AUTONOMOUS BODIES

A: COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH

1: BIOLOGICAL SCIENCES CLUSTER

2: CHEMICAL SCIENCE CLUSTER

3: ENGINEERING SCIENCES CLUSTER

4: PHYSICAL SCIENCES CLUSTER

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B: CONSULTANCY DEVELOPMENT CENTRE (CDC)

AUTONOMOUS BODIES

A. Council of Scientific & Industrial Research

1. BIOLOGICAL SCIENCES CLUSTER

Herbal Drug for Type 2 diabetes

India is also called the 'diabetes capital of the world'. According to estimates, there are almost 61 million diabetics in India. The number could go up to 100 million in the coming years, as per statistics furnished by the International Diabetes Federation. Two CSIR laboratories, namely CSIR-CIMAP and CSIR-NBRI have now stepped in with a herbal answer to diabetes, named as BGR-34 The drug is targeted at type II diabetes – the majority of Indians are suffering from this type of diabetes. The drug has been patented and will be marketed across the country by M/s Aimil Pharmaceuticals. BGR-34 has been validated scientifically. Studies have found it safe and effective, with clinical trials showing more than 67 per cent success. The scientific teams from the two laboratories studied plants such as vijaysar and tinospora, which have been documented extensively in ancient ayurveda texts. These plants have antioxidant properties, enhance immunity, help repair the pancreas and increase production of insulin within the body. The scientists claim that the drug, which does not have any side effects, can slowly reduce the dosage of allopathic drugs meant for type II diabetes. However BGR-34 may not be effective for those who are dependent on insulin injections, nonetheless it may be effective for pre-diabetics or those in the initial stages.

Packing of Herbal Drug for Type-2 Diabetes

Process for Misoprostol-a drug useful for medical abortion

CSIR-IICT has developed a process of Misoprostol useful for medical abortion. Misoprostol is an important prostaglandin based drug declared by the World Health Organisation as an essential medicine to induce labour. The drug is also used in combination with pain killers as an anti-ulcer agent. The technology has been transferred to M/s Avra Laboratories, which has successfully commercialised the technology. The

CSIR-IICT technology has successfully reduced the cost of production of the drug making it affordable for the common people in the country.

New Molecule Isolated by CSIR-IIIM; Promise Against Arthritis

CSIR-IIIM has isolated a new molecule found in a Himalayan plant with anti-arthritic properties. The molecule found in the plant locally known as *patalbheda (Bergenia ciliata)*, is a promising candidate for a drug against rheumatoid arthritis. Rheumatoid arthritis, common in the elderly, is characterised by morning stiffness and inflammation of the joints. The drug developed by scientists of CSIR-IIIM has been found to prevent inflammation and reduce pain. Current drugs against rheumatoid arthritis have serious side effects, like osteoporosis, weight gain, tuberculosis and increased susceptibility to infections. However, the new molecule has been found to be safe in animal studies.

Biodegradable technology for hygiene

CSIR-CIMAP has developed biodegradable, skin-friendly, medicated and scented sanitary napkin using plant-derived bio-actives, which prevent bacterial and fungal infections. It is a low-cost product, especially targeted for lower income group women who still use unhygienic cheap alternatives. Patent has been filed in India. The plant extracts used in this innovative product with pleasant aroma provide wellness and comfort, heal other skin-related infections.

Product for knee and joint pain ready for clinical study and licensing

CSIR-CIMAP has developed Rheumarth capsules for effective management of Knee pain, Joint pain and inflamation. The Rheumarth capsules were standardized and scientifically validated for anti-inflammatory and analgesic conditions for rheumatoid arthritis *(aam vat roag)* related disorders. Clinical studies are proposed to be carried out in collaboration with a suitable partner.

Successful genome sequencing of 'Tulsi' Plant

CSIR-CIMAP has successfully sequenced the genome of the tulsi plant, *Ocimum tenuiflorum*, also known as *Ocimum sanctum*, and holy basil. This is the first report of complete genome sequence of a medicinal plant of India, using composite next generation sequencing technologies. The successful sequencing opens up avenues to further investigating the medicinal properties of the tulsi plant, its leaves and also seeds. The plant has been in use in Ayurveda and even other traditional methods of medicine like the Greek, Roman, Siddha, Chinese and Unani. This will also facilitate identification of not-yet-identified genes involved in the synthesis of important secondary metabolites in the plant. The next phase involves producing synthesized metabolites paving the way for mining biosynthetic pathways in other related species employing breeding within the family of *Lamiaceae*, the plant belongs to. Tulsi is known for its organic compounds like phenylpropanoids and terpenoids that make it a multipurpose medicinal plant used in diseases like bronchitis, bronchial asthma, malaria, diarrhoea, dysentery, skin diseases, arthritis, painful eye diseases, chronic fever, insect bite, etc. It has also been described to possess anti-fertility, antidiabetic, anti-fungal, anti-microbial, hepatoprotective, cardioprotective, antiemetic, anti-spasmodic, analgesic, adaptogenic and diaphoretic actions. Many of the basil oil constituents have found applications as medicinal ingredients, flavours, fragrance, etc. With the genome sequencing, scientists hope that identifying specific genes for therapeutic molecules will make it easy to produce it in labs.

Anti-cancer tea capsule from extract 'catechin'

CSIR-IHBT has developed a eco-friendly, solvent-free green process technology to extract 'catechin' from young tea leaves. Catechin is a type of disease-fighting flavonoid and antioxidant. The technology

is being transferred to industries for commercial exploitation. Though catechins are not curative, they would act as preventive measures as they curb damage caused by free oxygen radicals in our body, which also cause various types of cancer.

Richome-less strain of *Mucuna pruriens* Kewanch/velvet bean) with high seed and L-dopayields

Trichome-less genotypes having bold dark black seeds with high L-dopa content (5.50%) CSIR-CIMAP has developed from parental variety CIM-Ajar having white seeds through single seed descent method followed by half sib selection. The trichome-less line gives L-dopa yield of 183.32 kg/ha with L-dopa content of 5.50% as compared to the L-dopa yield of 137.32 kg/ha with L-dopa content of 6.18% in the parental check variety. The newly developed line has dark black seeds with vigorous growth. This strain can easily be distinguished from others by dark black seed color as marker and vigorous growth.

Exploration of new sources of bioactive aroma chemicals/essential oils for future industrial use

CSIR-CIMAP has analysed Essential oil composition of *Melaleuca linerrifolia* Sm. from India using gas chromatography (GC-FID) and gas chromatography mass spectrometry (GC-MS). Forty-four constituents were identified, accounting for 98.90% of total composition characterized by a higher content of oxygenated monoterpeoids (86.63%) represented by 1,8-cineole (77.40%) and Ü-terpineol (7.72%). The essential oil exhibited good anti-bacterial activity against *Escherichia coli, Salmonella typhimurium, Bacillus subtilis,* and moderate activity against Staphylococcus epidermidis, *Staphylococcus aureus* (MTCC 2940), *Staphylococcus aureus (MTCC 96), and Streptococcus mutans. The essential oil composition was characterised for* M. linerrifolia grown in India for the first time for high 1,8-cineole (>75%) content hence it could be propagated and harvested as potential source of 1,8-cineole for cosmetics and herbal formulations.

Strains	ZI(MIC)
Escherichia coli	*11 (125 µg/ ml)*
Salmonella typhimurium	*11 (250 µg/ ml)*
Bacillus subtilis	*11 (250 µg/ ml)*
Staphylococcus epidermidis	*11(250 µg/ ml)*
Staphylococcus aureus-2940	*11 (250 µg/ ml)*
Staphylococcus aureus-96	*11 (125 µg/ ml)*
Staphylococcus mutans	*11 (250 µg/ ml)*
Klebsiella pneumoniae	*na*
Pseudomonas aeruginosa	*na*

Novel chemical constituents with anti-inflammatory activity from the leaves of *Sesbania aculeata*

Sesbania aculeate. Sesbania aculeate (Family Fabaceae) commonly called dhaincha belongs to legume family and it is an ideal green manure crop as it is quick growing, easily decomposable with low moisture requirements and produces maximum organic matter. From the extracts of the leaves of *Sesbania aculeate*, there novel chemical compounds were isolated by CSIR-CIMAP and fully characterized as compound 1, (ceramide type); compound 2, (cerebroside type) and compound 3 as triterpene acid 3-0-Ü-L-rhamnopyranoside along with nine known compounds. Hexane leaf extract (HL), ethyl acetate leaf extract (EAL) and compounds 1, 2 and 3 showed significant inhibition of TNF-á, a pro-inflammatory cytokine. In vitro cell cytotoxicity study using MTT assay revealed that these compounds were non toxic to the normal cells. Apart from having bio-fertilizer potential, *Sesbania aculeate* would also provide new opportunities to the chemists and biologists to explore the new chemical entities with pharmacological significance.

2. Chemical Science Cluster

Engineering Graphene for Better Electrodes and Sensors

CSIR-CECRI, in collaboration with Tata Institute of Fundamental Research (TIFR), has demonstrated the importance of engineering the electrode geometries in electrochemical applications such as sensing and energy technologies. The technical advancement in the field of ultra-small sensors and devices demands the engineering Graphene for better electrodes and sensors development of novel micro- or nano-based architectures. To address these necessities, cross-linked three-dimensional graphene nanoribbons (3D GNRs) based electrode have been designed and assembled where individual 2D GNRs are bonded together through a covalent linker. The 3D electrode thus designed exhibits a huge double layer capacitance (2482 $\mu F.cm^{-2}$) and faster electron transfer kinetics. Its exceptional electro-catalytic activity towards oxygen reduction reaction is a prior indication of its potential for a wide range of electrochemical applications. The study has opened up a new platform for the design of novel point-of-care devices for clinical applications and electrodes for energy devices. Usually, the availability of plentiful electroactive surface area is a critical need for several electrochemical applications including sensing and energy technologies. In order to achieve this, researchers have attempted the use of high surface area nanomaterials. However, such modifications have not resulted in any significant improvement in the electron transfer rate or towards other observed electrochemical responses. The results evidenced that 3D GNRs outperformed their 2D counterparts in all the electrochemical applications that have been performed in this study.

Heat-resistant Shoe Sole from CSIR-CLRI

CSIR-CLRI has developed a shoe sole that can withstand temperatures up to 250°C. The technology would enable indigenous production of safety shoes which are currently being imported. Of great use for safety workers who enter fire and hazard zones, the fibre reinforced plastic (FRP) sole is made from glass and carbon fibre coated with phosphorous based adhesives. Glass and carbon fibre can withstand high temperatures as their melting point is 1200°C and 3500°C respectively. To make the material flexible and suitable for functioning as a shoe sole, certain chemicals have been added. The heat-resistant shoe soles developed at CSIR-CLRI will give sufficient time for a person to escape. And shoe soles made with this material will also come in handy for safety workers. Besides, apart from safety shoes, the lightweight and elastic soles can also be used in regular shoes.

