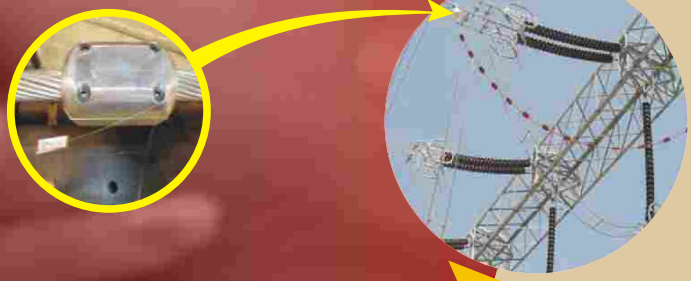
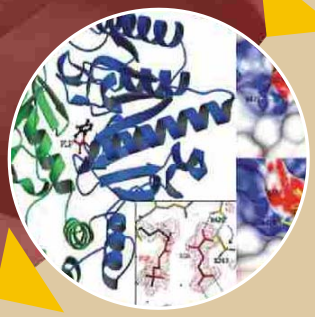
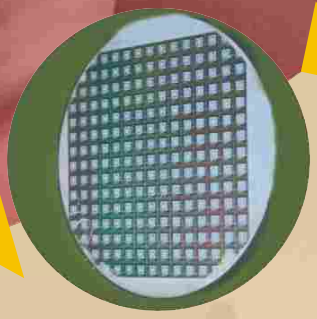
ANNUAL REPORT
2006-2007

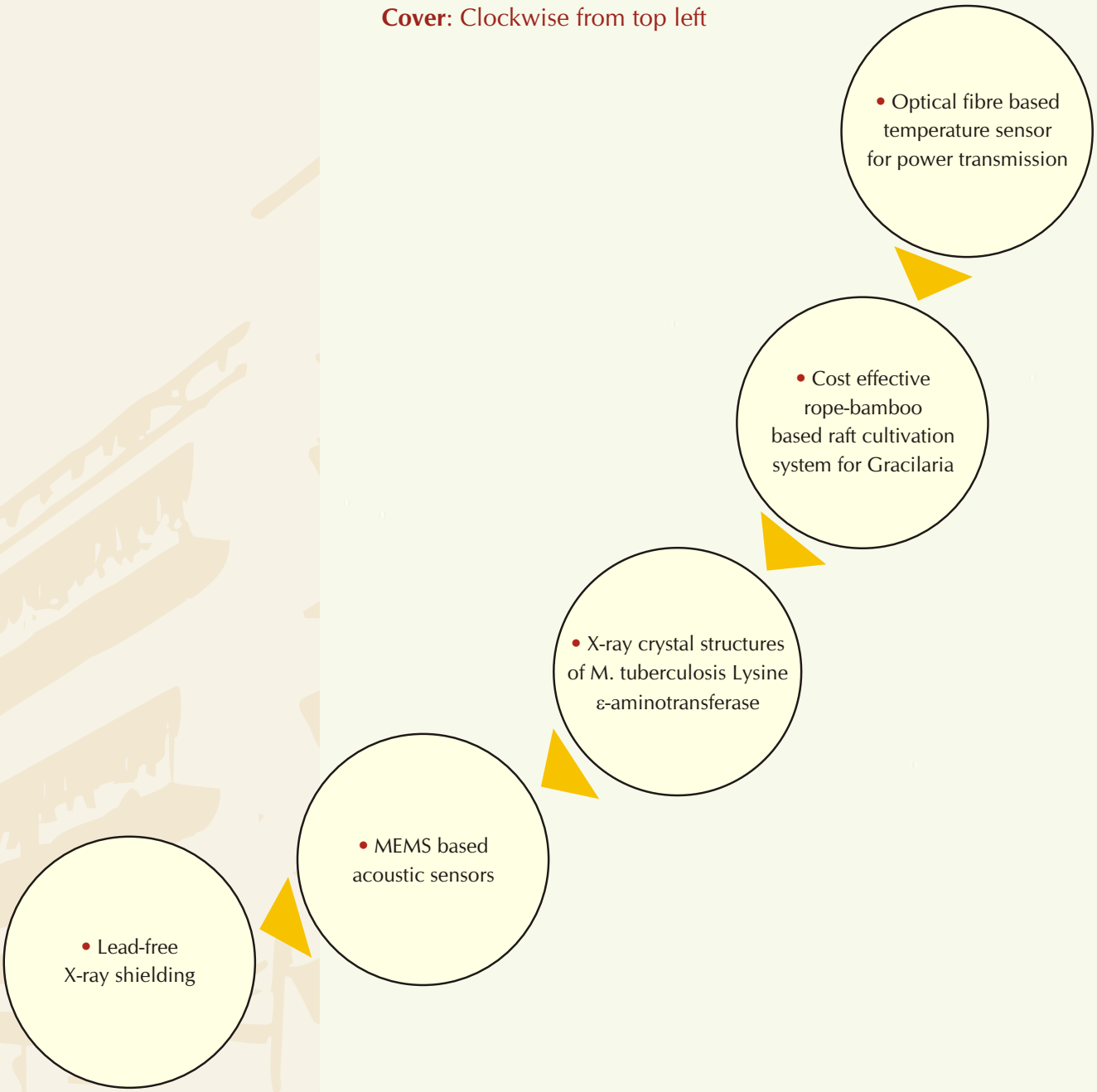






Council of Scientific and Industrial Research
New Delhi

Cover: Clockwise from top left



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With
compliments
of

Prof. S.K. Brahmachari
Director-General
Council of Scientific
& Industrial Research
New Delhi

ANNUAL REPORT
2006-2007

Council of Scientific and Industrial Research

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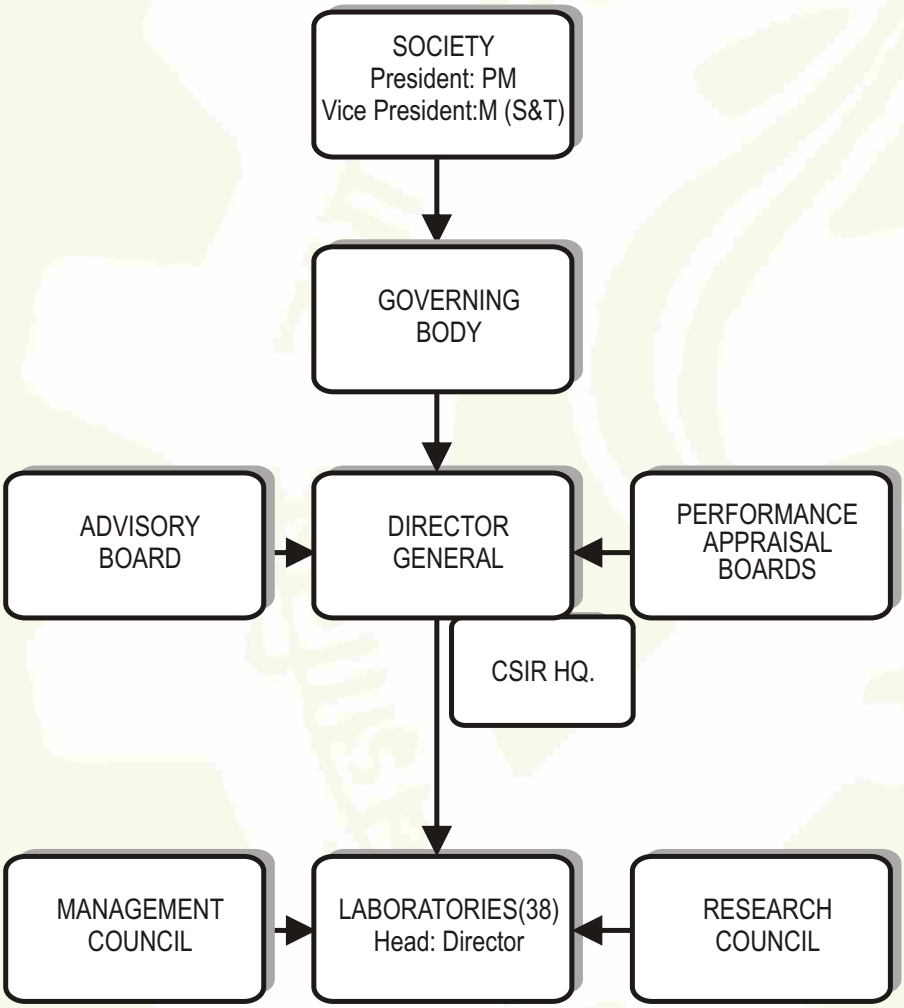
CSIR ORGANISATIONAL STRUCTURE



CONTENTS

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EXECUTIVE SUMMARY


CSIR-INDIA

EXECUTIVE SUMMARY

The Annual Report for the year 2006-07 highlights the salient contributions made by all the constituent units of Council of Scientific & Industrial Research (CSIR), which span a number of science and technology domains. The Council, the largest publically funded industrial R&D organization of the world, ever since its establishment in the year 1942, has contributed immensely not only in terms of many new products and technological processes but also in terms of significant basic research contributions. The range of its S&T contributions is unique and wide.

As a multidisciplinary, multi-locational network of 38 national laboratories and 39 outreach centers, CSIR over the years, has matured into a performance driven and knowledge-centric organization. Its laboratories are rich in talent, technology, and infrastructure, which are the basic building blocks for creating and nurturing scientific & technological innovations, both incremental and breakthroughs. Predominantly, CSIR strives to achieve excellence in science; global competitiveness in technology based on high science; and innovation in various key areas of S&T. It has been a proactive generator of technologies for industrial growth, S&T anchor for strategic sector, technology hub for societal welfare and science base for progression of knowledge capital. Its achievements subsume a wide science continuum from aerospace to biology to energy to materials & minerals.

The Report covers CSIR's S&T contributions in creating Societal, Strategic, Private and Public goods & services. The CSIR institutions have worked accordingly or provided services in one or more of these sectors and their outputs had direct socio-economic and, in many cases, techno-commercial significance.

The year under review being the terminal year of the 10th Five Year Plan has seen consolidation and culmination of many of the programmes that commenced during the plan period. The network projects spread across CSIR institutions, initiated during the plan, have led to a greater synergy and appreciation of each others' strengths in various science domains. Another significant scheme of CSIR aimed at promoting technological innovation, namely, the New Millennium Indian Technology Leadership Initiative (NMITLI) attracted larger participation of stakeholders and several new leads could come out of this programme.

Recognizing that S&T inputs could significantly contribute to improvement in the quality of life and public services, CSIR institutions have provided S&T based solutions to mitigate the vulnerability and improve the quality of life especially for rural society. Sustainable development of rural areas can be achieved by significant technological interventions in many areas including drinking water, shelter, energy, environment, health, food, farm and non-farm sectors. The CSIR institutions having a direct bearing in the **sector of societal goods and services** reported several achievements, namely, development of a novel hybrid Reverse Osmosis unit for desalination of highly saline seawater (a solar power operated community reverse osmosis desalination unit is of much benefit to those areas where electricity supply is not reliable and stable); an easy to assemble, light weight instant house for disaster victims; a new cultivar of haldi himhaldi - as a substitute of turmeric for bruises, corns and sprains; bio-village approach for widespread cultivation of aromatic and herbal plants; and a new variety of coffee species having low caffeine. Yet another contribution in the societal goods and services sector is development of a simple cost effective raft cultivation system for the sea weed *gracilaria edulis* from which agar is extracted, which is used as the chewing agent in food, confectionary, softdrinks, etc.

Strategic sector has always been of importance for a few of the CSIR institutions and the output reported has been of considerable technological

importance, such as development and fabrication of MEMS, Acoustic sensors used in Satellite launch vehicles; Vacuum Enhanced Resin Infusion Technology for weight and cost reduction of the aircraft parts, especially of wings; development of Drishti - a transmission meter for runway visibility indication; and development of a production standard Aircraft SARAS. CSIR strategic presence extends to the domain of materials, minerals and energy as well. Some of the developments during the period include optical fibre based temperature sensors having applications in power transmission and a novel process for making low cost, non-toxic, highly effective shielding material for attenuating x-ray and gamma radiations utilizing industrial waste of red mud and fly ash.

Ever since its establishment, CSIR has been catalyzing the growth of many of the industries, i.e., creation of **public and private goods and services**. This covers the distinct, yet cognate, areas of biology and biotechnology, chemicals and drugs and pharmaceuticals sectors, all of which fuel industrial growth. In these areas, CSIR has a traditional strength. Some of the new drugs and pharma related developments include processes for high level production of clot specific streptokinase and recombinant staphylokinase-two potent thromobolytics. The technologies have since been licensed for commercialization. Another achievement in this area relates to development of herbal formulation from Murraya koengii and Tribulus terrestris, useful for the treatment of prostate cancer. Yet another development is an all purpose skincare cream formulation with aloe vera as base which useful in wound healing and as antifungal formulation. In this sector some other notable achievements have been the development of a high yielding variety of *foeniculum vulgare*, whose essential oil is much coveted in culinary articles, cordials and toilet articles. Likewise, a process for extraction of virgin coconut oil which is colourless, having an intense coconut aroma, has been much appreciated as a functional food and which also acts as antibacterial, antiviral and antifungal agent. In the area of environment, a three step tanning methodology, which is a near zero waste water discharge leather processing technology, has been well appreciated by industrial stake-holders. Another environment friendly technology is a process for heptafluoropropane which is a substitute for halon, a chemical used in fire fighting. Based on yet another CSIR technology, a plant using a catalytic process for the manufacture of epichlorohydrin from allyl chloride has been commissioned in Thailand, which is a first plant of its kind.

CSIR's contributions to the growth of core knowledge have also been noteworthy. Development of hardware and software for monsoon forecasting, in-silico drug target identification, predicting the crystal structure of lysine epsilon-aminotransferase, which is a target for latent TB; creation of Indian genome variation consortium database having immense implication in predictive and preventive medicine, are a few of such achievements. Besides, CSIR's basic research contributions have maintained a rising trend with 3488 research papers in SCI journals of national and international repute during the year compared to 3018 in the previous year. The Average Impact Factor per paper stands at 1.983. Many research papers were published in topmost journals, viz., 'Science', 'Cell', 'Nature' in Biological Sciences; 'Chemical Review', 'Angew Chemicals International' in Chemical Sciences; and 'Physics Review Letters', 'Journal of Applied Crystallography', 'Applied Physics Letters' in Physical Sciences. Upholding its commitment to the challenges of IP related matters, CSIR filed 655 patents abroad and 169 patents in India, whereas it has been granted 316 patents abroad and 262 in India. It has secured 21 copyrights as well.

