Structures (Corrosion, Humidity, Temperature)
106.	Precast Ferrocement Toilet Core Unit (Prefer Toco)
107.	Improved Design and Retrofit Methodology for Seismically Vulnerable Open Ground Storey (OGS) Structures
108.	Development of cost effective water tanks using flowable cement mortar

D. Physical Sciences Cluster (Total No. of Projects: 31)	
CSIR-CEERI	
109.	Prevention of adulteration in milk-real time remote milk supply monitoring network (PRADUMAN)
110.	Handheld milk quality analyser
111.	Gas sensor for environmental monitoring
112.	Development of 3D rigid and flexible Endoscopes for Denture examination
113.	Development of Silent Killer Gas Detector using LTCC Technology
114.	High Frequency RF MEMS Capacitive Switches
115.	Development of MEMS-based Accelerometer
CSIR-CSIO	
116.	Development of Water Quality Monitoring Watchdog Pod
117.	Reading Machine for visually impaired
118.	Power Quality Analyser
119.	Head gesture based control module for Intelligent Patient Vehicle
120.	Postural Stability Assessment System
121.	Portable Energy Audit Tool
122.	Pump Efficiency Monitoring System
123.	AutoCEPH: A software for 2-D Computerized Cephalometric Analysis
124.	Earthquake Warning System
125.	Touch based Finger Gesture control for Intelligent Patient Vehicle
126.	Antiglare Filter for Automobiles
127.	Avionics Head Up Display Test Rig
128.	Head up Display Mk1N-NP for Naval LCA
129.	Head up Display for Intermediate Jet Trainer Aircraft
130.	Indigenous development of laser lithotripsy system for medical applications
CSIR-NGRI	
131.	Earthquake hazard assessment of the Himalaya and the Indo-Gangetic plains
132.	Imaging sub-volcanic mesozoics in Kerala-Konkan (KK) offshore from wide-angle seismic data (Energy and Mineral Resources)

CSIR-NIO	
133.	Development of software for High resolution velocity analysis for mapping of gas hydrate deposits/support for strategic sector
134.	Microbial consortium for aquaculture waste management and disease control
135.	Melanin from sponge associated bacteria
136.	Low cost Multipurpose Multichannel data logger unit
CSIR-NPL	
137.	Low-cost Peltier based refrigerators for rural regions
138.	Sunlight sensitized long afterglow phosphor powder & paint
139.	Fonoclock with a time synchronization accuracy of ±10 ms

In-house Laboratory R&D Projects List

S.No.	Laboratory	Project Tittles
1.	CSIR-CEERI	Indigenous design, development & qualification of Ku band (140-210 watts) and Ka band (100-150 watts) Travelling wave tube (TWT).
2.	CSIR-NPL	Strengthening of Primary Time Scale Ensemble for nation-wide dissemination of Indian Standard Time
3.	CSIR-NAL	Flight Testing and Evaluation of Saras PT1N
4.	CSIR-NPL	Creation and Calibration Facility for LED and LED based Lighting
5.	CSIR-URDIP	Informatics for drug-repurposing and rescue discoveries (IDrRD);
6.	CSIR-URDIP	Intellectual Property Evaluation and Commercialization (IPEC);
7.	CSIR-URDIP	Creation of E-Markets for Knowledge Products and Services
8.	CSIR-TKDL	Digitisation of Sowa Rigpa, Ancient Manuscripts and Oral Traditional Indian Systems of Medicine
9.	CSIR-TKDL	Modernization and upgradation of Information Technology Infrastructure of Traditional Knowledge Digital Library Unit (TKDL)
10.	CSIR-TKDL	Digitising Traditional Indian Systems of Medicine
11.	CSIR-AMPRI	Up scaling of technology for making advanced Non-Toxic Radiation Shielding Materials of Strategic Importance, Utilizing Industrial Wastes