New tech converts tannery waste into carbon to make green shoe soles

CSIR-CLRI has developed a process to convert fleshing, the soft tissue of animal muscle and fat, and one of the effluents produced in tanneries, into activated carbon. This compound is one of the major components in shoe manufacture. The process not only helps to reduce the industrial carbon footprint, but also successfully embrace the waste-to-wealth concept. The conventional activated carbon does not contain cross-linking agent like calcium oxide, therefore, cannot be used as filler in rubber manufacturing. However, the activated carbon converted from fleshing waste contains calcium and can be used effectively as filler in rubber manufacturing.

Technology for Production of Multi-utility Enzyme

The technology for the production of a multi-utility enzyme, developed by CSIR-IHBT, has been transferred to M/s Phyto Biotech, Kolkata. Discovered during a survey at an altitude of over 10,000 feet in the Western Himalayan region from the *Potentilla astrosanguinea* plant growing under snow cover, the Super Oxide Dismutase (SOD) enzyme finds use in anti-ageing creams, extending

shelf life of fruits and vegetables and during cryo-surgery and preservation of organelles. Owing to its high antioxidant properties and multiple uses, SOD is in heavy demand and hence commands a high price in the global market. A protocol has been developed to clone the gene in *E. coli* and it was further engineered by mutation of a single amino acid to increase its consistency and thermo-stability. SOD is highly stable and functional in a wide range of temperatures from sub-zero to more than 40°C.

Rechargeable Magnesium Battery

CSIR-IICT has developed a rechargeable battery with initial applications best suited to stationery devices like UPS and inverters. The magnesium metal battery with a natural graphite cathode can also be an efficient substitute to the commonly used lead battery. The technology for a rechargeable magnesium battery is not available for commercialisation in any part of the world. The eco-friendly materials used in the battery are magnesium (anode), modified natural graphite (cathode) and ionic liquid electrolyte, which are safe and easily available.

Waste-to-biogas technology draws good response

CSIR-IICT has developed organic waste-to-biogas system is witnessing significant interest from various quarters. The patented green technology is capable of generating 120-150 cubic metres of biogas (equivalent to around 30 kg of LPG) by using vegetable and food waste as the feedstock. Good quantities of organic manure are also generated during the process. CSIR-IICT is currently working on creating two-five tonne capacity systems, which are equipped to provide greater quantities of biogas and organic manure. Units are being installed at Tirumala Tirupati Devasthanam (TTD), and New Energy Development Corporation of Andhra Pradesh (Nedcap) (five-tonne capacity AGR systems across 20 municipalities in the state).

An Eco-friendly Technology to Treat Water

CSIR-IICT has developed a technology to manufacture hydrazine hydrate, which is used in agrochemicals, pharmaceuticals and water treatment. The technology's pilot project has been demonstrated at M/s Gujarat Alkalies & Chemicals Ltd, Vadodara (GACL), to overwhelming appreciation. Hydrazine hydrate is used in several industrial operations such as in certain organic pigments for dyes, as reagent for photography, anticorrosion additive in the water circuits of thermal and nuclear plants, oxygen scavenger in the water of industrial boilers and high pressure steam generators, refining of precious metals, recovery of metals from pickling and surface treatment solutions, and treatment of liquid and gas wastes. Since the process developed by CSIR-IICT is based on hydrogen peroxide, it reduces the adverse impact of pollutants on environment and living conditions. CSIR-IICT has signed an agreement with GACL for development of hydrazine hydrate technology. GACL will shortly establish a commercial plant initially of 8,000 TPA of 80 per cent hydrazine hydrate based on CSIR-IICT technology and detailed designs.

Capsicum for controlling diabetes, obesity

CSIR-IICT has analysed green, yellow and red bell peppers for their anti-hyperglycaemic and anti-hyperlipidemic effect and found encouraging results. It was found that yellow and red bell peppers slowed down digestion of carbohydrates and lipids. The research work has been published recently online in Natural Products Research. The yellow capsicum significantly inhibited the activity of alpha-glucosidase and lipase enzyme as compared to green capsicum. The inhibition was almost double than that of green capsicum. Yellow and red capsicums were more effective than green capsicum due to the presence of oligomerised anthocyanins. They were better inhibitors than pro-anthocyanins found in green capsicum.

Micro-Channel Reactors with Stable Catalyst Formulations

CSIR-IIP has developed micro-channel reactors with stable catalyst coating formulations that are used to intensify the processes involving vegetable oils. These reactors have great impact on the product yield and conversion in hydro-processing of vegetable oils. The micro-channel reactors find immediate applications as a tool to intensify the process at places where there is inadequate supply of raw material (biomass); where transportation of (feedstock) fossil fuels is a problem. All this is possible mainly due to excellent mixing, controlled reaction environment, and energy efficiency enabled by these micro-channel reactors.

Plastic to fuel

Plastics consumption in India is reported to be around ~10 MMT (2010) while plastic wastes in India are ~15,000 TPD amounting to high environmental pollution. 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. The salient features of the technology are that the process provides for exclusive production of either gasoline or diesel or aromatics along with LPG from polyolefinic wastes (e.g. HDPE, LDPE, PP etc) and the liquid fuel meets Euro III specifications. Further, the process is simple, pollution free and environment friendly. The estimated payback period for a 30 TPD plant is about ~ 3 years.

Nano-catalysts for manufacturing petrochemicals

CSIR-IIP has developed new energy efficient synthesis strategies for preparation of various nano structured material (nano-catalysts), which are useful for several challenging catalysis reactions. Nano catalyst which helps in adopting a new process of selective oxidation of propylene to propylene oxide (PO), in an economically viable and more environment-friendly means, with minimal waste. Propylene oxide otherwise is an important synthetic intermediate used in the preparation of commodity chemicals, such as polyurethane foams, propylene glycol, polypropylene glycol, propylene carbonate, etc, and currently, its production exceeds 10 million tons per annum.

New Process Developed by CSIR-NEIST

Natural pesticide against Red Spider Mite in Tea: A herbal pest control agent effective against a major tea pest, Red Spider Mite has been developed. Scale up Studies undertaken in pilot plant for production of anti-Red Spider Mite extract from plant leaves.

Wood Core: A bio formulation has been developed by CSIR-NEIST for treatment of bamboo and wood to enhance its durability.

Crude oil degrading bacterial diversity and full genome analysis of crude oil degrading strain *Pseudomonas aeruginosa N002*

CSIR-NEIST has identified the isolated bacteria from crude oil contaminated soil of Assam and developed the effective consortia. The combined use of crude oil degrading bacteria with nutrient supplements is found to revive degraded soil in large scale. The entire genomics and traits for crude oil degradation were analysed and evaluated. The whole genome of the strain *P. aeruginosa N002* was sequenced, 21 different categorises were found. Higher gene abudance responsible for various traits of cell molecular biology were compared with other crude oil degrading bacteria and found that 345 genes were involved in signal transduction, 173 in two component system categories. 40 Genomic Islands having probable horizontal origin were predicted, N002 genome is found to be equipped with few insertion sequences, 85 transcription genes, 13 transporters, 4 metal transporters, 5 multidrug

resistance super family, 2 biosurfactant regulatory genes, different cell motility and chemotaxis genes to facilitate the strain to utilize crude oil effectively.

3. Engineering Sciences Cluster

Detection and Hit Visualization using Acoustic-N-wave identification

In another notable achievement, the indigenous system for Detection and Hit Visualization using Acoustic -N wave Identification (DHAVANI) for locating bullet hits on targets developed by CSIR-NAL for the Indian Army has undergone rigorous field trials of Army ranges in Bengaluru, Secunderabad and Infantry School Mhow. The formal handing over of DHVANI to Commandant SDD Secunderabad took place on July 03, 2014. This automated and rugged system not only meets but even surpasses the specifications of comparable systems available internationally. The cost of this system is currently about 50 to 60% of the cost of similar international systems. Considering that there are over 2000 firing lanes of Army all over the country, significant savings in foreign exchange to the national exchequer is expected.

Drishti

Towards contributions for the civil aviation sector, a major milestone was achieved in the field of aviation safety by CSIR-NAL in collaboration with Indian Metrological Department (IMD), New Delhi. A partnership agreement was signed on May 20, 2014 for joint production of CSIR-NAL developed Drishti system, a runway visibility measurement instrument. Under the MoU, 70 systems are being manufactured at CSIR-NAL at a cost of Rs. 18 lakhs. The system will be installed in all the Airports of the Country. In the first phase, CSIR-NAL has received an order for 20 systems. The first phase installation of 20 Drishti systems in various airports of the country is under progress. In the month of February 2015, five newly designed Drishti systems have been installed and commissioned at IGI Airport, New Delhi. This airport is the first Airport in the country to have indigenous systems operating in all its three runways. Dual mode "Landline" and "Wi-Fi" communication along with integrated displays at Air Traffic Control Room and Approach Radar room have been also established jointly with IMD. The system is very cost effective, has low power consumption and a life span of more than 5 years. The complete system is engineered in such a way so as to enable easy installation and has a remote monitoring/maintenance capability.

Contribution towards the Advanced Medium Combat Aircraft (AMCA)

CSIR-NAL has significantly contributed towards the Advanced Medium Combat Aircraft (AMCA) programme of Aeronautical Development Agency (ADA). MCA 3B-09 Air frame design and analysis work was taken up as continuation of Phase 1 work of AMCA 3B-08. An experimental investigation was carried to measure the afterbody drag of the 1:25 scaled model of AMCA afterbody model in the presence and absence of jet flows. Further, models of the AMCA Simulator (AMCSim) was designed and developed using Matlab and Simulink. AMCASim provides an excellent analytical tool for conducting analysis of requirements, initial pilot-vehicle interface and flight control low development investigations.