RESOURCE BASE: 2006-07

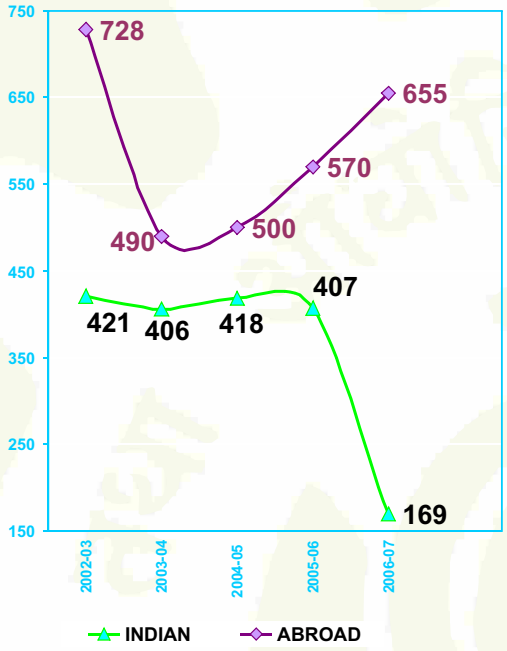
1.	**Infrastructural Resources**	**Number**
	• Laboratories/Institutes	38
	• Outreach Centers	39
2.	**Human Resources**	
	• Total Staff	17432
	• Total S&T Staff	12556
	» Scientists (Group IV)	4555
	» Technical (Group III)	2887
	»Technical (Group II+I)	5114
	• Total Administrative & non-technical (including isolated staff strength)	4876
3.	**Financial Resources**	**Rs. Crore**
	• Government budgetary support	1710
	» Government plan allocation	940
	» Government non-plan allocation	770

PERFORMANCE INDICATORS: 2006-07

1.	**Science Output**	**Numbers**	
•	Papers contributed		
	» Number	3488	(3018)
	» Average Impact Factor per paper	1.983	(2.007)
•	**Patents**		
	» Filed in India	169	(407)
	» Filed abroad	655	(570)
	» In force in India	1413	(1147)
	» In force abroad	1333	(1205)
2.	**National S&T Human Resource Development**		
	» Research Fellows/Associates Supported	7009	(7075)
	» Emeritus Scientists in position	116	(125)
	» Pool Scientists (SRAs) in position	157	(150)
	» Research Schemes supported	793	(769)

Figures in parenthesis correspond to the previous year 2005-06

PATENTS FILING



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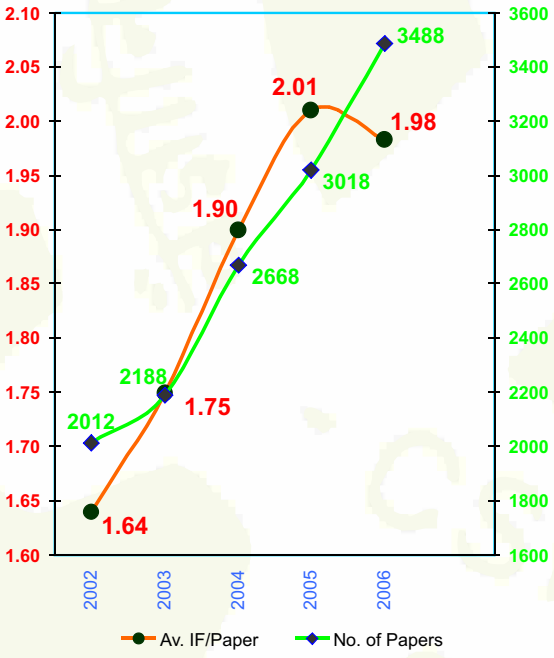


CSIR's knowledge output during the period 2002 - 03 to 2006 -07

S&T CONTRIBUTIONS


CSIR-INDIA

1.0. S&T CONTRIBUTIONS

Research on the fundamental or basic aspects of science is not only the major source of advancement of knowledge in science, but it also provides the building blocks for development of newer generic technologies for the future. CSIR continuously upgrades its core competencies and plans new research areas to lead the S&T developments primarily within the country and occasionally abroad. Its area of influence encompasses aerospace science & technology, modern biology and biotechnology, chemistry, geophysics, oceanography, materials science, etc.

During the Tenth Five Year Plan (TFYP), CSIR experimented with a model in which resources available with various laboratories were pooled together to achieve technological excellence. CSIR conceptualized and implemented 56 such network projects during Tenth Plan. 2006-07 being the terminal year of TFYP, majority of these network projects have been completed successfully; however, some projects are permitted to spill over for a year or two into the Eleventh Five Year Plan for their completion.

CSIR is not only the flag bearer of India's S&T processes, but also contributes significantly in developing research manpower. It does so by funding extramural research through its various fellowship schemes and through inducting thousands of young students to carry out their research programmes in its laboratories. Many of CSIR scientists have continued to contribute in shaping India's S&T policy initiatives in diverse science domains.

Some of the significant achievements of CSIR are described in the following sections devoted to Aerospace Science & Technology (1.1), Biology & Biotechnology (1.2), Chemical Sciences & Technology (1.3), Earth Sciences & Natural Hazards Assessment (1.4), Ecology & Environment (1.5), Electronics & Instrumentation (1.6), Energy (1.7), Food & Food Processing (1.8), Health Care, Drugs & Pharmaceuticals (1.9), Housing & Construction (1.10), Information Dissemination & Products (1.11), Leather (1.12), and Materials, Minerals, Metals & Manufacturing (1.13). Each of these sections describes major S&T achievements, progress made under Network mode projects, human resource development activities and recognition and awards received by the scientists of the labs coming in the respective sections.

1.1. Aerospace Science & Technology

CSIR is a major player in India's aerospace programmes. Its constituent laboratory, NAL, Bangalore has developed a world class capacity for design, development and fabrication of advanced composites for civilian and combat aircraft, aerospace electronics and systems, structural testing and analysis, innovative capabilities in surface engineering, etc. The activities in this sector are focused on design, development, fabrication and airworthiness testing of small civilian aircraft, and on creating, maintaining and providing expertise and test and certification facilities.

1.1.1. Scientific & Technological Achievements

Flight testing of SARAS aircraft

The first SARAS prototype aircraft (PT1) VT-XSD (Fig. 1.1) completed 56 test flights during the year (total 106 successful test flights so far). Basic handling qualities, Pressure Error Correction (PEC) test data, Parameter Identification Data (PID) test data, climb performance data, etc., have been obtained and evaluated.

The second SARAS prototype aircraft (PT2) VT-XRM has been fully integrated and has successfully completed low speed and high speed taxi trials.

Fig. 1.1: 100th flight of SARAS (PT1) at the AeroIndia 2007

Fig. 1.2: Skin splice parts and assembly

Fig. 1.3: Nose radome for jaguar aircraft

Fig. 1.4: Thermal barrier lining to steel pipe

Fig. 1.5: NALVAS showing the capability for aircraft models with ILS operation

Vacuum enhanced resin infusion technology

NAL has developed a Vacuum Enhanced Resin Infusion Technology (VERITy) process for manufacturing of advanced composites. An aircraft wing prepared using this new process would result in a weight saving of about 10% on the optimized metallic wing with a cost reduction of about 20%. Some of the advantages of the VERITy process are: relatively low cost for low volume production (significant reduction in cost when compared to autoclave-moulding cost), elimination of the need for clean rooms and expensive cold storage facilities (-18°C).

A Test Box (2.3 mx1.2 m) has been designed to prove the VERITy process and test the skin and spar splices with closely simulated conditions as well as to verify the adequacy of the sealing mechanism for the inter spar box joints (integral fuel tank area) and access covers. Some of the components made out of VERITy process are displayed in Fig. 1.2.

Rapid resin injection moulding technology

Another novel and cost effective technology developed by NAL is for the rapid resin injection moulding process. Flight-worthy nose radomes for Jaguar fighter aircraft have been designed, developed and fabricated by NAL for Hindustan Aeronautics Ltd. (HAL) / Indian Air Force (IAF) incorporating the above technology (Fig. 1.3). These radomes are further qualified to the stringent military specifications and have been cleared as flight-worthy. This has given an insight into the intricacies of composite radome engineering and has created a base for indigenizing the requirements of IAF for other fighter aircrafts. This competence is being used to propose development of an indigenous radome for SU 30 fighter aircraft.

Ceramic thermal barrier linings

For providing ceramic thermal barrier lining for strategic applications on axi-symmetric metal components, NAL has developed a novel technique using exothermic reactions under the effect of centrifugal force. This process makes the material immune to corrosion and erosion. The lining (Fig. 1.4) helps the material to withstand high temperatures of the order of 3000K. Another spin-off of the technique is the zirconia based ceramic insert, which has been developed for rocket thrusters. This near-net shaped casting has good thermal shock resistance and high temperature hardness. This technology is of a great strategic value for rocket and missile applications.

NAL visualization and animation software (NALVAS)

Another notable achievement from NAL is a software for incident and accident analysis of aircrafts along with the routine flight data analysis, which is a mandatory activity as per guidelines of the Director General of Civil Aviation for every scheduled airline. The tool unfolds the actual behavior of aircraft during flight in terms of events, exceedances and limits visually, instead of numbers and figures. The use of this software greatly enhances the air safety and mandatory quality assurance requirements. NALVAS is a configurable windows concept which can be configured the way user would like to see the windows during operation (Fig. 1.5).

1.1.2. Progress made under Network Projects

Some of the significant achievements detailed project-wise are:

I. Catering to specialised aerospace materials

The objective of the project is to formulate and execute a structured programme on

development and characterization of different specialized aerospace materials and to provide materials related technological services to aerospace organizations. Following are some of the materials developed under the project.

Convergent-Divergent nozzles used in strategic application have been lined with ceramics capable of withstanding temperature of 1600 to 1800°C. The nozzles have been tested in the Defence R&D Laboratory (DRDL) test bed and the performance of the coated nozzles was found excellent. The nozzle did not show any damage even after 22 seconds of firing (against a target of 20 sec) and there was no significant pressure loss for the entire duration of the firing. Pressure sensitive paints for measurement of the air pressure distribution over models during wind tunnel testing developed by NAL have successfully withstood endurance of over 50 blowdowns without any change in their sensitivity.

Billets of Mg-Al-Zn (AZ31) and Mg-Re-Zn-Zr (L126) alloys with size of 70 mm dia and 50 mm height were fabricated using spray forming technique. These billets have shown excellent compositional uniformity, low porosity and good mechanical properties.

A major development under this network project is the establishment of a state-of-the-art failure analysis laboratory, which facilitates failure investigations for IAF, Aerospace industries and Defence R&D labs. It has helped in providing critical data on failure investigations and courts of enquiry. Incidentally, NAL has completed the 1000th failure investigation during the current year.

II. High science & technology for national aerospace programmes

The main objectives of this programme are to enhance the capabilities for generating crucial design and certification data for aerospace systems; to enhance the knowledgebase through R&D activity for increased self-reliance and freedom; and to build up new and critical facilities in the area to minimize dependence on foreign test facilities.

Aerodynamics: Aerodynamic data have been generated on hypersonic research vehicle / its components. The most significant achievement is development of hardware for study of multi-jet interaction on after-body drag. The readiness for tethered flight of Remote Controlled (RC) Blimp has been tested at Aerial Delivery Research and Development Establishment, Agra.

Aerospace propulsion and energy systems: Detailed component drawings/manufacture of components and critical design review for Wankel engine have been carried out. Components have been designed and fabricated for 10 kW gas turbine. A national Test Facility for Rolling Element Bearings is being setup.

Aerospace structures and materials: Sources have been located for manufacture of components for autoclaves and related accessories for demonstration of adaptive wing technology. A customised un-balanced magnetron sputtering system has been commissioned. Hard nano layer coatings were done on sample cutting tools.

Aerospace electronics, controls and systems: Active Noise Control (ANC) for Tejas combat aircraft cockpit has been developed. The Tejas aircraft cockpit and the helicopter cabins have a serious problem of high noise levels. It affects health of the pilot and also causes inconvenience in communication. Algorithms used for the active noise control play a crucial role in reducing the noise level in the active noise

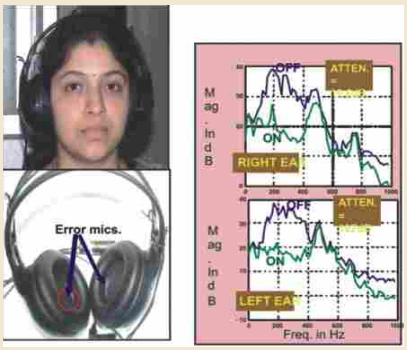


Fig. 1.6: Head set with active adaptive noise control for broadband noise.

Fig. 1.7: Parts manufactured for the landing gear actuators

Fig. 1.8: PT6A-67A engine and MT Propeller mounted on the Engine test rig

control systems used. NAL has designed and developed hardware and software (algorithms) for addressing this problem and noise reduction of 15 dB has been successfully achieved in the head phones of pilots (Fig. 1.6). This work is being attempted for a full aircraft. Active noise control is being attempted for the fighter aircraft cockpits and helicopter cabins.

III. Spearheading small civilian aircraft design, development & manufacture

The main objectives of the project are to design and develop stretched HANSA; civil aircraft R&D; indigenous development of critical Line Replaceable Units (LRUs) withParticular relevance to small aircraft; and weight optimization and other improvements of SARAS to production standards.

An MoU has been signed with M/s Mahindra Plexion Technologies, Bangalore for joint development of 4-seater HANSA aircraft. Also, a contract has been signed with M/s. Honeywell Technologies, Bangalore for the joint development of digital autopilot for the SARAS aircraft.

The design review for nose and main landing gears for the production version of SARAS have been carried out. A number of components were manufactured for the landing gear actuators (Fig. 1.7).

The first phase of optimization of nacelle, stub wing and engine mount has resulted in a weight reduction of around 30 kg

Three engines (PT6A-67A) with a power rating of 1200 SHP at 1700 RPM have been procured from M/s. Pratt and Whitney, Canada (Fig. 1.8). In addition, four pusher propellers rated at 1200 SHP at 1700 RPM were procured from M/s. MT Propeller, Germany. The 120 hrs of endurance tests for this Propeller-Engine combination, for certification as per JAR-33 regulations, were completed successfully in an engine ground test bed located at NAL. A flow computational programme for a transport aircraft in flight has been jointly worked out by NAL and the Cambridge University.

1.1.3. Recognition & Awards

Recognition and awards received by CSIR scientists in the area of Aerospace Science & Technology are listed below:

Distinguished Alumnus Award" of the Indian Institute of Technology, Kharagpur, for 2006 Member of the Board of Governors of Engineering Council of India (2006-2008)	Dr. AR Upadhya, NAL
1st IETECorporate Award instituted by the Council of the Institution of Electronics and Telecommunication Engineers (IETE)	Drs. AR Upadhya, TG Ramesh, V Shubha, NAL
The Title of Honorary DAAD Advisor (2006-2009)	Dr. GK Suryanarayana, NAL
Fellow of National Academy of Engineering (FNAE)	Dr. RMVGK Rao, NAL
Fellow of National Academy of Engineering (FNAE) Raman Research Fellowship	Dr. K Yegna Narayan, NAL Dr. R Mukund, NAL

1.2. Biology & Biotechnology

CSIR has emerged as a leading public funded R&D agency with many of its laboratories contributing significant R&D outputs and technologies in the areas of genomics, proteomics, molecular biology, immunology, biomarkers, biomolecules, etc. Some of the major accomplishments are listed below

1.2.1. Scientific & Technological Achievements

Engineering of host-defense antibacterial peptides as therapeutic agents

CCMB has investigated the antibacterial activities of synthetic human β - defensin analogs, constrained by a single disulfide bridge and in the reduced form. The peptides span the carboxy-terminal region of human β - defensins HBD-1-3, which have a majority of cationic residues present in the native defensins. The disulfide - constrained peptides exhibited activity against Escherichia coli and Staphylococcus aureus, whereas the reduced forms were active only against Escherichia coli. The antibacterial activities were attenuated in the presence of increasing concentrations of NaCl and divalent cations such as Ca^{2+} and Mg^{2+}. The site of action was the bacterial membrane. A 13-residue peptide present in mammalian neutrophils, which has both antibacterial and hemolytic activities, has been engineered such that only antibacterial activity is exhibited by the modified peptides. Since this research has important impact in the development of antibacterial peptides as therapeutic agents, a US patent has been secured.

Role of RNAi in animal development

CCMB & IICT have jointly unraveled the molecular mechanism associated with developmental abnormality in Drosophila, which is required for dynamic chromosome movement. This abnormality causes various birth defects, most common cancers including brain tumor and other fatal neuro-degenerative diseases. The normal function of several genes eliminates irreparable abnormalities. A genetically well-developed model system- fruit fly- was compared to understand the fundamental relationship of different developmental and segmentation genes, which are conserved in all animals including mice, flies and human (Fig. 1.9). It has been demonstrated that RNAi-based silencing machinery is required for establishment and maintenance of silencing state of different segmentation genes and developmental regulators. It is proposed that RNAi plays an immense and novel role in guiding complex animal formation during development and eliminates several fatal diseases in embryo. Further, results show that preferential switch "on and off" of different developmental genes is controlled by RNAi machinery. In future, this might help to repair different birth defects by controlling the RNAi machinery. It paves a new beginning for generating different types of RNAi-based therapies for birth defects.