Mission Mode Projects List

Project Tittle	Participation laboratories
CSIR Aroma Mission	CSIR-CIMAP
	CSIR-IHBT
	CSIR-IIIM
	CSIR-NBRI
	CSIR-NEIST
	CSIR-URDIP
CSIR Sickle Cell Anemia Mission	CSIR-CCMB
	CSIR-IGIB
	CSIR-IICB
	CSIR-IIIM
	CSIR-IMTECH
	CSIR-NCL
	CSIR-URDIP
Catalysis for Sustainable Development (CSD)	CSIR-CECRI
	CSIR-CSMCRI
	CSIR-IICT
	CSIR-IIP
	CSIR-NCL
	CSIR-NIIST
	CSIR-URDIP
CSIR Phytopharmaceutical Mission	CSIR-CDRI
	CSIR-CIMAP
	CSIR-IHBT
	CSIR-IICB
	CSIR-IIIM
	CSIR-NBRI
	CSIR-NEIST
	CSIR-URDIP
Innovative Processes and Technologies for Indian Pharmaceuticals and Agrochemical Industries (INPROTICS)" – Pharma and Agro	CSIR-IICT
	CSIR-NCL
	CSIR-IICB
	CSIR-IHBT
	CSIR-NEIST
Nano-Biosensors and Microfluidics for Healthcare	CSIR-CEERI
	CSIR-CCMB
	CSIR-IMTECH
	CSIR-NIIST
	CSIR-IICB
	CSIR-CSIO
	CSIR-CGCRI
Intelligent System (IS) - Intelligent Technologies and Solutions	CSIR-CEERI
	CSIR-CSIO
	CSIR-AMPRI
	CSIR-NAL

	CSIR-NCL
	CSIR-IGB
	CSIR-4PI
Nutraceuticals and Nutritionals	CSIR-IHBT
	CSIR-CDRI
	CSIR-CFTRI
	CSIR-CIMAP
	CSIR-NIIST
	CSIR-IITR
	CSIR-IIIM
	CSIR-NEIST
	CSIR-IGIB
	CSIR-CSMCRI
Establishment of CSIR-CMERI Centre for Post-harvest Processing and Research to augment the economy of rural tribal people of Arunachal Pradesh	CSIR-CMERI

CSIR Establishments

Biological Sciences Cluster

(i) CSIR-Centre for Cellular and Molecular Biology (CSIR-CCMB), Hyderabad
(ii) CSIR-Central Drug Research Institute (CSIR-CDRI), Lucknow
(iii) CSIR-Central Food Technological Research Institute (CSIR-CFTRI), Mysore
(iv) CSIR-Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP), Lucknow
(v) CSIR-Institute of Genomics and Integrative Biology (CSIR-IGIB), Delhi
(vi) CSIR-Institute of Himalayan Bioresource Technology (CSIR-IHBT), Palampur
(vii) CSIR-Indian Institute of Chemical Biology (CSIR-IICB), Kolkata
(viii) CSIR-Indian Institute of Integrative Medicine (CSIR-IIIM), Jammu
(ix) CSIR-Institute of Microbial Technology (CSIR-IMTECH), Chandigarh
(x) CSIR-Indian Institute of Toxicology Research (CSIR-IITR), Lucknow
(xi) CSIR-National Botanical Research Institute (CSIR-NBRI), Lucknow

Chemical Sciences Cluster

(i) CSIR-Central Leather Research Institute (CSIR-CLRI), Chennai
(ii) CSIR-Central Electrochemical Research Institute (CSIR-CECRI), Karaikudi
(iii) CSIR-Central Salt & Marine Chemicals Research Institute (CSIR-CSMCRI), Bhavnagar
(iv) CSIR-Central Institute of Mining and Fuel Research (CSIR-CIMFR), Dhanbad
(v) CSIR-Indian Institute of Chemical Technology (CSIR-IICT), Hyderabad
(vi) CSIR-Indian Institute of Petroleum (CSIR-IIP), Dehradun
(vii) CSIR-National Chemical Laboratory (CSIR-NCL), Pune
(viii) CSIR-North-East Institute of Science & Technology (CSIR-NEIST), Jorhat
(ix) CSIR-National Institute of Interdisciplinary Science & Technology (CSIR-NIIST), Thiruvananthapuram

Engineering Sciences Cluster

(i) CSIR-Advanced Materials and Processes Research Institute (CSIR-AMPRI), Bhopal
(ii) CSIR-Central Building Research Institute (CSIR-CBRI), Roorkee
(iii) CSIR-Central Glass and Ceramic Research Institute (CSIR-CGCRI), Kolkata
(iv) CSIR-Central Mechanical Engineering Research Institute (CSIR-CMERI), Durgapur
(v) CSIR-Central Road Research Institute (CSIR-CRRI), New Delhi
(vi) CSIR-Institute of Minerals and Materials Technology (CSIR-IMMT), Bhubaneshwar
(vii) CSIR-National Aerospace Laboratories (CSIR-NAL), Bengaluru
(viii) CSIR-National Environmental Engineering Research Institute (CSIR-NEERI), Nagpur
(ix) CSIR-National Metallurgical Laboratory (CSIR-NML), Jamshedpur
(x) CSIR-Structural Engineering Research Centre (CSIR-SERC), Chennai