LCA-Tejas

CSIR-NAL continued its support to the major design and development projects of the strategic sector including ADA's LCA-Tejas airforce and naval aircraft programmes. The first Ski jump launch of LCA Naval variant was successfully demonstrated during December 2014, from the Goa shore based test facility. The National Control Law team led by CSIR-NAL together with the team from National Flight Test Centre, ADA evolved safe and robust procedures to achieve this important milestone in flight testing. LCA Tejas (Air force Variant) has also undergone extensive flight tests including Parameter

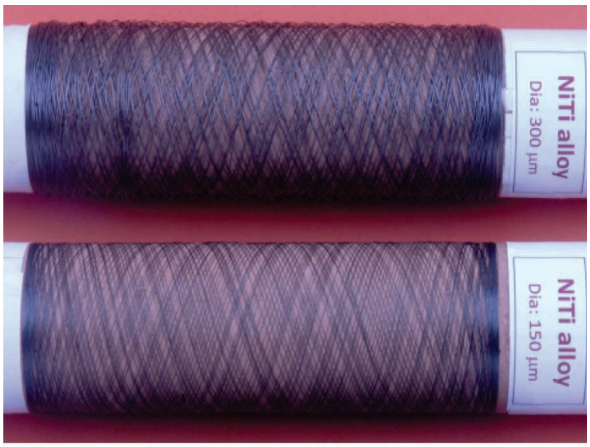
Identification (PID) tests at high angles of attack as part of the Final Operation Clearance (FOC) activities. The Flight Control laws and Airdata Algorithms were modified to carry out these specialized PID tests at the flight envelope limits. Apart from OCC envelope expansion, flight tests were also conducted with FOC stores. For the LCA series production (SP) aircraft, Centre Fuselage composites, and Main Landing Gear (MLG) Fwd doors with Fairings were delivered to HAL. Based on the training imparted to the Tata Advanced Materials Ltd. (TAML) team for manufacturing these composite parts on two sets, they have fabricated one set of composite parts for centre fuselage and 2 sets of Carbon Fibre Composite (CFC) detail parts of Fin and Rudder under the supervision of ACD-NAL team. Other significant contributions of LCA programme include; aerodynamic force and moment measurements on LCA aircraft model up to Mach 1.8 in CSIR-NAL's 1.2m Wind Tunnel to estimate internal drag due to the air flow static aero elastic load analysis of MK1 LCA Composite Fin (Modified Nose Box) and modeling and analysis support for the wake penetration studies of LCA-Tejas.

Aluminium Metal Matrix Composite Torpedo Nose Cone

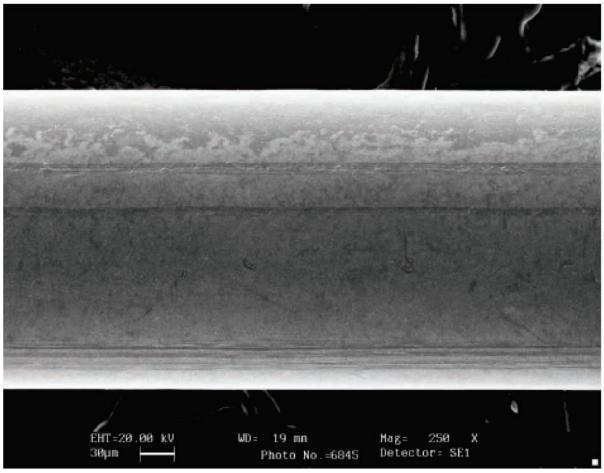
Aluminium alloy based components for various applications including that in fabrication of Nose Cone for Torpedoes have been prepared by Forging Technology, which is time consuming and labour intensive process. CSIR-AMPRI, under XII Five Year Plan Project, 'Novel Energy Effective Metallic Materials for Automotive and General Engineering Applications', has developed Aluminium metal-metal matrix based nose cone component for Naval related applications using 10% fine (~10 µm) SiC particles dispersed in an Al-Si (BS LM25) alloy matrix by liquid metallurgy route. The component has showed better mechanical damping characteristics without sacrificing the strength. The technology has been transferred to M/s Exclusive Magnesium, Hyderabad and the fabricated component is under user trial at Naval Science and Technology Laboratory (NSTL) Visakhapatnam, a DRDO laboratory.

Medical grade super-elastic NiTi wires and their manufacturing process developed for vital clinical needs

Medical grade archwires have clinical significance for the ageing population, externally injured people and for having quality life. These wire materials should fulfill an array of fundamental biological and mechanical requirements especially when they are implanted in the human body. Among wide range of materials, supper-elastric NiTi provides new insights into biomedical field for cardiovascular, orthopedic, dental applications, and also for making advanced surgical instruments. CSIR-NAL in collaboration with CSIR-CGCRI has developed super-elastic NiTi wires suitable for bio-medical applications though vacuum processe. The prepared alloy conforms to ASTM-2063 specification for Medical Devices and Surgical implants. The process parameters to fabricate NiTi wires have been established. The processed super-elastic NiTi wires exhibited an upper plateau stress of 450 MPa, recoverable strain of 6% with negligible plastic strain, and ultimate tensile strength of 1525 MPa. The surface of the these wire have been tuned to suit for cardiovascular, orthopedic, dental and for making advanced



Superelastic NiTi wire



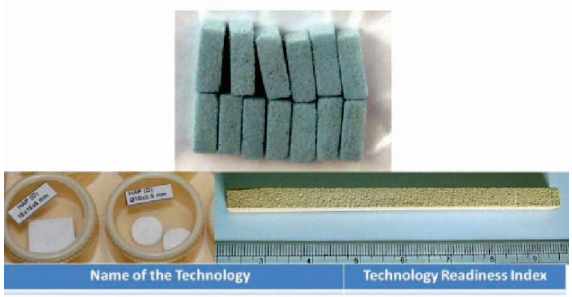
Secondary electron image of NiTi wire surface after surface treatment

Production Technology for Ni-Ti shape Memory Alloys

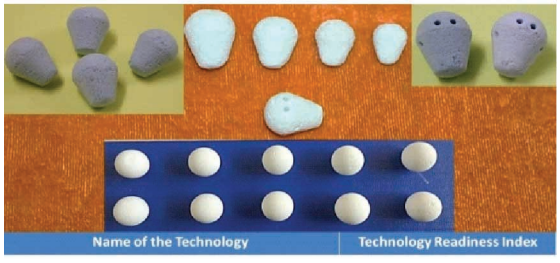
CSIR-NAL has made significant contributions in the area of special materials over the years. The technology development for production of NiTi shape memory alloys in 20-40 kg melt capacity in collaboration with Hindustan Aeronautics Limited (HAL), Bengaluru and Mishra Dhatu Nigam (MIDHANI), Hyderabad has been successfully completed. Various products such as rods, strips and wires have been fabricated for applications in both aerospace and other engineering domains. The technology transfer to HAL and MIDHANI is under progress. CSIR-NAL and Mishra Dhatu Nigam Ltd. (MIDHANI) have signed MoU on October 16, 2014 for 'Development of aeronautical grade carbon fibres and development of a continuous process' for the preparation of standard modules carbon fibres. This MoU is second in series with MIDHANI. Under this MoU in first phase, MIDHANI will support CSIR-NAL in evolving the continuous process for the preparation of standard modules carbon fibres. In the second phase the results of the investigations carried out under this MoU will be utilized for scaling up of the technology to produce larger quantities of carbon fiber. The capacity of the Pilot plant of CSIR-NAL shall be enhanced to 25 to 50 tons per annum of carbon fiber by augmentation/ modification of the few equipment and systems while continuing to use about 80% of the existing plant and machinery

Technologies licensed for manufacture of bioactive ceramic scaffolds, granules and integrated bio-eye orbital implants

CSIR-CGCRI has licensed its know-how to M/s General Surgical Company (India) Pvt. Ltd, Chennai for production of hydroxyapatite and bi-phasic calcium phosphate based scaffolds, granules and integrated ophthalmic orbital implants. The know-how meets the requirements for production of 10,000 pieces per annum for integrated orbital implants and as per requirements for the other items. It covers all the processing steps from powder preparation to finished products. These resemble and act like natural materials of the body and have porous, micro architecture as human bone or as the eye.



Bioactive ceramic scaffolds



Hydroxyapatite integrated orbital Implant

Solar power to shield energy tariff fluctuations

CSIR-CGCRI has conceived the plan and installed the solar power plant on the rooftop of a housing

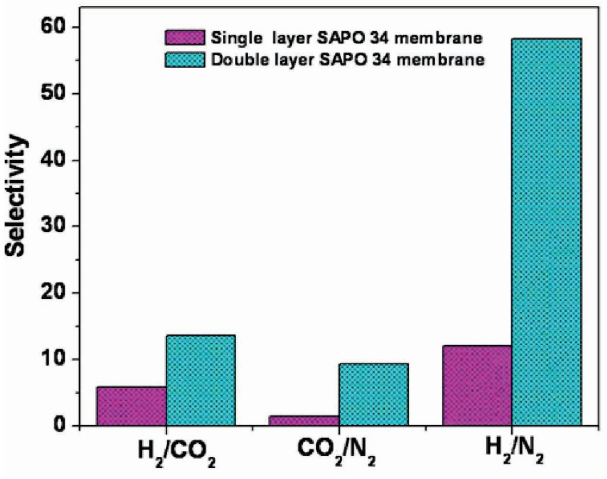
apartment meant for the scientists of CSIR in Kolkata. Total Estimated power from the Plant under Kolkata environment was considered in the tune of around 45,000 KWh in a year, and actual total generation was 52,269 KWh in past one year (From March 1, 2014 to February 28, 2015). Out of the total Solar power generation, 50,104 units were utilized in-campus, and surplus 2,165 units were sold to CESC at the prevailing rate of the month, as per Power purchase agreement, entered into between CSIR-CGCRI & CESC for 25 years. CSIR could save Rs.4, 15, 230 in this period.

Ceramic membrane-based water treatment plant

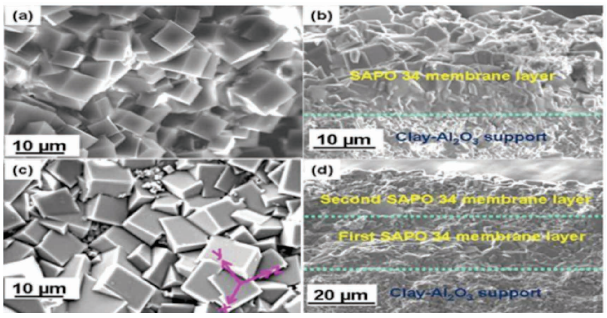
CSIR-CGCRI has signed an MoU with M/s Porel Dass Water & Effluent Control Private Limited, for removal of arsenic (including the process for media preparation) and iron from groundwater. It involves the utilization of Process Knowhow for Ceramic membrane-based water treatment plant based upto a capacity 20,000 LPD on non exclusive basis. It is initially for a period of three years, but subject to renewal on prevailing market, past history, performance and future prospect.

Cleaning of Hydrogen gas from its source

Hydrogen is already extensively produced and used, but it is now being considered for use as an energy carrier for stationary power generation units and transportation markets. Steam methane reforming and through other process, also known more generally as "gasification," hydrogen can be produced in large scale from a range of natural gas or other methane stream, such as biogas or landfill gas, hydrocarbon fuels, including coal, heavy residual oils, and other low-value refinery products. The efficiency of hydrogen production and its use can somewhat be lowered due to presence of impurities that require a pre-treatment cleanup step to remove the impurities upstream. CSIR-CGCRI has synthesized a silico-alumino-phosphate membrane, known as SAPO-34 membrane, with pore diameter as 0.38 nm on clay-alumina based tubular support for cleaning of hydrogen. It has been scaled up for real-world application.