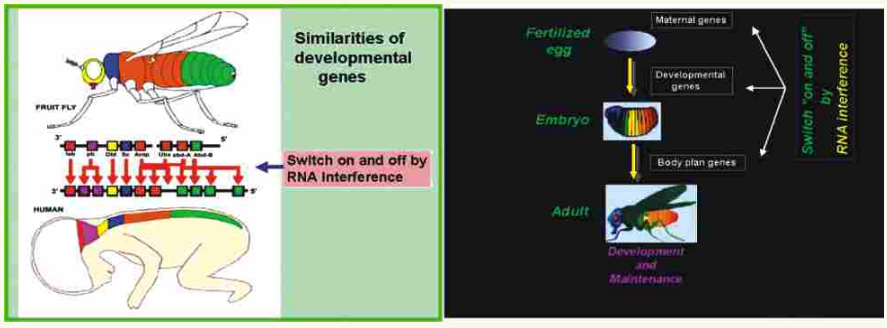


Fig. 1.9 : Role of RNAi in animal development

Genomic packaging and nuclear architecture

Eukaryotic genomes carry a complex set of regulatory elements that control the genes to allow development and functioning of such organisms. A key feature of this regulatory process is that packaging of the genome itself has influence on expression of genes. CCMB has characterized components of nuclear matrix at molecular level. Among the proteins of the nuclear matrix, a protein has been identified, known as boundary- element-associated factor (BEAF). It was earlier known to be the component of chromatin domain boundary. One of the major unsolved problems in this field is how genome is repackaged after every cell cycle in such a way that global expression state is maintained and how cells remember the epigenetic state in absence of early developmental regulators? It has been shown that BEAF remains associated with the genome even after the nuclear envelop has disintegrated. Further, it has been shown that BEAF remains associated with various mitotic components suggesting a link between genomic packaging and nuclear architecture that can serve as a structural platform for epigenetic memory. It is known that loss of such memory can lead to a variety of disease situations, including cancer.

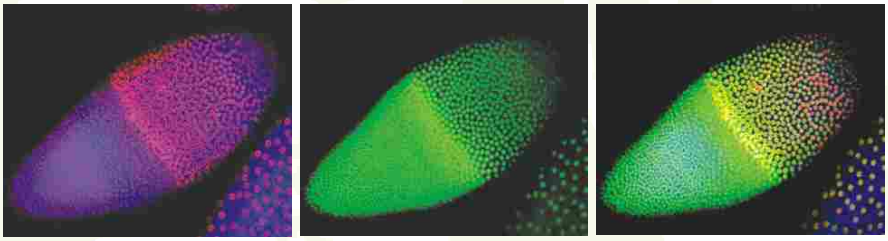


Fig. 1.10: Early Drosophila embryo stained for genome packaging protein, BEAF (green), DNA (blue) and nuclear envelop component lamin (red). The embryo shows mitotic wave going from left to right showing that in the regions where lamin has disappeared, BEAF still remains associated with the genome. The picture on left shows DNA and lamin, that in the middle shows BEAF and the right one shows a merged image of embryo

CLIV-92, the hepatoprotective phytoceutical

CIMAP has tested CLIV-92, a hepatoprotective molecule, for its effect on the pro- and anti-inflammatory cytokines. Pro-inflammatory mediators (IL-6, TNF-α and nitric oxide) were significantly inhibited in a dose - dependent manner when compared with macrophages stimulated with LPS alone ($P < 0.05$). The anti-inflammatory cytokine (IL-4) productions from spleenic lymphocytes culture supernatant were found to be enhanced in mice administered with CLIV-92 when compared with Con-A alone ($P < 0.05$). These results suggest that CLIV-92 can augment the protection of liver stressed by the intake of chemotherapeutic agents by inhibiting the expression of pro-inflammatory cytokinines.

CIMSujal: high yielding variety of fennel

CIMAP has developed the cultivar CIM-Sujal of fennel Foeniculum vulgare through intensive breeding efforts for high yield of seeds and essential oil of better quality. The Fennel family; 'Apiaceae', is important for its seeds and essential oil. The seeds are used to flavour liquors, vinegars, breads, pastries, candies and pickles. Leaves and stems serve as vegetable, salad or potherb. The essential oil is used in culinary articles, cordials and toilet articles. Besides above, it is also used in Indian, Folk and Unani systems of medicine as abortifacient, carminative, cardio tonic, stimulant, vermicide, lactagogue, etc. The seeds are also regarded as aromatic, carminative, emmenagogue, and stimulant and stomachic almost anywhere where the spices are encountered. The variety CIMSujal consistently shows high seed and oil yield in all field evaluation yield trials. The average seed and oil yield of this variety is about 9.73 quintal and 22.87 kg/ hectare, respectively with high t-anethole content (75-80 %)

and low fenclione content (8.08 %), respectively. The variety will find direct use in herbal preparations and nutraceuticals in addition to its spice value and also as a source of anethole for industrial cultivation.

Aloe vera - based all-purpose cream

An effective all-purpose skin care cream formulation, named H Aloe Skin, has been developed and released by CIMAP. The cream possesses wound healing and anti-fungal properties and can also be used to cure cracks in heels, chapped hands and dry skin. It is an herbal formulation, derived from age-old traditional skin recipe from a plant extract that is known for its healing activity and an essential oil, which has shown a promising anti-fungal activity. The cream is pharmaceutically more elegant, because it contains water-washable cream base in order to give a smooth and soft feeling on application. The technology is available to industry for its commercial exploitation.

Effect of altitude on primary products of photosynthesis

IHBT has reported for the first time a change in primary products of photosynthesis and the associated enzymes with change in altitude that could have functional advantages at high altitude (HA). There is not much information available on the primary products of photosynthesis and the change in the activity of the associated enzymes with altitude. Varieties of barley and wheat grown at 1300 m (low altitude, LA) and 4200 m (HA) elevations above mean sea level in the western Himalayas were studied. Plants at both the locations had similar photosynthetic rates, leaf water potential and the chlorophyll fluorescence kinetics. The short-term radio-labelling experiments in leaves showed appearance of $^{14}CO_2$ in phosphoglyceric acid and sugar phosphates in plants at both the LA and HA, suggesting a major role of ribulose-1,5-bisphosphate carboxylase/oxygenase (Rubisco) in CO_2 fixation in the plants at two altitudes, whereas the appearance of labelled carbon in aspartate (Asp) and glutamate (Glu) at HA suggested a role of phosphoenolpyruvate carboxylase (PEPCase) in photosynthesis metabolism. Plants at HA had significantly higher activities of PEPCase, carboxylase and oxygenase of Rubisco, aspartate aminotransferase (AspAT), and glutamine synthetase (GS). However, the activities of malate dehydrogenase, NAD-malic enzyme and citrate synthase were similar at the two locations. Such an altered metabolism at HA suggested that PEPCase probably captured CO_2 directly from the atmosphere and/or generated it metabolically, e.g., from photorespiration at HA.

New cultivar of Curcuma aromatica (HIMHALDI)

Yet another development of significance for hilly regions is the development of a new cultivar of Curcuma aromatica "HIMHALDI" by IHBT, which is suitable for cultivation in western Himalaya at locations above 1300 m altitude. The rhizome is light yellow (internally orange red) in colour and possesses a camphoraceous odour. Curcuma aromatica is some times used as a substitute for turmeric, but not as a condiment. Curcuma aromatica has vast ethnobotanical value, already known in India as a tonic, carminative, antidote to snake bite, astringent and is used for treating bruises, corns and sprains. HIMHALDI (Fig. 1.11) is raised by planting rhizomes. Plant is distributed in the Himalaya at 1000-2500 m altitude. On an average, 200 kg oil/ha is produced from 60 ton raw material (fresh rhizomes) after two years. Total cost of production/ ha (for two years) is Rs.70,000 - 1,00,000 / ha. Benefit to cost ratio (BCR) is 1.39.

Fig. 1.11: Himhaldi

Popularization of Alstroemeria

Alstroemeria (Alstroemeria hybrida) is an exotic high value cut flower crop. IHBT has standardized agrotechniques including nutrition requirement, plant spacing, time of planting, method of propagation, method of planting, impact of shoot thinning, irrigation, etc., for flowers production for Himachal Pradesh and other hill states. Agrotechnologies for cut flower as well as planting material production have been transferred to growers through training and demonstration plots. Three demonstration plots were set up, one each at Kangra and Kullu districts and IHBT. Growers are earning good returns by sale of alstroemeria flowers in domestic flower markets.

LeishMan topoisomerase I-an unusual enzyme

The active site tyrosine residue of all monomeric type IB topoisomerases resides in the C-terminal domain of the enzyme. Leishmania donovani possesses unusual heterodimeric type IB topoisomerase. The small subunit harbors the catalytic tyrosine within the SKXXY motif. To explore the functional relationship between the two subunits, IICB has replaced the small subunit of L. donovani topoisomerase I with a C-terminal fragment of human topoisomerase I (HTOP14). The purified LdTOP1L (large subunit of L.donovani topoisomerase I) and HTOP14 were able to reconstitute topoisomerase I activity when mixed in vitro. This unusual enzyme, 'LeishMan' topoisomerase I (Leish for Leishmania and Man for human), exhibits less efficiency in DNA binding and strand passage compared with LdTOP1L/S. But fusion of LdTOP1L with HTOP14 yielded a more efficient enzyme with greater affinity for DNA and faster strand passage ability. Both the chimeric enzymes are less sensitive to camptothecin than LdTOP1L/S. Restoration of topoisomerase I activity by LdTOP1L and HTOP14 suggests that the small subunit of L. donovani topoisomerase I is primarily required for supplying the catalytic tyrosine. Moreover, changes in the enzyme properties due to substitution of LdTOP1S with HTOP14 indicate that the small subunit contributes to subunit interaction and catalytic efficiency of the enzyme. Engineering of a hybrid 'LeishMan' topoisomerase I, from Leishmania and human provides an ideal chimera for drug development.

Interaction between IL1B gene promoter polymorphisms

It has been speculated that IL-1 genes play a crucial role in the genetic predisposition to duodenal ulcer upon H. pylori infection by modulating the host immune response. IICB has studied 310 individuals from Eastern India to determine the IL1B and IL1RN risk genotypes to H. pylori mediated duodenal ulcer. An analysis of genotype frequency revealed a significantly higher frequency of genotypes in H. pylori-infected individuals with duodenal ulcer compared to infected individuals with normal mucosa. Quantitative analysis of the mucosal IL1B mRNA revealed that among H. pylori-infected individuals, carriers of the -31CC genotype had significantly lower IL1B transcript levels than carriers of the CT ($P < 0.001$) and TT ($P < 0.001$) genotypes, independent of disease status. The results also show that H. pylori-infected individuals with the -31CC genotype secrete less IL1B and are susceptible to duodenal ulcers. It has been further suggested that the allelic interaction between the -511 and -31 polymorphic sites determines the overall strength of the IL1B promoter.

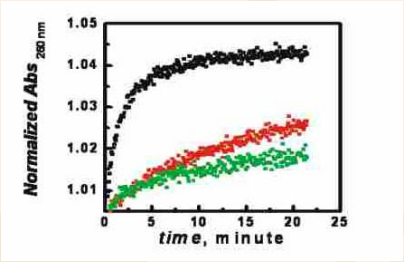


Fig. 1.12: RNase digestion assays for native RNA (black), HP/RNA complexes at Z+/- 3 (red) and 5 (green).

Water-soluble nanoparticles from PEG-based cationic hyper branched polymer

The research involving RNA molecules faces a practical limitation, since RNA is highly labile. IGIB has developed a novel method to protect RNA from cleavage by complexing it with a hyper branched cationic polymer (Fig. 1.12). For this, the property of total cellular RNA isolated from yeast to form a spherical nano particle morphology was used. This interaction protects the RNA against enzymatic degradation and, hence, can be easily adopted for long-term storage of RNA, long distance transfer of RNA, and genetic engineering using RNA as a building block.

Functional delivery of a cytosolic tRNA into mutant mitochondria of human cells

Many maternally inherited and incurable neuromyopathies are caused by mutations in mitochondrial (mt) transfer RNA (tRNA) genes. Kinetoplastid protozoa, including Leishmania, have evolved specialized systems for importing nucleus-encoded tRNAs into mitochondria. IICB found that the Leshmania RNA import complex (RIC) could enter human cells by a caveolin-1-dependent pathway, where it induced import of endogenous cytosolic tRNAs including tRNA(Lys), and restored mitochondrial function in a cybrid harboring a mutant mt tRNA(Lys) (MT-TK) gene. The use of protein complexes to modulate mitochondrial function may help in the management of such genetic disorders.

Genome-wide prediction of G4 DNA as regulatory motifs: role in Escherichia coli global regulation

IGIB has established the role of DNA structure in transcription on a genome-wide scale using the G-quadruplex (G4 DNA) motifs as a model. Analysis of more than 61,000 open reading frames(ORFs) across 18 prokaryotes has shown the enrichment of G4 motifs in regulatory regions and indicates its predominance within promoters of genes pertaining to transcription, secondary metabolite biosynthesis, and signal transduction. Therefore, it has been predicted that G4 DNA may present regulatory signals and induce the super coiling sensitivity for >30 operons in E. coli, implicating G4 DNA in DNA-topology-mediated global gene regulation in E. coli.

Recombinant human epidermal growth factor: from bench to bedside

The study of biology of wound-care at IGIB has led to the development of a range of advanced, genetically tailored therapeutic products, like growth factors. The epidermal growth factor, produced by salivary glands, enhances healing of diabetic foot ulcer, which is a major complication of diabetes. People with diabetes show a 5 to 50-fold higher risk of non-traumatic amputation compared with non-diabetics. In general, diabetic foot ulcers are difficult to heal, become readily infected & gangrenous and frequently lead to amputation. Through a public-private partnership between IGIB, Delhi and BBIL, Hyderabad, two important formulations have been commercialized: one under the brand name Regen-D^{TM}-60 for skin graft and burn injuries, and the other under the brand name Regen-D^{TM}-150, for diabetic foot ulcer.

New variety of Withania somnifera

A new variety of Withania somnifera designated as NMITLI 002, which is both genetically and chemically stable, has been developed by IIIM (Fig. 1.13). The root and leaf biomass produced by this high yielding variety is 8-10q/ha and 16-17q/ha, respectively. From multilocational trials at two varied locations, that is Jammu and Bhopal, it has been established that this variety can adapt to varied environmental

Fig. 1.13: Flowering plant and roots of New variety of Wathania somnifera

conditions and is stable in terms of both root yield and withaferin A content. Chemical consistency of the genetically pure lines developed from this variety has been established on the basis of ten bioactive markers. Pharmacological activities (Immunomodulatory and anticancer) of roots and leaves of this variety indicate high promises of yield.

Piperine, a phytochemical potentiator of ciprofloxacin against Staphylococcus aureus

In a trial conducted at IIIM, piperine, which was earlier reported as P-glycoprotein inhibitor, has been found to act as bacterial efflux pump inhibitor also. Piperine, when used in combination with ciprofloxacin, increases the activity of the drug by reducing its Minimum Inhibitory Concentration (MIC). This combination also decreases the frequency of mutation thereby decreasing the mutation prevention concentration. The inhibition of accumulation and efflux of ethidium bromide by piperine in the ciprofloxacin resistant mutant confirms its role as inhibitor of bacterial efflux. Several analogues have been prepared. One of the molecules thus developed is 4 times as potent as piperine and inhibits several bacterial efflux pumps. It is a significant step towards the development of combination therapy of anti-infectives to prevent the emergence of resistance.