Information Sciences Cluster

(i) CSIR-National Institute of Science Communication & Information Resources (CSIR-NISCAIR), New Delhi
(ii) CSIR-National Institute of Science, Technology and Development Studies (CSIR-NISTADS), New Delhi
(iii) Fourth Paradigm Institute (CSIR-4PI), Bengaluru

Physical Sciences Cluster

(i) CSIR-Central Electronics Engineering Research Institute (CSIR-CEERI), Pilani
(ii) CSIR-Central Scientific Instruments Organization (CSIR-CSIO), Chandigarh
(iii) CSIR-National Geophysical Research Institute (CSIR-NGRI), Hyderabad
(iv) CSIR-National Institute of Oceanography (CSIR-NIO), Goa
(v) CSIR-National Physical Laboratory (CSIR-NPL), New Delhi

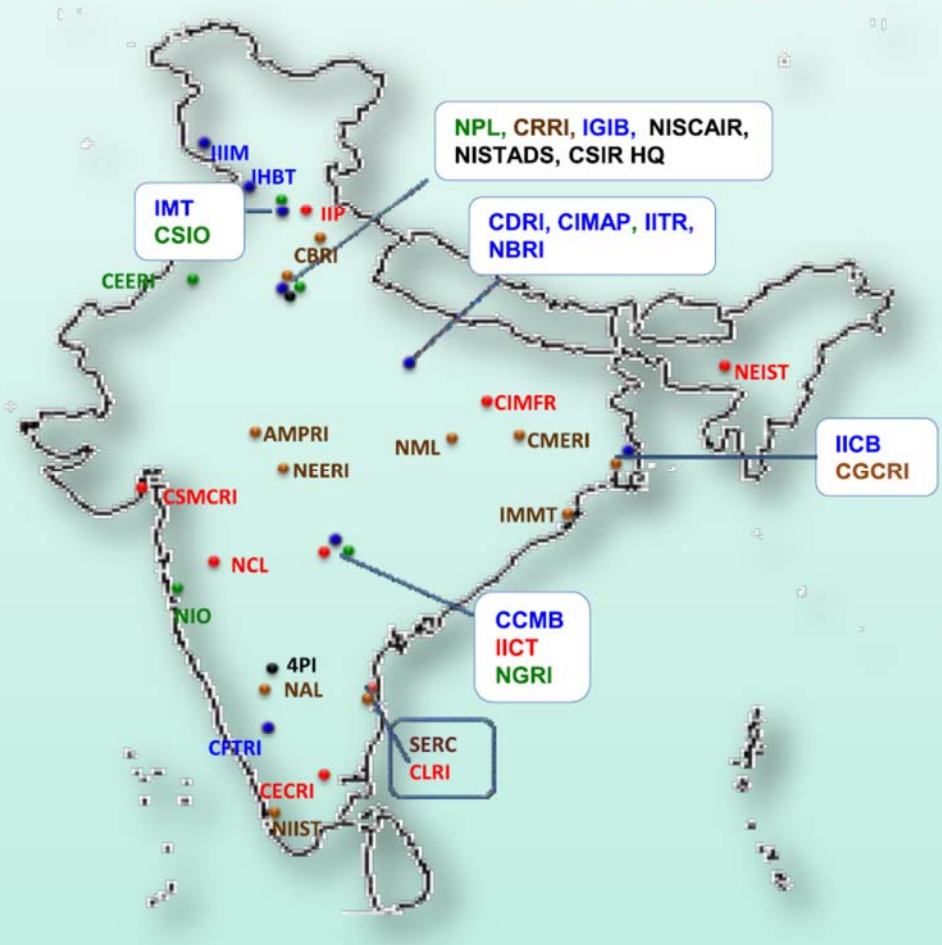
Units

(i) CSIR-Human Resource Development Centre (CSIR-HRDC), Ghaziabad
(ii) CSIR-Traditional Knowledge Digital Library (CSIR-TKDL), New Delhi
(iii) CSIR-Unit for Research and Development of Information Products (CSIR-URDIP), Pune

Innovation Complexes

(i) Innovation Complex, Mumbai

CSIR Pan India



Themes :

- Aerospace, Electronics, Instrumentation & Strategic Sectors
- Civil, Infrastructure & Engineering
- Ecology, Environment, Earth & Ocean Sciences and Water
- Mining, Minerals, Metals and Materials
- Chemicals (including leather) and Petrochemicals
- Energy (Conventional & Non-Conventional) and Energy Devices
- Agri., Nutrition & Biotech
- Healthcare

Council of Scientific & Industrial Research
Research, Project Planning and Business Development Directorate;
Anusandhan Bhawan, 2 Rafi Marg, New Delhi – 110 001