Comparison of separation selectivity of H_2/CO_2, CO_2/N_2, and H_2/N_2 SAPO 34 zeolite membrane

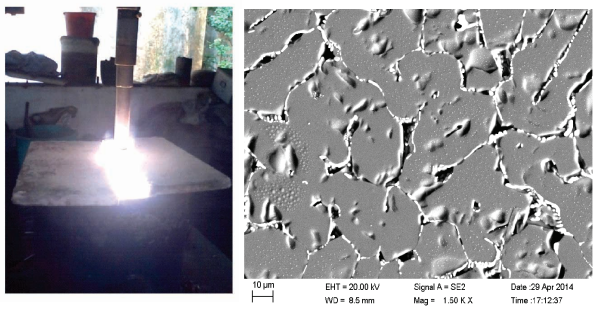


FESEM micrograph of SAPO 34 membrane (a, c) morphology , (b, d) cross-sectional view on indigenous clay alumina support tube (lab scale size : 10mm x 7mm x 60mm)

New process for manufacture of $MgO\text{-}Al_2O_3$ based Refractory Aggregates for high performance refractory application

There is a resurgence in interest in magnesium aluminate spinel raw materials for making products like steel that often requires extended treatment of the liquid steel in the steel ladle high performance functional refractories like purging plugs. Operational changes such as increasing tapping temperatures, longer hold times and more aggressive secondary metallurgy are countered by the need for

thinner refractory linings and longer refractories life. CSIR-IMMT in collaboration with CSIR-CGCRI has developed a plasma process where quality MgO-Al_2O_3 based refractory aggregates have been produced for making better high temperature refractories. The development includes the establishment of ceramic phase contents, the hardness as well as fracture toughness of the plasma treated aggregates of stoichiometric spinel. The refractories have been produced from and also aim to utilize indigenous refractory raw materials.



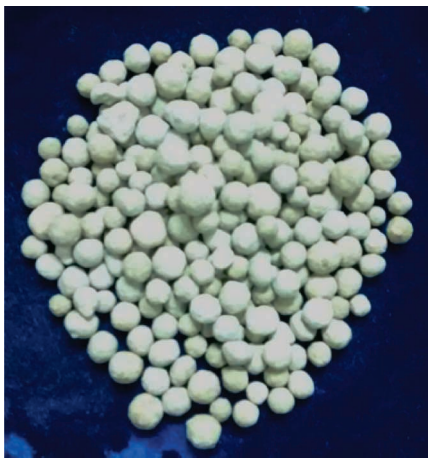
Plasma treatment of the refractory materials of CSIR-CGCRI. Microstructure of a MgO-Al_2O_3 based refractory aggregates

Optical coatings on plastic like materials with scratch-healing properties

CSIR-CGCRI has brought out a distinct technology as well as a coating to heal starches on plastic like Polycarbonate, Acrylic, Polypropylene based plastics, ophthalmic lenses and sheets. It is refractive index controlled, 1.48-1.65 ; and thermal as well as ultraviolet light curable coating. The coating restores the optical quality of the surface. Coatings of 1 to 4 mm thickness showed high transparency, excellent abrasion resistivity, good hardness, and adhesion properties, conforming to ASTM Class 5B as well as worthy thermal and chemical resistance characteristics. Matching refractive index value of the coatings and the plastic substrate is helpful to heal the scratches on the surfaces. These refractive index matching hard coatings would be useful for plastics of varying values.

Technology established for enhancing the use of Indian Bauxite reserves in making value added bauxite based products for steel, cement and glass industries

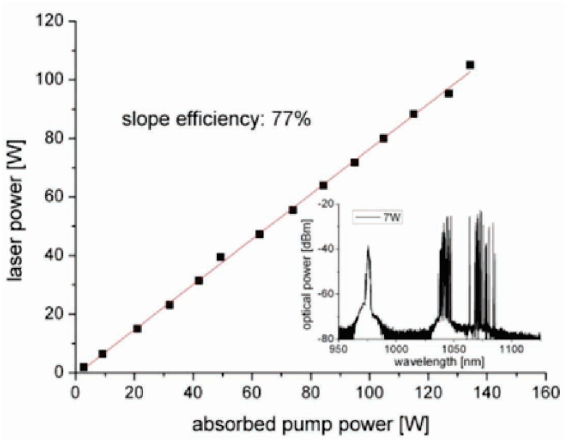
Bauxite is one of the significant refractory raw materials used as bricks in the steel, cement and glass industries. Bauxite is the only natural alumina materials to manufacture brick containing above 60% alumina. Even though India has plenty of bauxite reserves, it is mostly imported from China as Indian Bauxite does not have sufficient purity level for marketable use. Thus the price of bauxite keeps varying immensely during the last 5 years. Indian bauxite contains considerable amount of impurities beside the main constituent Al_2O_3. These impurities are mainly Fe_2O_3, TiO_2 and CaO in some regions. Therefore, these bauxites cannot be used as such for high temperature application, because the hot properties of the product get deteriorated due to low melting liquid phase formation. CSIR-CGCRI has developed a technology by which the impurities are eliminated either by in-situ encapsulation by a phase and also utilizing them as processing aids which reduces the low melting phase formations; thereby the high temperature properties are retained. The refractoriness under load has increased from 1450° to 1600°C by using this innovative technique. These value added high alumina aggregates from bauxite assist in making value added bauxite based products.



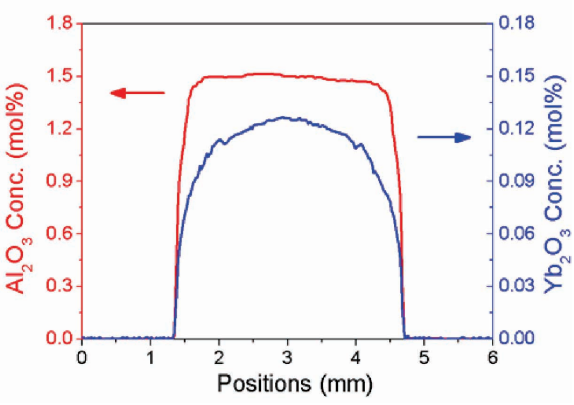
High Alumina value added bauxite based aggregates

Technology for fabricating large mode area fibers of special design for high power laser application

Optical fiber becomes lively when its core is doped with one or more atomic elements, usually rare-earths as they present absorption and emission bands ranging from UV to NIR. The fiber materials doped with these become very active in converting the properties of optical signals. CSIR-CGCRI has demonstrated technology for fabricating rare earth doped fibres for high power fiber laser application. The salient features of the technology include multiple rare earth doped core layer deposition for achieving large core size exceeding 4 mm with high dopant incorporation ability with lesser than 1% dopants concentration variation along the preform length and flexibility of doping different RE elements simultaneously. All these lead to better ability of fabricating large mode area fibers of special design for high power laser application. A significant outcome of the initiative is development of Yb-doped optical fiber with core diameter up to 40 µm with respect to an overall diameter of 125 µm, numerical aperture in the range of 0.08-0.12 and maximum Yb^{+3} concentration as high as 1.6 mol% through optimization of process parameters. Laser output power of 105 W at ~1.06 ìm with slope efficiency of 77% has been successfully demonstrated from the fabricated fibers with long term stability. The linear variation of laser output power with pump shows its potentiality of further power scaling. CSIR-CGCRI has now taken lead in this field globally. Indigenous fiber laser systems, both continuous wave and pulsed, are being building up for industrial and medical applications.



Laser characteristics of the fabricated Yb doped fiber



Uniform distribution of dopants

Natural Marine Sponge Skeleton as a Bone Mimicking Biomaterial

CSIR-CGCRI has identified and characterized natural sponges from sea as potential bioscaffolds stand alone in combination with Insulin Like Growth Factor-1 (IGF-1) and Bone Morphogenetic Protein-2 (BMP-2) on the in vivo bone healing performance in rabbit model. These natural marine sponges harvested from a beach in Goa were found to be promising materials for bone repair and augmentations both individually and in combination with growth factors. The IGF-1 impregnated converted sponge scaffold promoted excellent osseous tissue formation followed by the one with the BMP-2 loaded and the stand alone. This multi-institutional research has been carried out in collaboration with CSIR-NIO, Goa, IIT-Guwahati and West Bengal University of Animal and Fishery Sciences, Kolkata.

Studies on the effects of micro-fines in iron ore sintering

Sintering is widely used for agglomeration of ore fines where microfine is a perennial bottleneck in sintering process. Till date sinter plants have tried

to handle microfines within tolerable limit, but a huge stock of microfines from decades of mining operation and also from beneficiation of low grade ores has made their utilization imperative. CSIR-IMMT has tried microfines (-100#) up to the extent of 50%. It was possible to produce good quality sinters using these wastes. Sinters having FeO content <10%, TI around 50% could be produced.

Beneficiation of iron ore slimes from Barsua: Recovery of alumina from fly ash

CSIR-IMMT has studied recovery of alumina from fly ash using pyro-hydrometallurgical techniques. More than 90% recovery of alumina has been achieved through hydrothermal alkali leaching followed by sulphation roast-water leaching method. Silica was recovered as high pure di-calcium silicate and alkali was generated and recycled for leaching. A complete flow-sheet along with material balance has been prepared for NALCO, Bhubaneswar.

Smelting reduction of iron ores/fines by hydrogen plasma

Hydrogen Plasma Smelting Reduction (HPSR) has a potential for most environmental friendly steelmaking in the future. Keeping this in view CSIR-IMMT has implemented a programme to produce iron by smelting reduction of iron ore / fines using hydrogen plasma, thereby totally eliminating CO_2 emission and to demonstrate the above environmental friendly iron making process in bench scale and to develop the flowsheet accordingly. The steel thus obtained in both 1kg and 5kg scale contains more than 97.73% 'Fe'.

Mobile Pilot Plant for Toxic Emission Monitoring and Control

CSIR-NEERI has developed a Mobile Pilot Plant for Toxic Emission Monitoring and Control for undertaking flue gas emission monitoring and control studies in various industries including Small and Medium Scale Industries (SMEs). Flue gas comprising of dust of different sizes and gases of varying concentrations representing different small scale industries such as ceramic kilns, hot mix plants, other small scale industries etc. will be monitored for its emission characterization. Part of the gas will be fed into the different control systems and their collection efficiencies will be measured with respect to time, temperature, flow etc. The performance in terms of techno-economic feasibility will be checked and a system for control of emissions will be provided in the pilot scale which can be scaled up for full scale installation.

Seabed Resident Event driven Profiling System

Seabed Resident Event-driven Profiling System for use in Coastal Waters is an autonomous robotic system that is located on the seabed of the coast. The movable component of this system consists of a re-configured inverted version of the thruster driven profiler. The present thruster driven inverted profiler (named iAVP) is positively buoyant but carries an acoustic transponder and standard oceanographic sensors on its hull to measure water column properties in its upward ascent from the seabed to the sea surface. The fixed component of the system is a sea winch ensconced within an anchored truncated conical framework residing on the seabed, and connected to the iAVP by a neutrally buoyant monofilament line. The development throws open novel applications in environmental monitoring of monsoon processes, and also the strategic long term surveillance in coastal waters.