Rapid plant regeneration of chlorophytum arundinaceum Baker- an endangered medicinal herb

An efficient in vitro multiplication system via multiple shoot bud induction and regeneration in Chlorophytum arundinaceum using shoot crown explants has been developed at IIIM. Optimum regeneration frequency (87%) and desirable organogenetic response in the form of de novo organized multiple shoot buds without an intervening callus phase was obtained on MS minimal organics medium. Axenic secondary explants with multiple shoot buds on subculturing elicited best response with 1 x 10^{-5} M Kn and 5 x 10^{-6} M IBA giving rise to an average of 18.74 shoots per culture with mean shoot length of 7.6 cm $\pm$ 1.73. Varying molar ratios of either Kn/IBA or Kn/NAA revealed statistically significant differences in regeneration frequencies among the phytohormone treatments. It has been observed that shoot bud differentiation and regeneration are influenced by molar ratios of cytokinin / auxin rather than their relative concentrations. Genetic fidelity was assessed using Randomly Amplified Polymorphic DNA (RAPD), karyotype analysis and meiotic behaviour of in vitro and in vivo plants. Five arbitrary decamers displayed same banding profile in all the micropropagated plants and in vivo explant donor. The cytological and molecular analysis complemented and compared well and showed no genomic alterations in the plants regenerated through shoot bud differentiation. High multiplication frequency, and molecular, cytological and phenotypic stability ensure the efficacy of the protocol developed for the production and conservation of this important endangered medicinal herb (Fig. 1.14).

Fig. 1.14: Multiple shoot bud induction and regeneration in Chlorophytum arundinaceum

Fig. 1.15: Anant Carvone mint growing in fields at Tirunelveli Tamil Nadu

Extension of carvomint in South India

A new improved alternative potential source of l-carvone rich strain (carvone 65-73%) Carvomint (Mentha longifolia L.) Hudson var. incana, developed by IIIM, has been extended to farmers' fields in south India. The genetic stability and consistency of the essential oil production and desired quality of this strain have been proved over a period of three years, while the high adaptive value, faster regeneration and early maturation 100-110 (DAP) are added attributes of the Carvomint. Under north Indian conditions, the yield patterns / economic returns of this new strain are quite promising with 40-45 tonnes of fresh herbage/ha and 160-170 kg of essential oil/ha. This strain also exhibits a significant increase in essential oil production (37%) over spearmint (Mentha spicata), which is a known commercial source of l-carvone. Technology package and guidelines for cultivation, essential oil extraction and market potential have been provided to M/s South Indian Mint & Aromatic Products, Tirunelveli (Tamil Nadu). Approximately 10,000 kg planting material has been supplied to the party to cover 20ha of land in Tamil Nadu during the year (Fig. 1.15). The crop has performed well in terms of essential oil production and its quality characteristics.

Staphylokinase a potent clot dissolving agent

Staphylokinase (SAK), a clot-dissolving agent, has potential clinical applications as a thrombolytic agent for the treatment of mycocardial infarction and ischemic strokes. Its ability to display profibrinolytic activity in a fibrin selective manner is beneficial for thromobolytic therapy. As an extracellular bacterial protein, it is produced by several strains of Staphylococcus aureus. In its native host, SAK is produced in very small amounts along with other toxic proteins; therefore, highly purified preparation of SAK from its native host is difficult to obtain for clinical use. A recombinant system for high level production of this clot-dissolving agent was developed by IMTECH, where staphylokinase encoding gene was genetically engineered to overproduce SAK as a soluble cytoplasmic protein in E. coli. The technology for high yield production of SAK has been developed to produce this thrombolytic agent in gram quantities at fed-batch fermentation. Two - step chromatography was standardized to obtain highly purified preparation of recombinant staphylokinase displaying specific activity for plasminogen activation. Using this technology, large amount of this thrombolytic agent can be obtained in pure form that may be useful for clinical application for thrombolytic therapy.

Alternative pathway of glutathione degradation in Saccharomyces cerevisiae

Gluathione biosynthesis and metabolism proceed through the γ-glutamyl cycle. The degradation of glutathione is usually initiated by the action of γ-glutamyl transpeptidase. IMTECH has provided a genetic evidence for the existence of an alternative pathway for GSH degradation, independent of γ-GT. This was demonstrated through the use of cells disrupted in the ECM38 gene encoding the γ-GT enzyme. S. cerevisiae encodes a single enzyme for γ-GT. These cells retained the ability to utilize glutathione as a sulphur source demonstrating that an alternate pathway for GSH degradation exists in yeast cells. Using a genetic approach, participants in this novel pathway for the degradation of GSH have been identified. This pathway requires the participation of 3 previously uncharacterized genes in S. cerevisiae, viz., DUG1 (YFR044c), DUG2 (YBR281c) and DUG3 (YNL191w).

Although dipeptides and tripeptides with a normal peptide bond such as cys-gly or glu-cys-gly required the presence of only a functional DUG1 gene that encoded a protein belonging to the M20A metallohydrolase family, the presence of an unusual peptide bond such as in the dipeptide, γ-glu-cys, or in GSH, required the participation of the DUG2 and DUG3 gene products as well. The Dug1p, Dug2p and Dug3p proteins were found to form a degradosomal complex, through Dug1p-Dug2p and Dug2p-Dug3p interactions. A model has been proposed for the functioning of the Dug1p/Dug2p/Dug3p proteins as a specific GSH degradosomal complex.

Macrophage cell surface glyceraldehyde-3-phosphate dehydrogenase: a novel transferrin receptor

Glyceraldehyde-3-phosphate dehydrogenase (GAPDH) is known primarily as a cytosolic protein. IMTECH has demonstrated for the first time that GAPDH has a novel cell surface localization in mammalian cells. The studies reveal the presence of an entirely new uptake mechanism for the iron transport protein transferrin into mammalian macrophages, wherein these cells utilize the ubiquitous moonlighting protein GAPDH as a receptor. This mechanism provides an elegant pathway through which this abundant cellular protein is relocated to the membrane for this additional role. It has been proposed that mammalian cell surface GAPDH represents a primitive mechanism for the uptake of iron transport protein that has been conserved in cells. Since GAPDH is a ubiquitous protein, the broader implications of this finding are that in addition to macrophages, this may be an alternative mechanism for iron acquisition in other mammalian cells and tissues. The discovery identifies a new type of ubiquitously expressed transferrin receptor that bears no homology to the two previously known receptors. It has also been established that this receptor is regulated by the levels of extracellular iron.

Collection and compilation of small antigenic molecules

Infectious diseases, tuberculosis in particular, remain the leading cause of human mortality. IMTECH has developed a database for hapten (small molecules) and anti-hapten antibodies. The database would be of great help in identifying functional group(s) in smaller molecules using antibodies and also for the development of immunodiagnostics / therapeutics by providing data and procedures available so far for the generation of specific or cross-reactive antibodies.

Novel rhizosphere competent, high temperature/drought tolerant bacteria

A novel rhizosphere competent, high temperature/drought tolerant Pseudomonas putida strain, MTCC 5279, which has a very good potential for commercialization due to its ability to survive at high temperature, has been isolated at NBRI. This strain will be used to identify and isolate high temperature/drought tolerant gene(s).

Functional genomics of Withania somnifera for gene discovery and drug development

Scientists from NBRI have cloned and sequenced seven full-length genes from Withania somnifera gene family of sterol glucosyltransferase. One of the genes from the family has been cloned and expressed in E. coli. Isoenzymes of SGT were purified from membrane and cytosolic fractions of Withania somnifera leaves. Characterization of these enzymes reveals their role in various biotic, abiotic stresses and withanolide production.

Post-harvest biotechnology for prolonged shelf-life of fruits, flowers and vegetables

Several genes from banana, mango, rose and gladiolus have been cloned and characterized by NBRI, which are thought to be responsible for ripening and softening in fruits and abscission and senescence in flowers. Some of the important genes identified as candidates for future biotechnological uses to improve shelf-life of fruits and vegetables are: genes for ethylene biosynthesis, aminocyclopropane-1-carboxylate (ACC) oxidase and ACC synthase; MaMADS, a homologue of tomato MADSRIN, an important developmental regulator of ripening in tomato; eIF1A, a translational initiation factor; a SIN3 like transcriptional co-repressor; and expansins and pectate lyase that are known to participate in fruit softening. AP2/ERF domain transcription factors that are differentially regulated during ripening and abiotic stresses have been isolated and characterized. An increment of almost ten days in the shelf-life of transgenic tomato carrying an antisense gene of ACC oxidase from banana has been confirmed with second generation of the transgenic tomato variety. The same construct has been introduced in banana in order to develop transgenic banana with a higher shelf-life.

Phytoremediation of metal contaminated environment

Plants of Bacopa monnieri, Ceratophyllum demersum and Hydrilla verticillata could be useful for phytoremediation of metals and metalloids (arsenic, cadmium and lead) from polluted aquatic bodies, as significant accumulation of metals and metalloid was observed in both the plant species without any significant effect on their growth. NBRI scientists have characterized and cloned the gene Phytochelatin synthase, the gene responsible for the synthesis of phytochelatins from *C. demersum*. *Vetiveria zizanioides* (khus khus) and lemongrass (*Citronella citrates*) were found effective in removing metals thereby improving the physico-chemical properties of the contaminated soil. *Sida acuta*, *Cassis fistula*, *Spinacea oleracea* and *Chenopodium album* were found suitable for the decontamination of most of the metals from tannery waste contaminated sites. Vegetables like spinach (Spinacea oleracea) and Bathua (Chenopodium album) grown on tannery waste contaminated soil are, however, unfit for edible purpose due to accumulation of toxic metals, above the prescribed levels.

Synergistic bioinoculant composition

A synergistic bioinoculant composition comprising bacterial strains of accession numbers- NRRL B-30486, NRRL B-30487, and NRRL B-30488 has been developed at NBRI. It is useful individually and also in several possible combinations with each of the strains showing plant growth promotion and phytopathogenic fungi controlling activities, abiotic stress conditions tolerating capability and phosphate solubilization capabilities under abiotic stress conditions. Further, a method of producing the said composition and isolating the said bacterial strains from the cow 'Sahiwal' has also been developed. This being the first report of the isolation of plant growth promoting bacteria from milk, a USA patent (7,097,830 B2) has been obtained for this work.

Improved strain of lemon grass BLI-Arun through hybridization

A new clone of lemon grass developed at NEIST records very good herb yield (ca 35 to 39 t/ha) and 0.8 to 1.12% essential oil on Fresh Weight Basis (FWB). The major constituents of the oil were geraniol (30.5 to 30.8%), citronellol (24.1 to 24.3%), geranial (13.0 to 13.6%) and neral (10.1 to 10.3%). Lemon grass (cymbopogon) is an

important genus of aromatic grasses with about 120 species yielding varied combination of terpenes and non-terpenic phenolic compounds. Lemon grass oil is used in perfumery, cosmetic and pharmaceutical industries and India happens to be the major producer and exporter of lemon grass oil. However, export has declined considerably due to low production and competition from other countries. The reason for low production of lemon grass oil in India was due to non-availability of a strain with high biomass yield, oil and citral content.

A new and superior source of cinnamomum

Cinnamomum verum and C. cassia are used as sources of cinnamon spice. NEIST has identified *Cinnamomum pauciforum*, an indigenous species of Meghalaya having qualities superior to the former. The essential oil content of leaves varied from 3.5 to 4.0%. Twenty five components representing 98.8% of the total oil were identified. The main constituent is cinnamaldehyde (89.85%). The composition of the oil is different from that of essential oils of existing cinnamon sources due to the presence of 3 components (one aldeyde & two diterpene), constituting only 0.3% of the total oil.

1.2.2. Progress made under Network Projects

Network mode of working, wherein several groups of scientists across various CSIR laboratories work on commonly identified research problems, has gained acceptance and admiration of scientists, leading to mutually beneficial synergistic linkages.

Some of the significant achievements, project-wise, are

I. Exploration and exploitation of microbial wealth of India for novel compounds and biotransformation process

The project envisages to exploit microbial diversity of the country using both culture-dependent and culture-independent methods, with the ultimate goal of its commercial exploitation as a major source of biotechnological products and processes.

(a) Culture-dependent approach. Some leads obtained earlier have been actively pursued. Nearly 1200 bacterial isolates have been collected from different ecological niches of the Western Ghats. An armory of well characterized biocatalysts (like lipases/esterases, oxidoreductasaes, monooxygenases, hydantoinases and glycosidases), which are adapted to work at a variety of pH and temperatures, has been prepared. These are useful biotransformation solutions to pharmaceutical, agrochemical and fine chemical industry.

Further, twelve new taxa including two new genera and twelve species from different regions of India have been discovered and the studies published.

In addition, two microbial consortia developed earlier for biofertilizers (phosphate solubilisation, dessication resistance and nitrogen fixation) have been tested under field conditions in two different parts of the country. Another microbial consortium was developed for wastewater and poultry waste treatment and tested at pilot scale level.

(b) Culture-independent approach. In order to exploit the gene pool of uncultured bacteria, 25 metagenomic libraries of different environmental samples were made. Two libraries have been screened using both function-based and sequence-based methods for unique esterases and resistance to salt and arsenic. A few unique genes are being investigated.

II. Molecular biology of selected pathogens for developing drug targets

The project envisages in-depth study of molecular biology of a few pathogens, namely, Mycobacterium tuberculosis, Plasmodium, falciparum, Leishmania donovani, Fungal pathogens (*C. albicans* and *A. fumigatus*), Enteric pathogens (*V. cholerae*, *S. dysenteriae* and *H. pylori*).for developing drug targets.

Mycobacterium tuberculosis. Polypeptide deformylase, nucleoside diphosphate kinase A, peptidyl tRNA hydrolase, enhanced intracellular survival proteins from M. tuberculosis were cloned, over expressed, purified and their biological activity was confirmed. Crystal structure of the adenylation domain of NAD dependent DNA ligase was used for designing inhibitors of the enzyme. Further, robust DNA microarray and proteome analysis protocols were developed.

Plasmodium falciparum. Enzymatic properties of choline kinase, a putative drug target, have been elucidated and a screening assay developed. Three proteins coded by apicoplast genome were identified during the year.

Leishmania donovani. Mitochondrial tRNA binding protein, actin binding proteins were cloned, over expressed, purified and their biological activity confirmed. Some natural products (dihydrobetulinic acid, luteolin, diospyrin and indolyl quinolines) were identified as inhibitors of leishmanial topoisomerases.

III. Developing cell & tissue engineering

The project targets to develop methodologies for growing cells and tissues (of animal origin) in *vitro* and induce them to perform differentiated functions; to develop biomedical devices as substitutes for a defective organ or its parts; to develop methodologies for the transplantation of cells and tissues grown *in vitro* into hosts including humans; and in vitro production of pancreatic β-cells for transplantation in type I diabetic patients.

Plants. Candidate vaccine protein has been produced in the tobacco plant for immunization against rabies.

Animals. A new culture system for growth of limbal cells has been developed from the human eye.

IV. Toxicogenomics of polymorphism in Indian population to industrial chemicals for development of biomarkers

The project aims to understand the molecular basis of the toxic response, identify the biomarkers for toxic exposure, and screen the individuals in the population that are genetically predisposed for differential toxic response. It will help to design suitable strategies for reducing the risk of the chemicals, mitigation and treatment of the toxic response, and adoption of preventive methods for the susceptible individuals.

Polymorphism in the DNA repair enzyme ERCC2 codon 751 is associated with arsenic-induced pre-malignant skin lesions. Specific polymorphisms of gene p53 associated with keratosis in individuals were exposed to arsenic through drinking water. Single Nucleotide Polymorphisms (SNPs) in the gene for epoxide hydrolase showed significant polymorphism (>5%) in Exons 3, 4, 6 and 8. Most notably, a significant association of polymorphism was observed in facor of lung cancer development. 2D-gel electrophoresis of the blood plasma samples from control and lead-exposed rats revealed the proteins that are differentially present in lead-exposed animals. Thus, levels of three proteins, identified as different forms of J-chain of immunoglobulins, decreased after lead treatment. Another protein, identified as 'alpha-chain of Haptoglobin', was found to increase by 2-folds in lead-exposed animals.

V. Designing animals and plants as bio-reactors for proteins & other products

The project envisages designing of transgenic plant, animal and yeast bioreactors to develop genetic transformation technology in novel hyper expression systems, to exploit cells as bioreactors for production of high value biopharmaceuticals and to construct Gtases library for biotransformation (glucosylation) of natural products.