Novel Sewage Treatment System at Nagpur Ordnance Factory

To cope with water shortages in urban areas, particularly in Nagpur, CSIR-NEERI has initiated a radical shift from conventional end-of-pipe water management to an integrated approach. The Ordnance Factory Ambajhari in Nagpur has been selected to demonstrate and install a techno-

economic natural sewage treatment system developed by CSIR-NEERI. The treatment system consists of a high rate upflow anaerobic filter, which helps in removal of organic pollutants from sewage. Subsurface horizontal flow constructed wetlands remove the remaining pollutants including nitrogen and phosphorous. This treated effluent then passes through pressure sand filter and activated carbon columns, which remove non-biodegradable organic matter called recalcitrant organics. Finally, the treated effluent is disinfected using chlorination or ultra violet (UV) rays, and utilised for all non-potable purposes. Sludge management through constructed wetlands called "Sludge Drying Reed Beds (SDRB)" is being demonstrated for the first time in the country. This treatment system will treat and manage sewage generated by a population of 1000 and would treat 1 lakh litre sewage per day. The treated effluent will be utilised for maintaining multi-purpose lawn spread in 1.5-acre area and irrigating Mango Orchards at the Ordnance Factory, Ambajhari, Nagpur.

Alternative to wood and bricks

CSIR-SERC has come up with an alternative to wood and bricks that is not only cheap but durable as well. The alternative is a steel mesh plastered with cement mortar. CSIR-SERC has developed cupboards, roof rafters, water tanks and even toilets and bathrooms with the new technology replacing conventional bricks. While replacing bricks can cut costs by 30%, in the case of wood replacement the expenses can be brought down by 50%. The technology, however, requires skilled labour.

Technology Transfer of C-Wood

In India, use of timber has been restricted due to increasing price, non-availability and various environmental threats due to global warming, green house gas emission, which prioritise the necessity of safeguarding country's forest. As a small step towards the cause of betterment through scientific and technical intervention, CSIR-AMPRI has developed technology for making composite panels using industrial wastes, natural fibres and polymer as a hybrid wood substitute Composite Materials (CM-Wood). The technology has been transferred to M/s VSM Industries Pvt Ltd, Gujarat for commercial production on 29th August, 2015. The licensing is expected for effective use of different industrial wastes stream and introduces unique materials to the composites industry. It is waste utilization as well as green technology.

MagStar

A portable Magnetic Sensing Device based on magnetic Hysteresis loop and Barkhausen emissions for Non-destructive Evaluation of Steel Structures/ Components. The technology was licensed to M/s. Techno four, Pune. Two units were sold by Techno four, Pune in 2014-15: one unit to JSW Steel, Bellary and one unit to NTPC by CSIR-NML which is presently with CSIR-NML and will be handed over to NTPC later with the data generated in this project for evaluation of creep damage in P22 and P91 steel.

Preparation of Anti-tarnishing lacquer for Copper based Alloys

The widely accepted inhibition mechanism of organic inhibitors is that the heteroatoms (N,S, and P) form coordinative bonds with copper, resulting in chemisorption of these organic molecules forming a protective layer. Use of these organic inhibitors is successful in preventing corrosion in solution but very few of them provide efficient inhibition for long durations when used as a coating as required for corrosion protection of copper and its alloys in outdoor or marine environments.

CSIR-NML has developed a new organic polymer which can be used as a coating to provide protection of copper and its alloys in severe corroding environments like in sea water. The polymer binds strongly with copper through chemical interactions

and provides efficient protection in saline and sulphide environments. The polymer preparation technology was transferred to a company M/s. Multicoat Surface Private Limited, Kolkata for commercial production of the polymer. The company intends to use the polymer as the first coat on brass that is used in marine environments.

Anti-tarnishing Lacquer for Silver and Copper based Alloys

Anti-tarnishing lacquer developed at CSIR-NML has developed a fast drying non-toxic interior lacquer for use on brass, copper, bronze and silver surfaces. It prevents tarnishing (blackening) and provides a durable finish resistant to water, acid, and alkali environments; The formula contains active corrosion inhibitors chemically bonded to acrylic polymer backbone, hence prevents tarnishing of copper, brass, bronze and items for long durations of several years; The lacquer can be applied by spraying, brushing or dipping and takes 10 minutes to dry. Post treatment like baking not required; The coating passes 500 hours of salt spray test (ASTMB 117) and 72 hours of flower of sulfur test (ASTMB 809).

Production of High Purity tungsten Powder from Supplied WC-Hard Metal Scraps

Tungsten (W) is a rare and strategic metal which has several remarkable properties. The metal and its alloys find numerous critical applications in defense, energy, mining and other sectors. Global tungsten market is dominated by Chinese supply (~84%), and therefore this metal has a high supply risk index. Indian tungsten reserves are negligibly small and the country fully depends on imports. Efficient recovery of this metal from various available secondary sources has tremendous national relevance, not only in terms of foreign exchange savings but also in making our country partly self reliant for our critical domestic requirements.

CSIR-NML has developed an innovative process flow-sheet has been developed for recovering tungsten & other valuable metals such as Ni & Co from a variety of WC hard metal scraps. The highlight of the developed process includes high tungsten & other metals recovery (>95%) and high product purity. The process can cater to desired product specifications with the generation of little or no solid nor liquid effluents. The developed process know-how has been transferred to two MSMEs earlier and recently it has been transferred to M/s. MetChem Wolfram Ltd., Kolkata, who is setting up of a 5-8 MT/month capacity W-powder production plant near Nagpur.

Energy efficient Coke based Brass and Bell Metal Melting Furnace

Brassware artisans across the country are still using age old home based coal/ coke fired furnace for melting brass and aluminum alloys which are fuel inefficient, polluting and hazardous.

CSIR-NML has initiated steps to provide technological interventions to the brassware artisans of India. An eco-friendly and energy efficient brass and bell metal melting furnace has been designed and developed for the artisans of Balasore district of Odisha. The features of this developed furnace are: Reduced coke consumption (about 20%), Reduced harmful gas emissions and pollution (~80%), Reduced melting cycle per batch (20%), Minimum alteration of traditional furnace, increased productivity (30%).

Production of Ferrite and Pigment Grade Mono-dispersed Nano Iron Oxide from waste chloride pickle liquor

A simple innovative process was developed at CSIR-NML for production of monodispersed iron oxide of uniform size and shape from waste chloride pickle liquor. The process is so tuned that a particular size and shape could be engineered with required magnetic properties. The major advantages of the process are that it involves low temperature synthesis and takes care of various impurities present in the

system, and that it does not involve any major impurity removal steps. Jointly with M/s Tata Steel the process has been further scaled up kilogram scale and a complete flow sheet was developed. The submission/ nano size iron oxide produced were tested and were found to be promising with respect to its application as high grade pigment as well as a precursor for soft high end magnetic material. The developed process demonstrated and transferred to M/s. Tata Pigments Ltd. The process produced a variety of lighter grade iron oxide with superior pigmenting quality.

Soil Nail Pullout Capacity System as a remedial measure to land slide

CSIR-CBRI has developed State-of-the-art Soil nailing technology as a remedial measure to treat unstable natural soil slopes those causes landslide. It can be used a construction technique that allows the safe over-steepening of new or existing soil slopes to prevent landslides. It is cost-effective over other alternatives and vital in the production of high-quality soil nail walls.

Cost effective seismic resistant Confined Masonry Construction technology

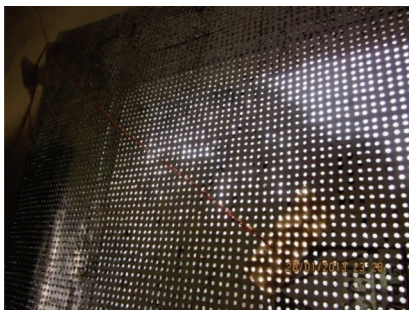
CSIR-CBRI has designed and devolved innovative and cost effective earth quake resistance technology, identified as confined masonry technology with three dissimilar features having sophisticated level of earth quake related safety. It uses the same basic materials as in unreinforced masonry construction and in reinforced concrete frame construction with masonry infills, but with a different construction sequence and system. This confined masonry constructions and their performance have been explored from Indian construction practices and materials point of view. To elucidate economy in the construction cost of confined masonry as compared to other building technologies prevailing in the country i.e., reinforced concrete framed structure with masonry infill, unreinforced masonry and reinforced masonry; a rigorous cost analysis have been carried out. The seismic performances of such masonry systems have been evaluated by means of full-scale tests under quasi-static lateral loads. These earth quake resistance building technologies have similar skill requirements as in unreinforced masonry and RC framed construction. The construction technology results in the cost savings of around 30%, of RC building for the similar design parameters and safety level. It utilizes locally available construction materials, skills. A compressive design procedure has been framed for constructing confined masonry buildings as no design rules or standards were yet available for usage.

Smart phone enabled Prepaid Energy Meter with load limiting feature

CSIR-CMERI jointly with CSIR-CBRI has developed a smart phone enabled and smart card operated prepaid energy meter. It uses embedded technology to dispatch electricity at the consumers end. This is able to effectively limit the amount of power a household can consume at a touch of a button. The distinguished feature of the present device is that it is smart phone enabled.

Solar Window System for cold climatic region

A solar window system has been designed and developed by CSIR-CBRI for cold climatic region. It is just placed behind the window glass. The system has been studied from illumination point of view



Solar Window System for cold climatic region by CSIR-CBRI

inside the room. Illumination is satisfied by keeping the opening area 10% of the floor area of the room. It improves the indoor air temperature. The maximum indoor air temperature difference of 7.5° C could be achieved in the room.

Electronic Nose for Environmental Monitoring jointly developed by CSIR-NEERI & C-DAC

An Electronic Nose (E-Nose) to sniff out dangerous gases in the pulp and paper industry has been jointly developed by CSIR-NEERI Centre for Development of Advanced Computing (C-DAC). The Electronic Nose, the first of its kind of technology to be developed in India that makes use of intelligent software to identify odorous molecules, is a portable device that measures odour concentration as well as odour intensity using an array of sensors that function on the principle similar to that of human olfaction (sense of smell). The sensor array generates a pattern based on the type of aroma. The software can be trained by feeding information based on observation of experts. The E-Nose is particularly useful for application in the pulp and paper industry that emits a variety of gases like hydrogen sulphide, methyl mercaptan, dimethyl sulphide, and dimethyl disulphide all of which beyond a certain concentrations may adversely affect the environment and human health. By continuously monitoring the concentration of these gases, it is a boon for workers. Besides, it also overcomes all limitations of the available analytical instruments that are expensive and time-consuming. The E-Nose is currently functioning successfully at the Mysore Paper Mills Limited at Bhadravati in Karnataka and Tamil Nadu Paper Mill.