Human AAT gene and cecropin gene from Drosophila melanogaster have been isolated, cloned into TOPO vector and E. coli transformants selected. Processes for purification of AAT and cecropin like proteins from plant tissue matrices have been developed. Chloroplast transformation for potato has been initiated as replication from the technology developed and optimized on Tobacco. Also, the productivity of laccase has been optimized at 5 L fermentor scale. The system is to be employed for the target transgene (therapeutic proteins- AAT, SOD, etc.). Collagen producing sponges have been identified out of the collected germplasm and putative alpha chain of collagen has been demonstrated by SDS-PAGE electrophoresis and Western blotting.

VI. Medicinal plant chemotypes for enhanced marker and value added compounds

The project envisages to enhance the production of around 20 commercially important high value drug molecules present in medicinal plants, viz., Artemisia annua, Acorus calamus, Bicopa monnieri, Cathranthus roseus, Picrorhiza kurroa, etc.

Protocols for Poly (A) +mRNA construction of cDNA libraries of leaf and root tissues, subtractive hybridization and sequencing of ESTs have been developed. A total of 150 ESTs were sequenced. Gene hunting based on EST analyses has led to the isolation of a pathway related gene, namely, Strictosidine β-D-glucosidase (sg) from alkaloid rich chemovar Dhawal. The full length sg gene has been successfully cloned on pUC19 vector and the construct has been named as pCRSG1702.

In another study of Picrorrhiza kurroa, seven genes of the irridoid pathway have been successfully cloned using differential display and degenerate primer approaches. Internal control gene primers have been developed for expression analyses of cloned genes.

In addition, agrotechnology packages in terms of seed rate, cultivation practices, fertilizer requirements, spacing, harvest management, intercropping patterns, etc., have been developed for newly developed chemovars/ chemotypes of Andrographis, Catharanthus, Bacopa, Artemisia, Chlorophytum and Acorus.

VII. Development and commercialization of new bioactives and traditional preparations

The objectives of the project are to discover new single molecules as drugs and take them to the IND stage for diseases of concern to India and to the international community; discover and develop herbals which function through different mechanisms including metabolic activation and are based on synergism; introduce combination drugs including the use of bioenhancers, which themselves are not drugs but increase the effectiveness of the drug; introduce formulations and novel delivery systems, which may be target specific; and discover and develop new herbal pest management agents that influence the pests in the desired fashion but are safe for humans.

The identified promising leads for various disease conditions such as cancer, ulcer, dementia, anti-psychotic, leishmania, etc., are under different stages of developments. An agreement has been signed with M/s Nicholas Piramal for joint development of one herbal formulation for immunostimulotary conditions.

1.2.3. Human Resource Development

CIMAP

- CIMAP Training School of two weeks duration on 'Advanced Instrumentation and Analytical Techniques for Natural Products (AIAT-2006)' was organized, in which 17 participants from different establishments participated.
- CIMAP Summer Training School (CST 2006) of one month duration on 'Techniques and Tools of Biotechnology and Bioinformatics for Graduate and Master level Students was organized in which twenty five trainees from 13 University/institutes participated.
- CIMAP Summer School of 15 days duration on "Molecular Techniques in Bioprospection and Biodiversity Analysis" was held for 14 participants representing 13 different universities/organizations from seven states of the country.
- The seventh CIMAP Winter School (CWS-2006) of ten days duration on "Recent Techniques in Structural and Functional Genomics" was organized. 23 participants representing 12 states were provided an extensive hands-on training in various modern molecular biology and genomics tools.
- Training Programmes on Medicinal and Aromatic Plant Production Technology: Six training-cum-demonstration programmes were conducted in different parts of the country through which 341 persons were provided technical knowledge and guidance for cultivation, processing and marketing of medicinal and aromatic plants and products of economic importance.
- A three-day Regional Symposium-cum-Workshop on "Extraction Technologies for Medicinal and Aromatic Plants" was held from 29th November to 1st December 2006. The workshop was held under the aegis of the "International Centre for Science and High Technology", a constituent of the United Nations Industrial Development organization (ICS-UNIDO), Italy. The workshop was attended by 26 participants from India, Indonesia, Malaysia, Nepal, Sri-Lanka, Thailand and Vietnam of the South-East Asian region.

IICB

- 23 persons from India and neighbouring countries were trained in neuroscience through a 10-day workshop organized at Kolkata.

IHBT

- A three-day Faculty Training & Motivation Programme for school teachers was organized in which sixteen teachers participated.
- A two-day demonstration-cum-training programme on 'Cultivation Technology for Flower Bulb Production' was organized with fifteen participants.
- One-day training programme on 'Plucking Strategies in Relation to Quality Tea Production' was organized for about hundred participants, which included tea growers, entrepreneurs, etc.
- A 12-day training programme on 'Plant Tissue Culture and its Implications' was organized for thirteen participants.

IIIM

- More than seventy engineering / post-graduate students from universities & Colleges were trained in the fields of tissue culture, medicinal chemistry, pharmacology and molecular biology for periods varying from one to six months.
- Two persons from the Department of Drug and Food Controller, J&K and two from Sher-e-Kashmir University of Science & Technology, Jammu were trained in quality control & assurance techniques for testing of drugs and food products.
- Sixty seven meritorious students of J&K state were exposed to field of science under CPYLS programme.

IMTECH

- A long-term training programme (6 months) for M.Sc. & B. Tech. students from the Universities of Calcutta, Panjab, Banaras Hindu, Kurukshetra, Goa, Pondicherry, Aligarh Muslim, Punjabi, Guru Nanak Dev, Devi Ahilya, Calicut, Jawaharlal Nehru, Nagarjuna, Delhi, etc., was conducted wherein a total of 100 students participated.

NBRI

- A number of training programmes were organized on various topics such as 'commercial floriculture', 'dehydration of flowers and floral craft', 'quality production of biopesticide and its use', 'cultivation and processing of medicinal plants used to develop nutraceuticals for SC/ST/ other economically weaker and unemployed women of the rural society', etc.
- For Non-Conventional Energy Development Authority (NEDA) and Railway officials, training programmes were organized on 'Jatropha curcas plantation'.

NEIST

- Science Motivation Programme: A 5-day Science Motivation Programme was organised in the laboratory from 4th to 8th July, 2006. The programme was organised with the aim of motivating the young minds for future scientific pursuit and exposing them to the activities and achievements of science.
- CSIR Programme on Youth for Leadership in Science (CPYLS): A two-day 'CSIR Programme on Youth for Leadership in Science (CPYLS)' was organised in the laboratory during 8-9 November, 2006.

1.2.4. Recognition & Awards

Recognition and awards received by CSIR scientists in the area of Biology & Biotechnology are listed below:

Honorary D.Sc. degree from Deen Dayal Upadhyay Gorakhpur University; LD Sanghvi Oration Award from Indian Society of Human Genetics; Father of DNA Fingerprinting Award from Jaunpur Journalists Association	Dr. Lalji Singh, CCMB

Hindware National Archi Design Award for the best Institutional Architecture of the year 2006 A prestigious international award-Cityscape Architectural Review Award 2006	CCMB LaCONES Building
Member of Editorial Board of Biochimica et Biophysica Acta (BBA) Biomembranes	Dr. A Chattopadhyay, CCMB
Raman Research Fellowship; UK India Education & Research Initiative Award	Dr. K Thangaraj, CCMB
Fellow of Indian National Science Academy	Dr. LS Shashidhara, CCMB
Fellow of the Academy of Environmental Biology (FAEB) Young Scientist Medal for the year 2005 of the Biotech Research Society of India (BRSI)	Dr. S Saxena, CCMB
Elected Vice President, National Academy of Sciences, Allahabad, India Elected President, Medicinal and Aromatic Plants Association of India (MAPSI)	Dr. SPS Khanuja, CIMAP
Eminent Scientist Award of UPCAR, Lucknow Elected Fellow of the Indian Society of Soil Science, New Delhi	Dr. DD Patra, CIMAP
Elected Fellow of the National Academy of Agricultural Sciences (NAAS)	Dr. RS Sangwan, CIMAP
Prof. Hiralal Chakravarty Award for the year 2006-2007	Dr. (Mrs) NS Sangwan, CIMAP
JJ Chinoy Memorial Gold Medal for the significant research in the Field of plant physiology	Dr. AHA Farooqui, CIMAP
Prof. SS Katiyar Endowment Lecture Award	Dr. B Ghosh, IGIB
UCB-ICAAI Young Scientist Award	Mr. P Tripathi, IGIB
Dr. Sita Devi Award	Ms. J Batra, IGIB
President, New Biology Section, Indian Science Congress Association	Dr. RH Das, IGIB
Fellow of National Academy of Sciences, India (NASI) Himachal Kesari Award 2007 for outstanding contribution in Agricultural Sciences	Dr. PS Ahuja, IHBT
Chairman, PCD-18, Flavour and Fragrance, Bureau of Indian Standards	Dr. VK Kaul, IHBT
Fellow of the Association of Microbiologists of India	Dr. G Sahni, IMTECH
National Bioscience Award for Career Development for the year 2006-2007	Dr. JN Agrewala, IMTECH

Member, Expert committee on BT Brinjal & related issues and Genetic Engineering Approval Committee (Ministry of Environment and Forests) Member, Uttar Pradesh State Biodiversity Board President, International Society of Environmental Botanists, India	Dr. R Tuli, NBRI
INSA Medal for young scientists for the year 2006 by Indian National Science Academy.	Dr. SV Sawant, NBRI
Assam Science Society, Ruhini Kumar Barua Memorial Award, 2006	Dr. P Barua, NEIST
Assam Science Society, Durlabh Deka Memorial, Award, 2006	Dr. DK Dutta, NEIST
Chemical Research Society of India (CRSI), Bronze Medal for the year 2004-2005	Dr. NC Baruah, NEIST
J N Baruah Memorial Science Award 2006	Dr. HP Deka Baruah, NEIST

1.3. Chemical Science & Technology

CSIR enjoys immense credibility with the chemical industry, especially in the areas, of agrochemicals, catalysts, and chemical intermediates subsectors characterized by high level of innovativeness. During the year, CSIR's chemical domain laboratories continued to work on projects having significant importance for the niche sector.

Some of the significant achievements of the period under report are presented below:

1.3.1. Scientific & Technological Achievements

Unprecedented $SnCl_2$-mediated cyclization of nitro arenes via N-N bond formation

CDRI has developed a mild, efficient, and one-pot protocol for the intramolecular cyclization of nitro arene substrates using $SnCl_2$. The mechanistic course suggests involvement of a hydroxylamine intermediate in cyclization via N-N bond formation. The versatility of the methodology has been demonstrated by using two nitro arene substrates derived from dihydroisoquinolines and dihydro-beta-carbolines. The intramolecular cyclization led to the formation of indazoles in high yields and purity. The methodology may find wide application in synthesis of heterocyclic compounds using a suitable molecular framework.

Computing shapes of nanocrystals from X-ray diffraction data

CECRI developed an elegant mathematical technique and tested it for computing the shapes of nanocrystals from X-ray diffraction (XRD) data. The shapes/ habits/ morphologies of the crystals present in the material specimen can be generated from the XRD of the specimen. X-ray diffractometer alone can be used to generate both the internal structure and the external shape of crystals.

The invented algorithm provides quantitative information, whereas Transmission Electron Microscope (TEM) and High Resolution Transmission Electron Microscope (HRTEM) yield only visual images. The algorithm is superbly suited to find the crystal shapes of nano-crystals and materials. Crystal shapes can be viewed from arbitrary angles. The invented technique assigns unique Miller indices (hkl) to each of the crystal faces identified.

Novel hexaborides by molten salt technology

Novel rare earth hexaborides have attracted attention because of their interesting physical properties like high electrical conductivity, valence fluctuations and high magnetic ordering. These are promising materials for various engineering applications because of their high melting points, strengths and stabilities. Their high thermal conductivity, ionic bombardment resistance and low work function make them suitable materials as electron emitters in thermal emission cathodes. The electron emitters made up of these compounds are much more desirable as cathodes for higher current density applications.

CECRI has used molten salt technique to produce high purity materials (samarium and neodymium) with precision stoichiometry (Fig. 1.16). Characterization of above materials reveals that 1:6 (Nd: B) composition is more suitable for producing high purity crystals and the remaining molar ratios, namely, 1:8, 1:10, 1:12 are fairly good for producing crystals of NdB_6. The influence of current density has been evaluated and it is found that 1.3 & 2.3 A/Cm^2 produces good quality crystals with maximum yield.

Deposited SmB_6 *NdB_6 Deposit*

Fig. 1.16: Novel hexaborides

Electrolytic production of Ti metal from TiO_2 using molten $CaCl_2$ electrolyte

A process based on electrolytic reduction of TiO_2 to obtain Ti metal using $CaCl_2$ melt by the electro-deoxygenation process has been developed by CECRI. The electrolytic cell was designed and operated at 50A capacity. After a predetermined duration of electrolysis, the cathode was removed and analysed. The cell consisted of inconel retort where the reduction process was carried out. Sintered TiO_2 served as cathode whereas circular graphite tube was anode. The cell operates at 650-700°C with molten $CaCl_2$ as the reductant as well as the electrolyte. The final product serves as intermediate compound of Ti as magneli phase.

Surface acidity of activated acid montmorillonite

Scientists from CSMCRI have studied the surface acidity of montmorillonite treated by conventional hydrothermal reaction with acids as well as ultrasonic- and microwave-assisted acid digestion using diffuse reflectance FT-IR (DRIFT) spectroscopy of adsorbed pyridine molecules. An attempt for semi-quantitative measurement of Brønsted acidity generated during the acid digestion was also made. The conventional hydrothermal, ultrasonic- and microwave-assisted acid digestions yield strong Brønsted acid sites of similar nature and strength, which retained pyridine up to 400-450°C. Strong Lewis acid sites have also been developed at higher temperature (>300°C), which were able to retain pyridine at 450 °C. The results show that surface acidity of similar strength can be generated with conventional hydrothermal treatment at 80 °C for 4 hr or ultrasonic-treatment at room temperature for 1 hr or microwave-assisted acid digestion for 10 min using 3N concentration of

H_2SO_4. Therefore, microwave- and ultrasonic-assisted acid digestions are potential and rapid alternative methods to conventional hydrothermal acid digestion for preparing acid-activated clays. The technique offers an alternative method for preparing acid treated clays, which find extensive applications in industry.

Covalently bonded chiral Mn(III) salen complexes as efficient catalysts

Another notable development from CSMCRI has been the preparation of chiral Mn(III) salen complex supported on modified mesoporous supports (MCM-41 and SBA-15) using 3-aminopropyltriethoxysilane as a reactive surface modifier by a covalent grafting method. The supported catalysts show higher chiral induction (ee, 71%) for enantioselective epoxidation of styrene and 4-chlorostyrene in presence of pyridine N-oxide (PyNO) as axial base using aqueous NaOCl (12%) as an oxidant than that seen in the homogeneous counterpart (ee, 48%). SBA-15-based catalyst, with a larger pore diameter, was found to be more active than MCM-41-supported catalyst. In addition, bulkier alkenes like indene, 1,2-dihydronaphthalene, and 2,2-dimethylchromene were efficiently epoxidized with these supported catalysts (ee, up to 96%), and the results were comparable with those for the homogeneous system. It is a novel approach for the heterogenization of chiral Mn(III) salen complex where the performance of the chiral catalyst improved for the epoxidation of styrene as compared to homogeneous system. Epoxides in high chiral purity are required as intermediates for the synthesis of various chiral drugs.

Discrete propeller- shaped undecameric water cluster

Studies on water clusters in host lattice have shown that "discrete" even-member water ring morphologies such as $(H_2O)_n$ (n = 4, 6, 8, 10, 12, 14 &16) are common within the lattice of crystal host. Curiously, little is known of the structural constraints required in stabilizing "discrete" odd-member water cluster morphologies of "higher nuclearity" though trimers and pentamers are familiar in crystal hydrates. This is the first ever report by IICT of a "discrete" propeller-shaped undecameric water cluster.