Sensor array in E-Nose developed jointly by CSIR-NEERI and CDAC-Kolkata

4. Physical Sciences Cluster

Moisture Sensor for On-line Measurement of Moisture in Coconut Chips

CSIR-CEERI has developed an on-line assessment of moisture content of copra at M/s Marico, Puducherry. High moisture content makes the copra vulnerable to fungal and pestilential attack. An NIRS filter type moisture sensor system was configured and enhanced with wireless transmitter/ receivers, and suitable repeaters to communicate the measured data to a remote PC at the control room. The system was installed and commissioned at M/s Marico Ltd. and its functioning has been found satisfactory. Based on the feedback, the system will be suitably modified and improved for on-line measurement and control.

M 8.7 Shillong 1897 earthquake scenario: NE multi-state preparedness campaign

To make awareness and alert the people of North East India for the vulnerability of the probable loss and damage due to recurrence of a mega earthquake having magnitude of 8.7, the vulnerable population in isoseismal ZoneI-III were estimated by CSIR-NEIST. Houses vulnerable to earthquakes were accounted to assess the population at risk in all the 8 North Eastern State / districts based on the seventy of ground shaking (acceleration) and building types. The isoseists I-III, equivalent of MSK XII – VIII covers almost the entire NE India. For public awareness on earthquake hazard mitigation, capacity development program, training on rapid visual screening of buildings & lifeline structures, mega

mock exercise and school children sensitization programmes were conducted.

Mud banks of Kerala

CSIR-NIO has also launched a new research initiative to work on the causes for the formation of mud banks of Kerala, in collaboration with CMFRI, Kochi. A weekly multidisciplinary – physical, chemical, biological & geological, – time series observation has been embarked upon to understand the process of mud bank formation during this year. While the general hydrographic parameters including water/sediment quality, planktonic studies are done by CSIR, CMFRI is carrying out experimental trawling (in mud bank and non-mud bank areas), distribution, taxonomy, size and sex of different fishes in the area.

Machine Vision (Camera) based Head/Neck movement controlled wheel-chair

CSIR-CSIO has developed Prototype of a Camera based head/neck movement controlled wheel-chair under XII Five Year Plan Project "OMEGA" which can be used by quadriplegic people having neck/ head movements only. The control signals for manoeuvring the customized wheelchair are generated by detecting the Head/Neck movements using machine vision system. These control signals are sent to the motion controller to control the movements of the motors of the wheelchair. The direction and speed control of the wheelchair is implemented by neck movements such as the Roll and Pitch. The motion control developed using microcontroller and motor drivers is being tested on the commercially available powered wheelchair.

Optical time division reflectometery

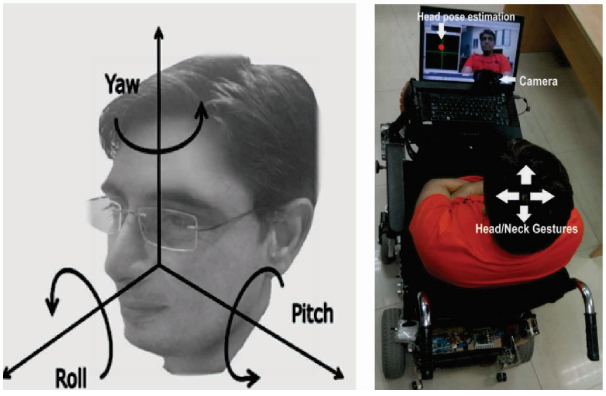
CSIR-CSIO has developed and demonstrated an optical time division reflectometery (OTDR) field technique to monitor site landslide activity. It is inexpensive, less time consuming over the traditional methods and is for remote monitoring at multiple locations. Technology for disaster resistant shelters has been established.

Bio ceramic grinding & polishing technology

CSIR-CSIO has developed a bio ceramic grinding & polishing technology has been developed and equipment fabricated based on novel design. Exceedingly difficult to make Superelastic NiTi shape memory alloy wires have been developed and fabricated for orthopaedic implants applications.

Touch based finger gesture controlled wheel-chair

Touch based finger gesture controlled wheel-chair can be used by subjects who have motor disability and their weak limbs does not allow them to hold the joystick of the powered wheelchair. The control



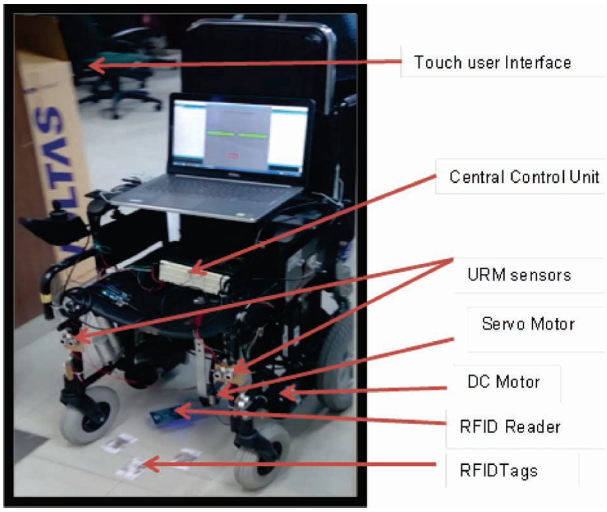
Machine Vision based Head tracking setup

Touch based finger gesture controlled wheelchair

signals for maneuvering the wheel chair are generated by sliding the finger on the capacitive touch screen. The control signals after proper conditioning are used to control the direction and speed of the patient cart. Under XII Five Year Plan Project 'OMEGA'; CSIR-CSIO has developed prototype of Finger Touch/ Finger Gesture controlled wheelchair for the paraplegic and weak limb patients. In-house trials for motion control algorithm are being conducted.

Autonomous navigation of patient wheel-chair

Autonomous guiding of patient within the hospital can improve hospital's operational efficiency by reducing labour, automating in-house patient's movements and reducing overall time delays. Hence need felt for fully automated sensor data capture and processing system for autonomous navigation.

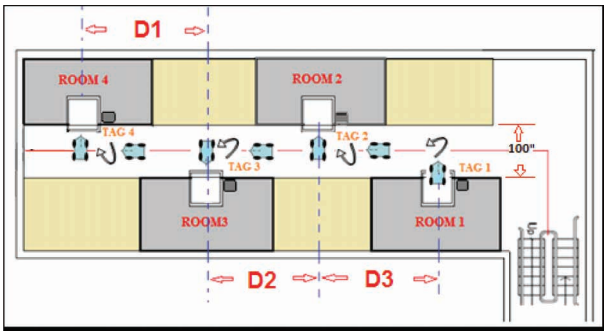


Control system for autonomous navigation and motion control

CSIR-CSIO, under XII Five Plan Project 'OMEGA', has developed a prototype of autonomous navigated patient wheel chair Intelligence which is being implemented through wireless RFID communication technique by storing the navigation map of a particular work area in the system's memory with centralized control system. Location identification is based upon RFID tags fixed on the walls of the passage and patient cart. Automated sensor data capture and processing unit keeps track of obstacles during navigation. Two 8-bit microcontrollers work in parallel mode to complement one another in master-slave configuration. One controller is dedicated to obstacle avoidance while the other is for navigation, communicating with each other through serial interface. The system has an interactive graphical user interface. Various commands namely forward, reverse, right, left, slight right, slight left and hard stop are issued to the right and left motors to achieve the desired movement of the cart in a constrained environment.

Motion control algorithm for autonomous navigation of patient vehicle based upon keyboard input, six ultrasonic sensing modules & RFID tags group, is developed and tested on powered wheel chair.

Presently navigation is being experimented according to the floor map by placing four groups of passive tags in crescent type pattern at the entrance of each room and storing the possible routes in the look up table. Crescent type pattern of 6-8 cards per room has enabled us to reduce the number of tags required in the detection process.



Floor map & placement of RFID tags

Solution to mitigate drastic depletion of Groundwater level

The Mandollagudem TECHVIL Cluster located in Nalgonda District, Telangana falls under drought prone area as it receives an average rainfall of 620

mm. The region is characterised by low infiltration of surface water and poor connectivity between the aquifers. Groundwater levels dropped significantly during the past decade due to the over exploitation of ground water induced by the shifting of crop pattern from Castor/Cotton to paddy cultivation in addition to the exogenous processes. Since it is very difficult to suddenly shift to new crop, CSIR-NGRI has suggested that the adoption of the System of Rice Intensification (SRI) method along with Alternate Wetting and Drying (AWD) and Direct Seeding (DS) methods will reduce the consumption of water up to 30 percent with more grain productivity compared to continuous uncontrolled flooded field methods. From the statistical analysis of various data sets, it is concluded that the adoption of low water consuming crops and scientific irrigation practices are the most recommended solutions to mitigate the drastic depletion of groundwater levels.

Impact of Tidal forcing on critically generated earthquake phenomena

Complexity in the earthquake mechanism is manifested in different forms such as fractal distribution, clustering of seismicity, etc., and characterized as critical phenomenon. Occurrences of earthquakes generally represent the state of metastable equilibrium. The Andaman–Sumatra subduction zone is one of the most seismically active corridors (possibly in metastable state) in the world. Recently, the region faced three major earthquakes of magnitude more than 8.5 (M ~ 9.1 on December 26, 2004; M ~ 8.6 on March 28, 2005; M ~ 8.6 on April 11, 2012). Researchers have suggested multiple causes of earthquake generation in this region including the one with possible correlation of tidal stresses with earthquake occurrences. The latter issue, however, has been hotly debated in view of the fact that a small stress generated due to tidal forcing cannot cause such a bigger magnitude earthquake. CSIR-NGRI has studied the impact of tidal forcing on critically generated earthquake phenomena. The statistical behavior of recurrence time interval of earthquakes using the available data for period of about 40 years from 1973 to 2013. CSIR-NGRI has constrained the simple empirical toy model using the concept of catastrophe theory to evaluate the impact of small tidal forcing on the critical state of earthquakes occurrences. In addition to the major role of Helmholtz free energy during the plate motion, our analysis suggests that the stability and critical behavior of the earthquake in Sumatra region could be associated with tidal forcing, however, only for triggering of some of the "Catastrophic–Chaotic" earthquake phenomenon.