Heptahydrochloride salt of cryptand encapsulates one chloride inside the proton cage. Crystallographic analysis shows that the cage stablizes the structure of discrete propeller-shaped tricyclic water $[(H_2O)_{11}]$ clusters (Fig. 1.17). This water cluster, oriented symmetrically around the cryptand moiety, interacts with the encapsulated chloride inside the cryptand cavity.

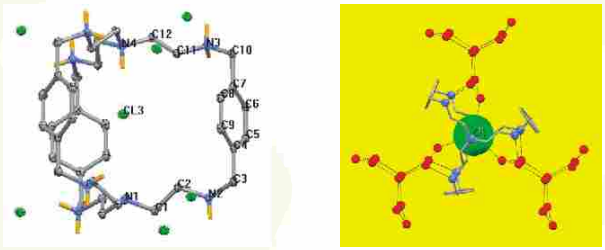


Fig. 1.17: (a) ORTEP diagram of heptahydrochloride salt of octaamino cryptand; (b) encapsulated chloride and its interaction with the discrete $(H_2O)_{11}$ cluster

Solar power operated reverse osmosis desalination unit

The social work and research center (Barefoot college) Tilonia, Rajasthan and CSMCRI, Bhavnagar have jointly developed a solar powered community scale RO desalination unit, which has been installed in the Sambhar Lake area of Rajasthan (Fig. 1.18). The unit is producing 700 liters per hour of drinking water from brackish water containing excess fluoride and catering to the requirement of the entire area.

The electricity to power the unit is generated by 2.5 kW solar panels. This is the first community scale solar powered unit set up in India. Efforts are under way to raise the output of the unit to 1000 LPH. The people in the rural areas where electricity is not available are expected to be benefited the most.

Fig. 1.18: First solar power operated community scale reverse osmosis desalination plant installed in the country

Fig. 1.19: Cultivation of Gracilaria edulis by coastal communities in Andaman islands

Fig. 1.20: Heptafluoropropane plant

Cultivation of Gracilaria edulis in Andaman and Nicobar Islands

CSMCRI has transferred technical knowhow for cultivation of Gracilaria edulis and extraction of agar therefrom to Community Enterprise Forum International (CEFI), which is actively engaged in empowerment of coastal communities in Andaman and Nicobar Islands through development of sustainable community enterprise for livelihood security and poverty alleviation. CSMCRI with CEFI demonstrated cultivation using the raft method and imparted training to end-users in seaweed cultivation, farm maintenance, post-harvesting practices in Andaman and Nicobar, who are farming this alga successfully in Andamans (Fig. 1.19). The geographical conditions are conducive for its growth and the seaweed cultivators can directly reap the benefit.

Improved process for heptafluoropropane

An important contribution from CSIR towards mitigating the ozone layer depletion has been the development by IICT of an improved process for heptafluoropropane (FM-200) at 70 g/hour scale and release of the same to Centre for Environment and Explosive Safety (CEES/DRDO). The technology has been commercialized by M/s Mechvac Fabricators (I) Pvt Ltd., Mumbai. Apart from India, the technology for making heptafluoropropane is available only with the USA. FM-200 is a halon substitute used in firefighting systems. As per the Montreal Protocol, halons should be phased out as they cause depletion of ozone layer. The company has already received advance orders for 500 tonnes of FM-200 and is considering to set up three more facilities to meet the demand. The annual domestic requirement of the gas is around 750 tonnes. M/s Mechvac will be able to provide about 300 tonnes during the first year of operation set up at an initial cost of Rs.10 crore (Fig. 1.20). The market size for this halon substitute is about Rs.150 crore per annum.

V_2O_5-O_2 as a simple and efficient protocol for the oxidative coupling of 2-naphthols to bi-naphthols under mild reaction conditions

IIP studies found vanadium pentoxide to be an efficient catalyst for the oxidative coupling of 2-naphthols to binaphthols using molecular oxygen as the sole oxidant under mild reaction conditions.

The reported methodology is new and environmentally benign for the oxidative coupling of the 2-naphthols to binaphthols using vanadium pentoxide as a catalyst and molecular oxygen as oxidant. Commercial availability of the catalyst, green nature of the oxidant, simple reaction conditions and excellent yields of the products make this an economically and environmentally acceptable tool for the synthesis of binaphthols, which are extensively used as chiral inducing agents in asymmetric synthesis.

Synthesis of styrene-butadiene-styrene (SBS) triblock copolymers

Thermoplastic elastomers take an intermediate position between rubbers, which are soft, flexible and elastic, and thermoplastics, which are rigid. These materials are used as specialty elastomers in adhesives, noise reduction applications, production of foams, films, tapes, and cable sheathing.

NCL, in collaboration with University of Bordeaux, France, has discovered a new dicarbanionic initiator by lithium-halogen exchange reaction of a dibromo compound with sec-butyllithium. This dilithiated initiator is totally soluble in hydrocarbons in the absence of any additive and efficiently generates well-defined polybutadiene telechelics and poly (styrene-b-diene-b-styrene) triblock copolymers with high 1,4-units in the polybutadiene segment. The dibromo compound, viz., 1-bromo-4-(4'-bromophenoxy)-2-pentadecylbenzene used for synthesis of dicarbanionic initiator was derived from 3-pentadecyl phenol, which in turn was obtained from cashew nut shell liquid (CNSL), a naturally occurring plant derived material. This dicarbanionic initiator is totally soluble in non-polar media without any additives, which allowed synthesis of well-defined polybutadiene telechelics with a high percentage of 1,4-PB units (91%). This initiator proved to be very efficient in providing SBS triblock copolymers containing 91% 1,4-microstructure polybutadiene segment with good mechanical properties (ultimate tensile strength higher than 30 MPa and elongation at break of 1000%).

Beating the ferroelectricity limit in barium titanate nanoparticles

Among the ferroelectric oxides, barium titanate has been studied in detail both in bulk as well as in nano-size, but it shows the absence of ferroelectric-tetragonal phase at room temperature when the particle size is reduced below a few tens of nanometer. NCL has synthesized barium titanate particles (5 nm) using a room-temperature fungus-mediated technique in a proper crystalline phase. These particles and their composites in polymethyl methacrylate (PMMA) were investigated for the structural and dielectric properties. It has been demonstrated that it is indeed possible to store electrical information in tiny barium titanate particles, as small as 5 nm, by polarizing them at will (in reverse directions) by using atomic force microscopy probes. The electrical information thus recorded was directly imaged using Kelvin probe microscopy technique. This is a direct evidence of a clear ferroelectric to paraelectric (tetragonal to cubic) phase transition across the Curie temperature that could be shown at such a small size in any ferroelectric material.

Synthesis of oligosaccharides and glycoconjugates

Isolation of oligosaccharide and glycoconjugate biomolecules from natural sources is a complicated task and is often laborious and time consuming; hence, chemical synthesis of oligosachharides is the most sought after technique. NCL has developed a novel transglycosylation methodology for the synthesis of these biomolecules

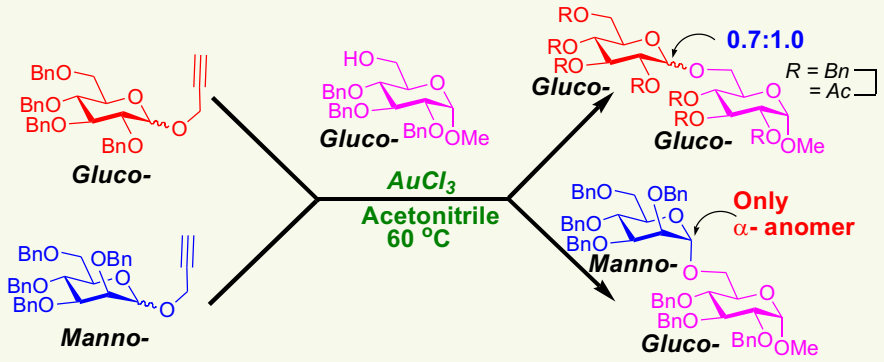


Fig. 1.21: Synthesis of oligosaccharides and glycoconjugates

exploiting a gold catalyst (Fig. 1.21). The procedure developed at NCL enables conversion of stable propargyl glycosides to transglycosylated products in the presence of catalytic quantity of $AuCl_3$ in acetonitrile. Utility and efficacy of the transglycosylation was demonstrated using various aglycones, and respective glycosides and disaccharides were synthesized. It can be envisioned that transition metal mediated activation of propargyl glycosides would be advantageous as propargyl glycosides can be (i) synthesized from aldoses by modified Fisher glycosidation, (ii) stable to diverse chemical manipulations, (iii) directly used for saccharide coupling, and (iv) chemoselectively activated.

Conversion of methane and methanol into gasoline

A process having significant commercial potential for conversion of methane to gasoline through non-oxidative activation of methane and its simultaneous conversion with methanol into gasoline-range hydrocarbons over bifunctional ZSM-5 type zeolites has been developed by NCL. It has also been shown that the amount of methane converted could be equimolar to the amount of methanol converted in this novel process, depending on the specific conditions. Conversion of methane to higher hydrocarbons was confirmed by using carbon-labeled methanol and analysis of the reaction products. In this process, methane is converted at low temperatures ($< 600°C$) over bifunctional zeolite catalysts. Simultaneous conversion of methane and methanol results in a significant change in the hydrocarbon product distribution. The formation of benzene was very small. In the absence of methane, an appreciable amount of benzene is produced in the aromatization of methanol. Therefore, the presence of methane as a co-reactant in this process is beneficial, as the aromatization of methanol results in no net formation of benzene. The required methanol itself can be produced from methane through a well-established technology ($CH_4 \rightarrow$syngas$\rightarrow$methanol).

Functional polymers from divinyl monomers via cyclodextrin host-guest chemistry

Crosslinked polymers find a wide range of applications, such as ion exchange resins, adsorbents, molecularly imprinted polymers, supports for reagents in organic synthesis, and in enzyme immobilization and drug delivery systems. A sequential multistep approach, wherein a soluble linear polymer is first synthesized, isolated and then crosslinked offers significant advantages in most applications. NCL in collaboration with IICT has developed a methodology for selective polymerization of divinyl monomers, such as ethylene glycol dimethacrylate and ethylene glycol

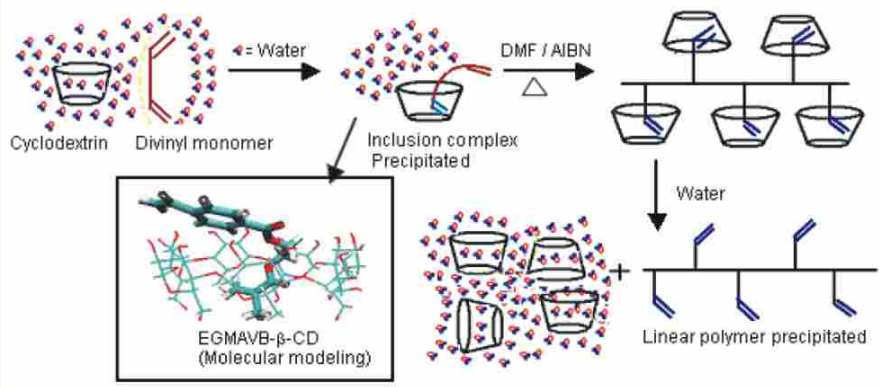


Fig. 1.22: Synthesis of functional polymers

methacrylate 4-vinyl benzoate by exploiting the principles of host-guest chemistry (Fig. 1.22). In the methodology developed at NCL/IICT, the water-insoluble divinyl monomers form an inclusion complex with β-cyclodextrin and its derivatives such as dimethyl β- cyclodextrin. The vinyl group included in the cavity of β-cyclodextrin does not participate in polymerization. As a result, a divinyl monomer behaves as a monovinyl monomer. The polymerization results in a solvent-soluble linear polymer containing one vinyl double bond per repeat unit.

Biotransformation of amorphous silica in rice husk to nanocrystalline silica

An exciting futuristic biomedical application has been reported by NCL scientists, who have found that use of silica nanoparticles can enhance the image quality of tumour cells, making it possible for an ultrasound device to track them and thereby detect cancers. Using the fungus Fusarium oxysporum, commonly found in garden soil, the NCL scientists have demonstrated that almost the entire silica present in rice husk (up to 97%) can be converted to high value nanocrystals of 2-6 nanometres in size. More importantly, the entire operation takes place at room temperature.

Protein β-sheet-like structure of acrylamide oligomers

Poly-N-alkyl acrylamides are polymers formed by the polymerization of acrylamide monomer units. As a class of functional materials, these synthetic polymers are gaining prominence, primarily due to their enormous potential for applications in various fields, from disposable nappies to micro fluidic devices and from advanced drug delivery materials to high-tech materials. NCL has demonstrated that acrylamide chains form sheet-like structures, similar to protein β-sheets (Fig. 1.23). Isotactic acrylamide tetramers were synthesized and crystallized using a method usually used for protein crystallization. Conformation of these oligomers was investigated by single crystal X-ray and two-dimensional NMR studies. A layered structure was found held together by hydrogen bonds, "reminiscent of protein β-sheets". This insight should help in understanding how the spatial arrangement of atoms and groups in the monomers (i.e., the stereochemistry) translates into final macromolecular shapes.

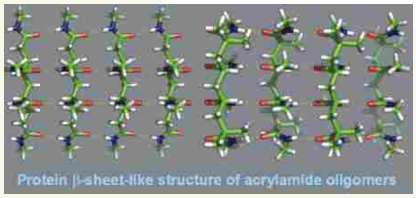


Fig. 1.23: Acrylamide chains

Novel cyclic conjugate for selective recognition of purine nucleotides in aqueous medium

Detection of nucleosides and nucleotides has paramount importance as they form the fundamental units of all the life forms. Of all the nucleotides, the recognition of adenosine 5'-triphosphate (ATP) and guanosine 5'-triphosphate (GTP) is vital, since ATP plays an important role in energy transduction in organisms and controls several metabolic processes, whereas GTP is involved in RNA synthesis, citric acid cycle and acts as an energy source for protein synthesis. Available sensors do not work in aqueous medium, since it involves multiple hydrogen bonding. NIIST has developed a highly sensitive fluorescence assay for GTP, which makes use of the beneficial non-fluorescent and selective binding properties of the receptor, highly fluorescent properties of the indicator, 8-hydroxy-1,3,6-pyrene trisulfonate (HPTS; $_F$ = 0.7). The system is unique in the sense that it differentiates between ATP and GTP involving synergistic effects of electronic, γ-stacking and electrostatic interactions inside the cavity and recognizes micromolar quantities of GTP in buffer and biological fluids through a visual "turn on" fluorescence mechanism (Fig. 1.24). The findings are useful in developing sensor for biologically important molecules.

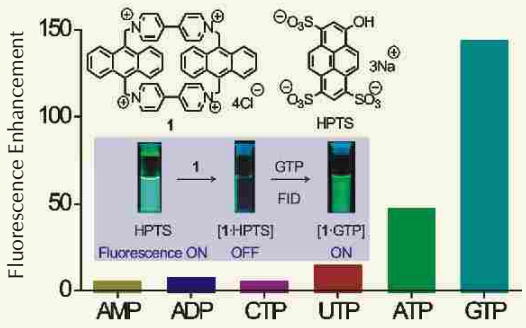


Fig 1.24: Selective recognition of ATP and GTP

Metal ion imprinted polymers

Thiruvanathapuram based NIIST is a pioneer in trapping-based ion imprinted polymers (IIPs). IIPs have many important applications and perhaps the most important one is detoxification of synthetic nuclear power reactor effluents containing uranium an emerging pollutant. Imprinted polymer inclusion membrane sensors have been fabricated by dispersing atrazine and dysprosium imprinted polymer materials in polyvinyl chloride matrix. The resulting devices enable highly selective and sensitive detection of atrazine/dysprosium. An on-line flow injection preconcentration- flame atomic absorption spectrometry (FAAS) methodology was developed for analysis of dust and rock samples for palladium(II) using exfoliated graphite/inorganic or inorganic-organic hybrid materials, and for analysis of soils and sediment samples for cobalt using dihaloquinoline-8-ol embedded polymeric materials.