Neoarchaean felsic volcanic rocks from the Shimoga greenstone belt, Dharwar Craton, India

CSIR-NGRI has studied the felsic volcanic rocks of Neoarchaean Shimoga greenstone terrane of western Dharwar Craton in India which are dominantly represented by rhyolites occurring at stratigraphically upper horizons. The Shimoga rhyolites are associated with conglomerates, quartzites, argillites, limestones, cherts, basalts and intermediate volcanic rocks clearly suggesting an accretionary package. The rhyolites of Daginkatte and Shikaripura areas are potassic, with porphyritic alkali feldspar and quartz as essential minerals and chlorite, biotite and opaques as accessory phases. Geochemically, the rocks show enrichment in LILE and depletion in HFSE relative to primitive mantle values, with negative Nb-Ta, Zr-Hf anomalies and positive Th anomalies. These features of the Shimoga rhyolites compare well with the geochemical characteristics of magmas generated in subductionrelated tectonic settings. Their alkaline compositions, intermediate to low HFSE abundances, moderate to high Zr/Y values (1.5–8.3), with La/Yb n (2–28), pronounced negative Eu anomalies, and variable LREE/HREE fractionation trends resemble the FI and FII rhyolites of Wabigoon and Uchi belts of Superior Province, Canada. The Shimoga rhyolites are interpreted to be products of melting of thick basaltic crust metamorphosed to amphibolite/eclogite grade, with garnet-and amphibole-bearing mantle residue. The rhyolites

show prominent negative Eu and Ti anomalies, moderate to strong LREE fractionation, flat to mildly fractionated HREE patterns and are geochemically analogous to Type 1 and Type 3 rhyolites of Superior Province, Canada suggesting their derivation from intra-crustal melting and fractional crystallization of basaltic liquids with prominent contribution from mantle wedge and slab components. Our data suggest the contribution of Neoarchaean active continental margin processes for the growth and evolution of continental crust in the western Dharwar Craton.

Oblique convergence and slip partitioning in the NW Himalaya: Implications from GPS measurements

CSIR-NGRI has reported GPS measurements of crustal deformation across the Kashmir Himalaya. Combining these results with the published results of GPS measurements from the Karakoram fault system suggest that in the Kashmir Himalaya, the motion between the southern Tibet and India plate is oblique with respect to the structural trend. We estimated this almost north-south oblique motion to be 17±2mm/yr, which is partitioned between dextral motion of 5±2mm/yr on the Karakoram fault system and oblique motion of 13.6± 1mm/yr with an azimuth of N198°E in the northwest-southeast trending Kashmir Himalayan frontal arc. Thus, the partitioning of the India-Southern Tibet oblique motion is partial in the Kashmir Himalayan frontal arc. However, in the neighbouring Nepal Himalaya, there is no partitioning; the entire India-Southern Tibet motion of 19– 20mm/yr is arc normal and is accommodated entirely in the Himalayan frontal arc. The convergence rate in the Kashmir frontal Himalaya is about 25% less than that in the Nepal Himalayan region. However, here the Karakoram fault system accommodates about 20% of the southern Tibet and Indian plate convergence and marks the northern extent of the NW Himalayan arc sliver. The Kaurik Chango rift, a north-south oriented seismically active cross-wedge trans-tensional fault appears to divide the sliver in two parts causing varying translatory motion on the Karakoram fault on either side of the Kaurik Chango rift.

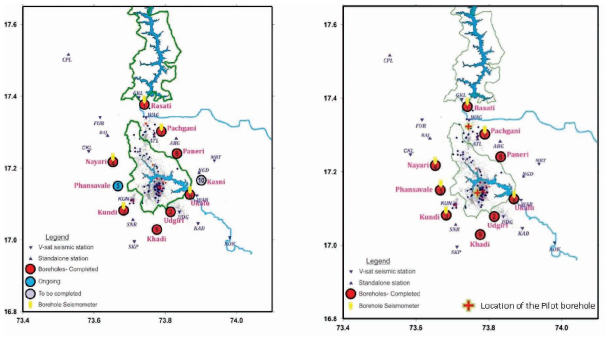
Chemistry and petrology of Fe-Ni beads from different types of cosmic spherules: Implication for precursors

CSIR-NGRI has observed Fe–Ni beads to occur in all three (Stony, Glass, Iron) types of cosmic spherules collected from deep sea sediments of the Indian Ocean. Fe–Ni beads in cosmic spherules can provide insights for understanding metal segregation mechanisms and their refractory metal element (RME: Re, Os, W, Ir, Ru, Mo, Pt, Rh including Pd) compositions can help ascertain their precursor meteorites. We measured RME compositions of 55 Fe–Ni beads using LA-ICP-MS in all three basic types of cosmic spherules selected after examining <“2000 cosmic spherules. The RMEs of Fe–Ni beads provide unique information on formation and differentiation during atmospheric entry. The variability in the concentration of the RMEs depends on the initial mass of the cosmic spherules, volatility, temperature attained and efficiency in metal segregation during entry. The CI chondrite and Os normalized RME compositions of the beads display a pattern that is close to CI chondritic composition. The presence of Pd, a non-refractory metal having condensation temperature similar to Fe, in Fe–Ni beads of all types of cosmic spherules indicates that the heating undergone was below its vaporization temperature. Not all parent bodies lead to the formation of beads, the precursor needs to exceed a certain minimum size and temperature to facilitate the metal to get segregated into beads. The minimum size of a parent particle that could enclose a Fe–Ni bead is estimated to have a size <“1 mm. This places constraints on the sizes of materials that are ablated during entry and the accompanying mass loss during entry. Our study further points out that all the three basic types of cosmic spherules have a chondritic origin based on their RME distribution patterns. Only metal-rich carbonaceous chondrites contain the required quantities of metal for the formation of Fe–

Ni beads during atmospheric entry and during this process the RMEs are also efficiently segregated into these beads.

A unique borehole seismograph network in the Koyna area, Maharashtra

Under the preparatory phase of the deep scientific drilling program at Koyna-Warna region a major initiative by CSIR-NGRI was deployment of a unique borehole seismic network in eight boreholes drilled to depths ranging from 1200m to 1520m. One of the main objectives of this deployment is to accurately delineate the subsurface faults through accurate determination of hypocentral parameters of the Koyna-Warna earthquakes. Due to the overlying basalt layer and also the high noise levels on surface, there are limitations in the accuracies of earthquake locations obtained through the broadband seismograph network. Hence, it was decided to install borehole seismometers in the boreholes drilled through the Deccan traps into the granitic basement, at selected locations, covering the seismically active zones of the Koyna-Warna region. A total of 4 borehole seismometers have been successfully installed at Rasati, Kundi, Nayari and Ukhalu, with a locally made Tri-podWheel assembly. The Koyna borehole seismic network consisting of 4 borehole seismometers along with 20 surface seismometers are already recording micro-earthquakes with magnitudes as low as 0.3. With the installation of the remaining 4 borehole seismometers, it is expected to get much improved accuracies of earthquake locations, since the borehole seismometers are installed on hard rock basement and free from the noise introduced on surface and the basalt layer. Figure shows a sample record of a microevent on a surface seismometer and a borehole seismometer at the same location.



A

A: Boreholes drilled in the Koyna region where aseismograph network is being installed

B

B: 4.5Hz, 3- component Borehole sonde being installed using a Tri-pod setup at Ukhalu (1500 m)

C

C: Wheel and Gear assembly specially designed to handle long seismometer cables of ~ 1.5 km .

Uranium Exploration

CSIR-NGRI has carried out Heli-borne electromagnetic, magnetic and gamma ray

radiometric surveys along 11,355.5 LKM in Singhora Block – II of Chhatisgarh sedimentary basin. The processing of this data is in progress and a report emphasizing the Uranium potentiality in this basin is being prepared for submission to Atomic Minerals Directorate (AMD) under Department of Atomic Energy.

Implications of sea level rise scenarios on land use/land cover classes of the coastal zones of Cochin

CSIR-NIO has studied the implications of sea level rise scenarios on land use/land cover classes of the coastal zones of Cochin, India. It was initiated to find out the response of coastal regions under climate change conditions and to demarcate the probable inundation regions with different sea level rise scenarios. Though the sea level rise trend varies as per the regional influence, this study throws light on the importance of mitigation measures need to be considered at this hour. Cochin has been designated as one of the smart cities along the coast of India for the "Smart City" mission of Honourable Prime Minister of India Mr. Narendra Modi. It is one of the most populated and fast growing cities of India and millions of dollars are invested in infrastructural projects such as Metro rail, setting up of industries, etc. Certainly, this city will become an urban conglomerate in the near future. This study will help Cochin authorities to demarcate environment and social sustainable regions unaffected by climate change effects. Physical responses of the coastal zones in the vicinity of Cochin due to sea level rise were investigated based on analysis of inundation scenarios. Quantification of potential habitat loss was made by merging the Land use/Land cover (LU/LC) prepared from the satellite imagery with the digital elevation model. Scenarios were generated for two different rates of sea level rise and responses of changes occurred were made to ascertain the vulnerability and loss in extent. LU/LC classes overlaid on 1 m and 2 m elevation showed that it was mostly covered by vegetation areas followed by water and urban zones. For the sea level rise scenarios of 1 m and 2 m, the total inundation zones were estimated to be 169 km^2 and 598 km^2 respectively using Geographic Information System (GIS). The losses of urban areas were estimated at 43 km^2 and 187 km^2 for 1 m and 2 m sea level rise respectively, which is alarming information for the most densely populated state of India. Quantitative comparison of other LU/LC classes showed significant changes under each of the inundation scenarios. The results obtained conclusively point to the fact that sea level rise scenarios will bring profound effects on the land use and land cover classes as well as on coastal landforms in Cochin region. Coastal inundation would leave the ocean front and inland properties vulnerable. Increase in these water levels would alter the coastal drainage gradients. Reduction in these gradients would increase flooding attributable to rainstorms which could promote salt water intrusion into coastal aquifers and force water tables to rise. Changes in the coastal landforms associated with inundation generate concern and the coastal region may continue to remain vulnerable in the coming decades due to population growth and development pressures. Assessments of climate change impacts using the scientific data generate new knowledge. The process of adaptation includes the latest technologies as well as the traditional knowledge. The overall probable inundation zones, their land use, land cover, the expansion plans of future and the assessment of current situation will help to devise the adaptive management. Preventive planning will reduce lot of hassles in the future. Adaptation to sea level rise situations should go with the improved versions of integrated coastal zone management projects. Mostly, agricultural lands, urban areas and vegetation zones are affected in this region. Alternate or modified agricultural practices, security for the fresh water, and managing the urban and industrial areas should be initiated immediately.

5. Information Science Cluster

India stops Colgate-Palmolive from patenting mouthwash formula

India has foiled an attempt by consumer goods giant Colgate-Palmolive to patent a mouthwash formula containing herb extracts by citing ancient texts that show it was traditionally used in ancient medicinal practices. CSIR, through its programme Traditional Knowledge Digital Library (TKDL), submitted proof in the form of references from ancient books, which led to withdrawal of patent application.

6. CSIR-800

Co-cultivation of menthol mint with traditional crops for enhancing farm productivity and profit

Cultivation and production of menthol mint has been profitable for the farmers of India for the last few decades. But after introduction of synthetic menthol mint in market at cheaper rate, the crop has become less profitable due to decrease in the demand for natural menthol. Hence there is a need to produce natural menthol mint at a lower cost. If this crop is grown with major food crops as an additional crop, the production cost of menthol mint oil can be reduced as compared to its pure culture.

Data recorded on the productivity and profit of the different cropping system by CSIR-CIMAP revealed that menthol mint can be grown successfully with traditional food crops such as sugarcane, maize, has been was reduced significantly under co-cultivation system with all crop. The lowest cost production (Rs. 137/kg) was under onion + menthol mint.

Cropping system	Cost of Cultivation (kg ha $^{-1}$)	Total income from main crop (kg ha $^{-1}$)	Equivalent yield of menthol mint oil (kg ha $^{-1}$)	Yield of Menthol mint oil (kg ha $^{-1}$)	Total yield of menthol mint oil (kg ha $^{-1}$)	Production cost of Menthol mint oil (kg ha $^{-1}$)
Menthol mint sole	54000	-	-	150	150	360.00
Sugarcane – Menthol mint	78000	150000	223	110	333	234.00
Vetiver – Menthol mint	6600	138000	197	140	337	196
Maize (for grains) – Menthol Mint	60000	49000	70	140	210	286.00
Maize (for cobs) – Menthol mint	72000	150000	214	140	354	203.00
Okra – Menthol mint	66000	120000	171	130	301	219.00
Radish – Menthol Mint	78000	250000	357	120	477	164.00
Onion – Menthol mint	78000	300000	429	140	569	137.00
Wheat – Radish = Menthol mint	89000	144000	205	80	285	312.00
CD (P=0.05)					55.5	50.5

Production cost of the essential oil of menthal mint under different co-cultivation system

Entrepreneurial training on making of agarbattis using floral bi-resource

Entrepreneurial trainings programmes on making of scented agarbattis using flowers and other plant bio-resources were organised by CSIR-CIMAP. More than 90 participants were imparted hands on training during the year. Two such training programmes were held at CSIR-CIMAP's Women Entrepreneurial Training Facility (WETF) located near Chandrika Devi Temple, Vill. Kathwara Bakshi-ka-Talab, Lucknow on 4th April 2014 and 18th October, 2014 for 16 and 40 participants, respectively. Another programme was organised 12 April, 2014 at vill. Kalli Pashchim in which about 20 women participated. The trainees were also apprised about the perfuming and packaging of the agarbattis and encouraged to form the groups for manufacturing and marketing.

Impact assessment of distillation technology

Survey Feedback studies have been carried out by CSIR-CIMAP to assesses impact of innovating technology based on interactive research inputs taken from 200 farmers. The study was conducted among the farmers of east U.P, West U.P and Bihar. The result analysis demonstrated/exhibited better oil recovery with minimum cost input, CIMAP improved field distillation unit demonstrated better results in case of low consumption period (3.25 hrs), high recovery of oil (54.6 litre), high oil recovery percentage (79.3%) and low cost (Rs. 346) per shift distillation time. Comparison between the conventional, rural type and CIMAP distillation technology have been illustrated.

State	No. of Farmers	Distillation (Distl.) unit type	Av. Oil recovery/ shift/ton capacity	Av. Distl. time (hrs)	Av. Cost/ shift distl.	Av. Oil recovery %	Av. Cost of 5 q distl. unit with no. of farmers	Av. Cost of 10 q distl. unit with no. of farmers
East UP	20	Rural type distillation unit	34 Lit.	6	700	50%	3000 (16)	80000(4)
	40	Improved distillation unit	55 Lit.	3 1/2	350	80%	50000 (35)	250000 (5)
West UP	25	Rural type distillation unit	32 Lit.	5 1/2	750	52%	30000 (22)	800000 (3)
	15	Improved distillation unit	53 Lit.	3 1/4	340	78%	50000 (13)	250000 (2)
Bihar	40	Rural type distillation unit	32 Lit.	5 1/4	725	52%	30000 (36)	80000 (4)
	60	Improved distillation unit	56 Lit.	3 1/2	350	80%	50000 (50)	250000 (10)

Economic benefit of distillation units:

Comparison of conventional, local and improved field distillation unit

Parameters	Primitive/ conventional	Rural type field distillation unit	Improved field distillation unit
Efficiency	Water/hydro distillation Process is slow and the distillation time is much higher and consuming more fuel	Water and steam distillation – Low steam generation, lesser time consuming than conventional type but inferior than improved one Constructed with more fuel consumption, cheaper quality material	Technologically improved over easier, higher steam generation due to more heating surface area and consuming lesser time. More fuel efficient and save 20-30% fuel, technically designed with better quality material.
Tank	Made up of copper call 'Deg' Bamboo pipe, copper vessels etc.	Mild/Stainless steel, tank shape varies circle, oval and cylinderical	Using high quality mild steel/ stainless steel, cylindrical distillation tank fitted on a square inbuilt boiler/calandria having smoke pipe.
Capacity	Capacity is around 40 kg per batch	Capacity varies from 5 quintal per batch	Capacity varies from 10 quintal per batch.
Condenser	Material dipped in water, bamboo pipe is use for vapour connection, small furnace, and water tank is used for consideration of oil and vapour in a copper vessel	Material is loaded on a grid below which water is boiled. Furnace has no design, vapour and oil passed through long vessel and then simple coiling in water tank, manual discharge of distillation waste	Cylinderical distillation tank fitted with specifically designed furnace having fire gate, fuel duct and fire door. Furnace connected with chimney of optimum height, tube type condenser, stainless steel type separator with inbuilt baffle, chain pully hoist system for easy discharge of waste.
Operation	Easy, simple and portable and used for rooh and attar of Gulab, Khus, Rajnigandha, Bela etc	Easy to fabricate, installed at farmers field, low cost, simple construction, easy operation, not safe and less recovery of oil and time consuming, used in Menthol mint, Citronella, Lemongrass, Basil oil distillation	Slightly costly, economic and efficient, fuel and time saving, eco-friendly and safe, can be used Menthe, Citronella, Lemongrass, Basil, Palmarosa, Geranium, Vetiver, Chamomile, etc.
Quality of oil	Poor quality of oil due to direct contact of material with fire which imparts an objectionable odour to the essential oil. Deterioration of essential ester of essential oil. It also causes air pollution at work place.	Oil recovery less than improved field distillation unit, utilizes more quantity of agro waste/ spend marc as fuel due to inferior technology. Deterioration of essential easter essential oil due to high temperature in condensation.	Good oil recovery, 10-15% higher, utilizes agro waste/spent marc as fuel, no smoke work area. No deterioration of essential ester of essential oil.
Self life	2-3 years	4 years	10 years
Cost of Unit	Rs. 30,000/-	RS. 50,000/-	Rs. 25,000/-

Economics of *Artemisia Annua cultivation*

Artemisia annua crop is an important source of artemisnin used as anti-malarial drug. The present study was conducted in Uttar Pradesh by CSIR-CIMAP. Primary data on cost aspects has been collected from 80 selected farmers. It has been observed that total variable cost was found to be Rs. 21.84 per hectare. The major portion of cost of cultivation was shared by human labour. The total return was found Rs. 87.63 per hectare. The net return over variable cost was found to be Rs. 65.75 per hectare with a benefit cost ratio of 4.01. The estimated resource-use efficiency in this crop (R^2 value) was found 0.907 which indicates that 91 percent of the variations in *Artemisia anuua* were influenced by the explanatory variables like human labour, seed and nursery raising, manure and fertiliser and transport charge.

Technology feedback of CIM-Asvika

Performance index of newly developed multi-utility portable distillation technology was evaluated amongst the farmers of Uttar Pradesh and Bihar. These units were sold to farmers and received feedback of the technology. CIM-Asvika-distillation unit is especially designed for producing good quality oil and rose and Khus water. It can also be used for extraction of spices and other aromatic oils of high grades. It is made up of stainless steel, simple low cost, portable type, highly efficient and low fuel consuming distillation unit. This unit can produce 10-15 kg fresh rose water from 12kg of rose flowers. The cost of this unit is about Rs. 12000/ unit. It can be operated by firewood, agro waste, liquefied petroleum gas, kerosene burners.

The performance report indicates that 95% farmers are satisfied with CIM-ASVIKA in terms of usability and quality in micro enterprises development. A self Help Group has been formed in village Samraha Udholi of Barabanki and women groups have started cultivation desi rose for the production of rose water. It produces nine liters rose water from ten kilograms flower and generates Rs. 1200/- with an expenditure of Rs. 475 and selling in open market under brand name, Sakhi Gulabark.

CSIR-Centre for High Altitude Biology (CSIR-CeHAB)

CSIR-IHBT has set up the CSIR-Centre for High Altitude Biology (CSIR-CeHAB) in the remote tribal region of Lahaul and Spiti which focuses on studies pertaining to bio-systems at high altitude vis-à-vis the climate change, conserving bio-resource and transferring knowledge to local communities for inclusive growth. A food processing unit has been set up at the CSIR-CeHAB. Recently, the CSIR knowhow related to food & agri-processing was showcased at the Tribal Fair at Keylong and training organized for the benefit of progressive farmers in making novel products from Buckwheat and also brining of the peas and cauliflower, major crops of the region.

New range of leather products for North East

CSIR-CLRI has introduced aesthetic appeal, standardization and new range of leather products in North East for higher profits to leather artisans. The handbags and other leather products crafted and designed with the ethnic designs and materials of the North east based ornaments, Dresses & Artifacts adorned by tribal folks of North East India.

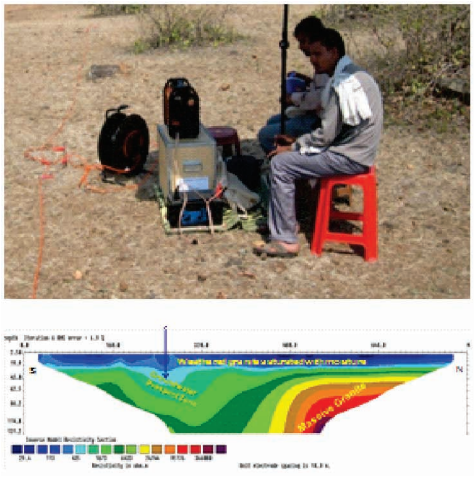
Exploration of Groundwater Resources in Hard Rock Areas and supplying the same to local folks

CSIR-NGRI has a Field Observatory, located in Nalgonda district of Telangana which is a known hard rock area. The area is marred with shortage of drinking water since 2012 due to very low rainfall (~600 mm), excessive use of Ground water for irrigation and poor water management practices. CSIR-NGRI, utilizing its expertise in geophysical techniques like 2-D Electrical Resistivity Tomography (ERT), identified and explored

Groundwater aquifers in hard rock areas. Institute digged a number of bore wells at identified places and regularly supplying water to the nearby villages. In first phase already three nearby villages and one primary school are benefiting

Aerial view of — field observation

Water scarcity



Identification and Exploration of Groundwater through geophysical techniques like 2D Electrical Resistivity Tomography (ERT)

Borewells at identified locations

Water coming from bore-well and being carried to over-head tank of near by villages