1.3.2. Progress made under Network Projects

I.Development of catalysis and catalysts

The project envisages development and standardization of novel mesoporous materials that include nano tubes and nano particles and their evaluation in catalytic oxidations.

Under this project being coordinated by NCL, several related developments took place. The scale-up of the mesoporus materials (MCM-41 and MCM-48) up to 1 kg level has been successfully achieved. A lab scale twin-process for the conversion of carbon dioxide and olefins/epoxides to cyclic carbonate, and transesterification of organic carbonates with various alcohols has been developed, where the catalyst as well as reaction conditions are optimized. Non-noble metal based catalyst has been synthesized and found to be active for removal of NO_x from automobile engine exhaust under lean burn conditions. The catalyst (Co based) has been identified for indirect route of nitrogen utilization. Chiral ligands, their anchoring on porous support and catalytic application for asymmetric reactions have been formulated. Asymmetric hydrogenation of various substrates like ketones, olefins, imines, enamines, etc., is important for the synthesis of enantiomerically pure pharmaceuticals / intermediates.

II. Developing green technologies for organic chemicals

The project being led by IICT aims to develop good processes for bioactives from medicinal plants, value-added organic chemicals from biomass and agro industrial wastes, alkylation and oxidation of aromatic compounds, fluoroorganics by chemical/electrochemical methods and novel mesoporous nanomaterials.

Several processes for the production of medicinally important products and intermediates have been developed. These include artemesinin in batch of 5 kg; pheromone components IV (E11-hexadecene-1-ol) and V (E11-hexadecenyl acetate) (25 g batch); processes for trifluoroethanol 1,1,1-trifluoro-2,2-dichloroethane (HFCFC-123) & heptafluoropropane (FM200); and novel mesoporous materials for gas storage.

Ruthenium based complexes were used for catalytic oxidation of methane by molecular oxygen under moderate conditions of pressure and ambient temperature. The catalyst is being investigated in detail for oxidation of methane by molecular oxygen to study the effect of various parameters on the formation of the oxidation product.

Nanocrystalline TiO_2 prepared by sol-gel method was calcined at 583, 683, 753, 833, 913, and 1023 K under airflow. The photo-catalytic activities of these catalysts were tested for degradation of nitrobenzene under UV light irradiation for 1-8 hours. It was found that the catalyst calcined at higher temperature showed highest rate of degradation of nitrobenzene.

III. Globally competitive chemicals, processes and products

This network project with IICT as the lead laboratory aims to develop new generation technologies for high demand chemicals and strategically important chemicals for the country, e.g., novel bioactives, alternative fuels, new natural functional dyes, etc.

- **Tissue culture and processing of natural dyes:** Calli formation with respect to its proliferation/growth medium has been optimized. Also, fresh *T. erecta* flowers (10 kg) were produced in an experimental farm.
- **Towards the development of functional dyes:** Dipotassium rhodizonate, dipotassium croconate, barium croconate and croconic acid have been prepared at gram level. Further, new homogeneous and supported catalysts on biopolymer were synthesized and evaluated for Heck reaction. Titanium oxide

electrodes have been prepared from chemical grade TiO_2 and are being characterized.

- Aluminium phosphate catalysts and aluminium zirconium phosphate were prepared and tested for dehydration of methanol to dimethyl ether (DME).
- A promising catalyst formulation has been identified for the synthesis of p-methoxy benzonitrile.
- **New catalyst systems**: Cr-terephthalate mesoporous materials were prepared for direct hydroxylation of benzene.

IV. Development of novel polymeric materials

The project being coordinated by NCL aims to use sustainable raw materials for the preparation of specialty polymers such as organic-inorganic hybrids and nanocomposites, UV/E-beam curable coatings and adhesives, functional polymers for chiral separations, specialty polymers for petroleum industry and specialty polymers from renewable resources. So far, highly luminescent bulky-conjugated liquid crystalline poly(p-phenylenevinylene)s and perylenebisimide derivative materials have been developed for applications in opto-electronics.

1.3.3. Human Resource Development

CECRI

- Organised three one-week duration training programmes to impart basic & applied knowledge on various aspects of Electroplating & Industrial Metal Finishing Industry.

CSMCRI

- Two-day training programmes were conducted for farmers to impart training to utilize marginal land and wasteland for cultivating plants like Jatropha curcas.
- Two training programmes, each of three days duration, on the production of high purity salt for the grass root populace, particularly marginal agarias.

IICT

- **Advanced Course in Bioinformatics:** A six months fulltime course consisting of thirteen modules and an industry relevant project was conducted in collaboration with C-DAC, Pune and JNTU, Hyderabad.

NCL

- An advanced training programme of 12-days duration on 'Micropropagation' was organized for students and teachers from various universities of Maharashtra.
- An advanced training programme of 5 days duration on 'Plant tissue culture' was organized for a group of fifteen officials from Department of Horticulture, Jammu and Kashmir.
- A specialized 5-day long training programme for researchers was organised at GE's Jack F. Welch Technology Centre at Bangalore. The course was attended by thirty-four researchers with diverse backgrounds, spread across chemistry, physics & materials, and engineering science disciplines.
- A two-day workshop on 'Design and scale-up of catalytic multiphase reactors' was organized for representatives of industry and academia.

1.3.4. Recognition & Awards

Recognition and awards received by CSIR Scientists in the area of Chemical Science and Technology are listed below:

CHEMTECH PHARMABIO Award for the year ChemTech Foundation, Mumbai Dr. Vikram Sarabhai Award (2005-06)	Dr. PK Ghosh, CSMCRI
The Chemical Research Society of India (CSRI) Bronze Medal	Dr. RV Jasra, CSMCRI
CHEMTECH Foundation Outstanding Achievement in R&D/Innovation Institutions category in the Pharma + Biotech 2007 Awards Fellow of TWAS (The Academy of Sciences for the Developing World), Italy "CDRI-2006 ORATION" by Indian Pharmacological Society DST- J C Bose Fellowship	Dr. JS Yadav, IICT
RANBAXY Research Award- 2005 in the field of Pharmaceutical Sciences Andhra Pradesh Scientist Award 2007	Dr. A Kamal, IICT
NASI-Reliance Industries Platinum Jubilee Award Fellow of the INSA, New Delhi DST-Ramanna Fellowship	Dr. TK Chakraborty, IICT
Swarnajayanthi Fellowship for 2005-06	Dr. GN Sastry, IICT
Dr. RBGV Swaika Award (Team Award for Enzymatic Degumming Process) by Oil Technologists Association of India (OTAI), Mumbai	Drs. RBN Prasad, V Kale, BLA Prabhavathi Devi, PP Chakrabarti, Smt. KN Prasanna Rani, Shri SK Roy and Dr. BVSK Rao, IICT .
CSIR Young Scientist Award 2006 in Chemical Sciences	Dr. R Banerjee, IICT
DST- Ramanujan Fellowship	Dr. SV Kalivendi, IICT
Chemito Award for the year 2005	Dr. M Vairamani, IICT
Vice president, Indian Academy of Sciences, Bangalore	Dr. S Sivaram, NCL
J.C. Bose National Fellowship, DST	Drs. S Sivaram, K N Ganesh, G Pandey, NCL
Dr. Jagdish Shankar Memorial Lecture (2006) award by the Indian National Science Academy	Dr. S Pal, NCL
Fellow of Zoological Society, Kolkata	Dr. SN Mukherjee, NCL
INSA Medal for Young Scientist for the Year 2006 in Chemical Sciences 2006 CSIR Young Scientist Award in Chemical Sciences	Dr. S Hotha, NCL

Fellow, Maharashtra Academy of Sciences	Drs. MV Badiger, MN Deshmukh, SN Mukherjee, VR Pedireddi CV Rode, and Shri VS Chavan, NCL
Manthan-AIF Award 2006	Shri VS Chavan, NCL
Shanti Swarup Bhatnagar Prize in Engineering Sciences for the year 2006	Dr. A Lele, NCL
Young Scientist Award of Catalysis Society of India for the year 2006	Dr. P Manikandan, NCL
Professor M. Santappa Silver Jubilee Award in Polymer Science for the year 2006 by the Society for Polymer Science	Dr. PP Wadgaonkar, NCL
Ramanna Fellowship FICCI Award 2005-06 in the category of Outstanding Contribution to Knowledge Based Industries Vice-President of the National Academy of Sciences, India, Allahabad for the years 2007 and 2008	Dr. A Kumar, NCL
20th Khwarizmi International Award	Dr. RP Singh, NCL
CDRI Award 2007 for excellence in Drug Research Young Associate, Maharashtra Academy of Sciences	Dr. DK Mohapatra, NCL

1.4. Earth Resources & Natural Hazards Assessment

CSIR laboratories NGRI, NIO and NEIST are primarily devoted to R&D on earth resources. These laboratories continued to work during the year on R&D programmes, both through Network and Non-network modes on new hydrocarbon resource location, estimation of recharge of ground water systems, coastal and ocean science mineral explorations, seismic studies, etc., as detailed below:

1.4.1. Scientific & Technological Achievements

Shillong plateau earthquakes in Northeast India

Jorhat based NEIST has examined the complex tectonic model of the Shillong Plateau, the source area of the 1897 great earthquake in the Northeast India using the high precision data of a 20-station digital seismic network that is in operation in the Plateau since 2001. Although the dominating thrust/strike-slip faulting earthquakes in the western Plateau could be explained by the 'pop-up' tectonic model, the seismological data, however, show that the north dipping Dapsi and the south dipping Brahmaputra faults are the possible boundary faults, and not the Dauki and Oldham faults as proposed in the model. The more intense normal/strike-slip faulting earthquakes in the eastern Plateau (Mikir massif), on the other hand, are generated by a long and deep rooted Kopili fault by transverse tectonics, and this could be the more vulnerable source area for an impending large/great earthquake in the region. The study has generated some seismological data which might be useful for earthquake prediction related studies.

Prediction of water table variation

A mathematical model has been developed using approximation scheme by NGRI to predict water table variation in an unconfined aquifer induced by time-varying recharge and/or withdrawal from any number of recharge basins, pumping wells and leakage sites of different dimensions. Advantage of this approximation scheme is that any complex pattern of recharge and/or withdrawal rates for any number of recharge basins, pumping wells and leakage sites and for any number of these operations can be approximated with greater accuracy.

Deep seismic sounding refraction profile of Vattalkundu to Kanyakumari

Using wide angle seismic refraction data, NGRI has derived upper crustal velocity image from tomographic inversion and its relation with compositions of different rock assemblages from the study of Vp/Vs and Poisson's ratio, respectively. The tomographic study, for the first time, clearly reveals these aspects by imaging shallow (8 km) anomalous high Vp/Vs ratio (>1.75), large variation of Poisson's ratio (0.25-0.29) in upper crust of Southern Granulite Terrain representing numerous shear zones cutting across south block with major compositional boundaries. The dominant metamorphic event of southernmost block is ~ 550 Ma.

Paleo-seismological investigations

Palaeo-seismological investigations conducted by NGRI in upper Assam and Arunachal Pradesh, which are the meizoseismal areas of 1950 earthquake, led to the identification of a number of liquefaction features along the banks of Burhi Dihing river near Dibrugarh and Duliajan areas in upper Assam. The timing of the causative earthquake was studied through the radiocarbon and optically simulated luminescence dating of liquefaction features. About 30 OSL and 16 radiocarbon ages were obtained from various liquefaction features. The radiocarbon ages of the lower bound varied between 870 ± 80 and modern period (about 50 yrs); however, one sample indicated the lower bound as 5080 ± 130 yrs.

Relevance of biofilm bacteria in modulating the larval metamorphosis of Balanus amphitrite

Natural microbial communities found on different substrata exposed to the marine environment, including barnacle shell surfaces, are reported to have varying influences on the settlement and metamorphosis of competent cypris larvae. NIO has carried out experiments to compare the influence of settlement inducing compounds from the bacteria isolated from the shell surface of Balanus amphitrite on its larval metamorphosis. The effect of multispecies bacterial film was also assessed. The production of different molecules by the bacteria was influenced by the nutrient media under which they were grown. It was observed that the promontory multispecies bacterial film turned to inhibition mode in the presence of the adult extract of the barnacle, indicating that bacteriaadult extract interactions alter the synthesis of different compounds produced by bacteria. The studies also show that the water-borne and the surface-associated cues from the bacteria function differentially in mediating larval metamorphosis.

Glycolipids from the red alga Chondria armata (Kütz.) Okamura

NIO has isolated three distinct fractions containing polar glycolipids (PF_{1-3}) from the chloroform soluble fraction of crude methanolic extract of red alga Chondria

armata (Kütz.) okamura. The coupling constant of the anomeric proton in ^{1}H NMR spectrum and sign of rotation indicate an exclusive configuration of the sugar molecules in the glycerolipids. Major glycolipids were identified as (2R)-2-O-(5,8,11,14-eicosatetranoyl)- 3-O-a-D galactopyranosyl-sn-glycerol (GL_2), its pentacetate (Gl_1), and (2R)-1-O-(palmitoyl)-2-O-(5,8,11,14,17-eicosapentanoyl)-3-O-b-D-galactopyranosyl-sn-glycerol (GL_3). Each one of these was methanolysed to give the same galactosylglycerol which on ESI-MS provided a pseudomolecular ion at *m/z* 309 representing deacylated glycolipid with the sodiated sugar moiety. Additionally, six minor glycolipids were also identified on the basis of ESI-MS. These include a 1,2-di-O-acyl-3-O-(acyl-6′-galactosyl) glycerol (GL_{1a}), sulfonoglycolipids 2-O-palmitoyl-3-O-(6-sulfoquinovopyranosyl)- glycerol (GL_{2a}) and its ethyl ether derivative (GL_{2b}), 1-oleoyl-2-palmitoyl-3-O-galactosyl glycerol (GL_{3a}), and 1,2 diacyl phosphatidyl glycerol (GL_{3b}). GL_1, GL_{1a}, and GL_{2b} are new to the literature. The novelty of the remaining identified compounds lies in the diversity of their fatty acid composition. Antimicrobial properties of these glycolipids against pathogens were evaluated. The yeast Candida albicans and the bacteria Klebsiella sp. were as sensitive as the standard Nystatin and antibiotic Streptomycin against PF_3. Considerable activity was expressed by the same metabolite against the fungus Cryptococcus neoformans as compared to the control. Antimicrobial activity of glycolipids is being reported for the first time.

Formation of genotoxic nitro-PAH compounds in fish exposed to ambient nitrite and PAH

Mutagenic nitrated polycyclic aromatic hydrocarbons (nitro-PAHs) have been known to arise in the environment through direct emissions from combustion sources and nitration of PAHs, primarily in the atmosphere. NIO has reported the formation of nitro-PAH compounds in fish contaminated with PAH and exposed to nitrite (NO^-_2) in the ambient water. Electrospray ionization mass spectrometric analysis of the bile of the euryhaline fish Oreochromis mossambicus exposed simultaneously to field relevant, sublethal concentrations of phenanthrene NO^-_2 and collision-induced dissociation of selected ions revealed the presence of two strongly genotoxic nitro-PAH metabolites, namely phenanthrene-6-nitro-1,2-dihydrodiol-3,4-epoxide and dihydrodihydroxy acetylamino nitrophenanthrene. These two metabolite peaks present only in the bile of fish exposed simultaneously to phenanthrene and NO^-_2 constituted, respectively, about 3.1 and 2.7% of the highest peak among the putative unconjugated phenanthrene metabolites in the mass spectrum. The presence of the oxidized phenanthrene metabolite dihydroxyphenanthrene (*m/z* 233) in fish exposed to phenanthrene alone as well as phenanthrene plus NO^-_2 suggested that oxidation of phenanthrene precedes nitration in the sequence of reactions leading to the formation of the observed nitrophenanthrene metabolites. However, the route of PAH administration seems to determine the nature of metabolites formed. Nearly 92% of the hepatic cells of the fish exposed to phenanthrene in the presence of NO^-_2 were found to have suffered extensive DNA fragmentation on comet assay.

Biological indicators in relation to coastal pollution along Karnataka coast

NIO has examined marine pollutants in relation to planktonic and benthic population at two locations along Karnataka coast. One site is at Kulai (74°47.74″E and 12°55.16″N) receiving huge amount of industrial effluents from fertilizer,

petroleum and chemical plants along with the sewage discharges. The other site, Padubidri (74°45.74″E and 13°10″N), is located 20 km away, which is a typically agricultural and fishing village having no stress of industrial discharges. Although the concentrations of dissolved oxygen, nutrients and trace metals in water and sediment showed marginal differences at these two locations, the concentration of petroleum hydrocarbon (PHC) was exceptionally high at kulai with a maximum of 1523 mg/l, which is 10 times higher than that at Padubidri (144 mg/l). Biomass and population of phytoplankton and zooplankton showed that the seasonal differences were more conspicuous rather than the regional changes. Macro and meiobenthic population remained high at both the locations during the two seasons. Phytoplankton species indicated that centric diatoms such as Rhizosolenia, Leptocylindricus, Chaetoceros, Thalassiosira and Coscinodiscus contributed to 490% of population in May and 470% in January at Kulai. While mixed population of centric, pennate, cyanophycean and dinoflagellates prevailed at Padubidri in January. The results suggest that although Kulai receives large quantities of industrial and sewage effluents responsible for alteration of the ecosystem structure, the excellent wind-driven mixing and tidal flushing keep the waters well aerated thus reducing the severe pollution stress by dispersing the organic and other pollutants. Direct relationship of PHC with Cd and Pb as contaminants, NO_3 and PO_4 as oxidants of excess PHC further suggest that these biological parameters could serve as indicators for detecting moderately high environmental stress at Kulai, compared to Padubidri.

Methane from sea-bed

NIO participation in the drilling and coring operations carried out by 'JOIDES Resolution', an American drill ship, in the Exclusive Economic Zone of India has opened up doors to new areas of exploration in the field of microbiology, geochemistry and sedimentology of gas hydrate bearing sediments. It was found that methane is available in the form of solid crystalline structures in the organic rich sediments. The methane hydrate structure is composed of methane and water molecules in a cage (clathrate)-like pattern. The hydrate structure, which is otherwise stable within the in situ temperature-pressure conditions, rapidly destabilizes into methane gas and fresh water by the time it is brought on-board. This may be due to evaporation of hydrate when the cores are brought to the water column having higher temperature and lower pressure. A suitable technology has to be developed to harvest the existing resources.

1.4.2. Progress made under Network Projects

I. Study of mesozoic sediments for hydrocarbon exploration

The objectives of the project are application of new strategies of integrated geophysical studies of seismic refraction, gravity, magnetotellurics and deep resistivity sounding for the delineation of mesozoic basins in areas covered by Deccan Traps, which are likely to contain oil and gas; investigation of unexplored areas for hidden Mesozoic sediments for oil and gas; and location of prospective hydrocarbon potential structures in the study area.

During the year, 160 km seismic line of Umapur-Hewarkhed-Assegaon-Saur-Shirala-Brahmandwadi (W-E) has been profiled. 181 stations have been surveyed for magnetotelluric studies. Preliminary results of 61 soundings indicate large thickness (>1.5 km) of Mesozoic sediments under trap in the Burhanpur, Amravati and Jamner

regions. 6000 gravity stations with zero grid intervals have been surveyed for gravity studies. Topographical correction was applied to the acquired data. Bouguer and Free air anomaly maps of acquired data have been prepared.

Result of Deep Resistivity Sounding Survey indicates the presence of large Mesozoic thickness near Barhanpur (MP) and Amravathi (Marashtra).

II. Development of techniques and methodologies for exploration, assessment and management of ground water

The project aims at development of techniques and methodologies and integration of the available advanced geophysical and hydrogeochemical data to thoroughly investigate various aquifer systems in hard rocks. The aims also include delineation and characterization of the fractured and Island aquifer systems to understand the recharge mechanism as well as geochemical contamination and simulation of flow and mass transport. It is proposed to develop techniques to simulate the process of artificial recharge and test their effectiveness for a value added groundwater management in hard rocks.

Fracture delineation. Groundwater potential zone has been delineated through the integration of hydrogeological and geophysical data. Artificial tritium experiments reveal that secondary recharge in granitic terrain is most significant. Source well, capture well, subsurface barrier and check dams have been constructed to ensure sustainable fluoride-free drinking water supply to villages in Wailapalli watershed (A.P.). Suitable structures for groundwater augmentation have been constructed. Groundwater flow and mass transport models have been used to assess the pollution due to fertilizers in alluvial terrain and due to industrial waste in basaltic terrain. Its impact on groundwater regime has also been studied for better management of pollutants. Another method of soil gas radon studies helped in delineation of good potential zones as the Rn concentration was detected to be as high as 50000 cpm. This has led to drilling of successful bore wells.

Anthropogenic pollution. In order to assess the contamination migration, groundwater flow and mass transport models of Loninala watershed, covering Unnao, CETP Tannery Cluster has been simulated through development of a 4 layer model in the alluvial terrain of Ganga plain. Visualization of contaminant migration (TDS plume) has been shown for the next 20 years. TDS, sulphates, chlorides and sodium have been found exceeding the WHO limits in groundwater samples. Heavy metal concentrations are also found elevated, particularly chromium, arsenic and lead, in groundwater. Similarly, groundwater flow and mass transport modeling of Chambal river sub-basin have been completed and prediction of contaminant transport for next 20 years has been made in the mass transport model.

Assessment of utilizable fresh groundwater potential on islands. Detailed hydrogeological, geophysical and chemical analysis have been carried out on Androthi island to delineate area of island vulnerable to seawater ingress. The study suggests seawater ingress during non-monsoon period in the western as well as eastern part of the Androth island. In the western and eastern parts of the island, where groundwater quality begins to deteriorate during the non-monsoon period, the aquifer system becomes more vulnaerable to seawater ingress. It is suggested to minimize the groundwater abstraction in these zones and implement rainwater harvesting measures to augment groundwater resources.

III. Tectonic and oceanic processes along the Indian ridge system and back arc basins

The project proposes to concentrate on Carlsberg ridge (CR)- Central Indian ridge (CIR) and Andaman backarc spreading system to understand the tectonic and oceanic processes that are occurring at these dynamic plate boundaries.

Multi-disciplinary investigations have been conducted along the Carlsberg and Central Indian Ridge segments in the Indian Ocean by undertaking cruises onboard ORV Sagar Kanya. During these oceanographic expeditions, mid-ocean ridge segments along the CR and CIR have been explored. Extraction of helium from water samples and analysis for $^{3}He/^{4}He$ ratio were attempted for the first time on specially collected samples. Based on the analysis of the data acquired, two potential sites have been identified on CR and CIR for detailed investigations to locate active hydrothermal vent sites. Manganese-oxidizing bacteria have been encountered in the CR and NCIR segments in abundance during recent findings. These bacteria are distinguished by the formation of dark brown colonies with Mn-oxide precipitate around them. The relatively high specific activity of these mixotrophic bacteria under relatively oligotrophic conditions suggests that they may be responsible for scavenging dissolved Mn from the Carlsberg Ridge waters and could potentially participate in oxidation.

The shipboard gravity, bathymetry and seismic data across the West Andaman Fault (WAF), a major tectonic feature in the Andaman Sea, have been analysed to infer the crustal structure and to examine the influence of WAF in controlling the aftershock pattern of December 2004 and March 2005 megathrust events. The two megathrust earthquakes of 26 December 2004 ($M_w = 9.3$) and the 28 March 2005 ($M_w = 8.6$) in the Andaman-Sumatra region exhibited distinct and divergent rupture patterns, controlled by the WAF lithospheric boundary. It is suggested that the active strike-slip motion along the WAF, presence of backarc spreading coupled with increased obliquity of subduction in the Andaman Sector reduce the probability of occurrence of major or great earthquakes north of $10^{o}N$.

It is proposed to investigate these areas with high-end exploration tools, such as deep-tow and ROV during the second phase of field work on chartered vessel.

1.4.3.Human Resource Development

NIO

- Special training course on water quality parameters for officials of the Indian Coast Guard was arranged.
- Long Hydrography Course "Industrial Offshore Surveying" was conducted for National Hydrography School, Goa. The participants were Indian, Lankan Navy, Nigerian-1, Bangladesh-1, Myanmar-1 and Royal Malaysian Navy-1.
- A course on Fundamentals of Oceanography was conducted for students of M.Sc./ Engineering from various universities and colleges (28 summer interns).
- An Advance Oceanography Course was conducted for Naval officers from various parts of India. The course included topics on Meteorology, Physical Oceanography and instrumentation.
- A Short term course, specially designed on Coastal Oceanography and Meteorology was conducted for ONGC.

1.4.4. Recognition and Awards

Recognition and awards received by CSIR Scientists in the area of Earth Resources and Natural Hazards Assessment are listed below:

CSIR Young Scientist Award in the area of Earth, Atmosphere, Ocean & Planetary Sciences for the year 2006	Dr. SK Mukhopadhyay, CSMCRI
Krishnan Gold Medal 2006, IGU	Dr. VK Gahlaut, NGRI
CSIR Young Scientist Award 2006	Dr. P Kumar, NGRI
Scientist of the Year Award for the year 2005 by National Environmental Science Academy, New Delhi	Dr. U Goswami & VK Rathod, NIO
Elected Fellow of the Academy of Environmental Biology	Dr. BS Ingole, NIO
Biotechnology Overseas Associateship Award for the year 2005-06	Dr. C Mohandass, NIO
Fellow of the Academy of Environmental Biology	Dr. ZA Ansari, NIO
Elected Fellow of the Indian National Science Academy	Dr. VP Rao, NIO
Elected Fellow of the Indian Academy of Sciences, Bangalore	Dr. SSC Sheno, NIO

1.5. Ecology & Environment

CSIR provides significant S&T inputs for evolving national policies on environmental resources and ameliorating environmental problems. A few of its laboratories have developed expertise in air, water and soil quality management, near space environment, ionospheric chemistry, stratosphere - mesosphere coupling, 'toxic & hazardous' waste management, etc. CSIR is achieving these goals both through network and non-network programmes. Significant scientific achievements in this area are outlined below.

1.5.1. Scientific & Technological Achievements

Drishti-Kuha

CSIR has initiated a comprehensive programme to develop a multi-scale environmental modelling and forecast platform, specially calibrated for India with special concern towards high-impact weather events like episodes of extreme rainfall and fog. As a part of this programme, CSIR has christened the forecast platform 'Drishti-Kuha', to emphasize forecast-based vision to manage fog. The fog forecast platform, developed and calibrated by CMMACS, has a built-in Flight Schedule Decision Support System that allows flight rescheduling based on fog forecast and management parameters. This is India's first and only Flight Schedule Decision Support System with high-resolution, long-range dynamical forecasts, developed completely in-house. CMMACS is currently involved in the implementation of 'High-Resolution Regional Atmospheric Analysis (HiRRAA) through Meso-scale Observation Network for Urban System (MONUS)'. The purpose of HiRRAA-MONUS is to develop a high-resolution data-set over select vulnerable locations for model calibration and model validation. MONUS will be initially a pentad of

observation stations with meteorological towers over Delhi, with subsequent expansion to other cities.

Interaction of lead with some essential trace metals in the blood of anemic children

The effects of lead on the hematological system result in inhibition of heme synthesis and anemia. ITRC has correlated the association of elevated blood lead levels (≥10µg/dL) with anemia, and some essential trace metals (iron, copper, zinc & calcium) in children. Results indicate that elevated blood lead levels are significantly associated with risk of anemia. In addition, blood lead levels also influence the status of essential trace metals. The correlation as established in the above study gave a new insight in understanding the causation of anemia in children. Also, the regulatory agencies are required to control overall lead emissions even after phasing out of leaded petrol.

Antimicrobial antioxidant capacities and chemical fingerprint profile of Zingiber officinale from different ecological zones of India

Zingiber officinale (Zingiberaceae) is one of the most utilized herbal drugs in traditional system of medicine. Its therapeutic uses include protection against throat ailments, bronchitis, dyspepsia, colic and as stimulant. ITRC has studied variation in the chemical fingerprint profile and biological activity of the drug obtained from different regions of India. Camphene and Geraniol, two important constituents of the drug were found to be maximum, i.e., 98% & 40%, respectively, in the sample from Madurai representing southern region. The Madurai sample was also found to have highest superoxide scavenging capacity. Antimicrobial activity of the extracts was tested against seven Gram +ve and Gram -ve test bacteria. All the extracts showed strong to moderate antimicrobial activities against *B.cereus, B. subtilis, S.typhi, S.flexneri, S.sonnei, S.auerus, P.aeruginosa and E.coli*. The MIC values of *B.cereus* and *P.aeruginosa* ranged from 0.01 mg/ml to 10 mg/ml indicating strong activity against these bacteria, which was again highest in Madurai sample. Results confirm that *Z. Officinale* obtained from the Madurai region of India has higher antioxidant and antimicrobial activities, and bioactive constituents. The information can be useful while procuring the raw material for preparation of therapeutic formulations.

Solar photocatalytic treatment of textile wastewater

A novel bench scale, pebble bed photo-reactor (PBPR) has been fabricated by NEERI to treat aqueous dye solutions and synthetic textile wastewater under solar illumination. Silica-rich white pebbles coated with Degussa P-25 TiO_2 catalyst were used for fabrication of photocatalyst bed surface. The use of pebbles as a support for TiO_2 and of a pebble bed reactor has been made for first time for the treatment of aqueous dye solutions. Various experiments for optimization of parameters, viz., dye concentration, pH and flow rate on the performance of reactor were conducted using artificial UV light and reactive black dye. The results indicate that PBPR (Fig. 1.25) can be successfully used for the decolorization of dyes from dye wastewater under sunlight.

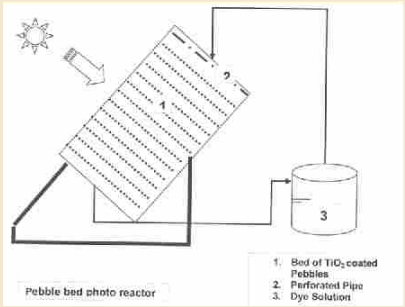


Fig. 1.25: Schematic diagram of solar photocatalytic treatment plant

"NEERI-Zar" portable instant water filter

NEERI has developed a water purification system 'NEERI-Zar', which is suitable for potable water supply, particularly during floods. A typical unit, with two 100 L vessels, can serve about 20-30 persons, when operated for 10 hours a day, on the

Fig. 1.26: NEERI Zar

basis of 6-10 liters per capita/day for drinking and cooking purposes. It brings down the turbidity of filtered water to less than 3 NTU from raw water with 100-300 NTU. It is based on the principles of oxidation of organic matter in water, using the oxidizing chemical agent to remove organisms, and filtration through a sand bed to remove turbidity and suspended matter as well as to bring down the micro-organisms, including bacteria and zooplankton. A typical unit (Fig. 1.26) comprises two plastic containers of 100 L capacity placed at elevation difference to manage gravity flow. The top container contains raw water. The oxidizing chemical solution is mixed into the raw water container placed on top. The water flows due to the effect of gravity into the second container, passes through the filter bed and gets accumulated. The water coming out from the second container is collected in the third container. The disinfectant solution is added to this treated water. In usual circumstances, safe potable water is ready for use after half an hour.

1.5.2. Progress made under Network Projects

I. Pollution monitoring, mitigation systems and devices

The project envisages developing innovative sensors, indicators and instruments for pollution monitoring and study of assimilative capacity of environmental media for pollution mitigation. During the year under report, tin oxide and ceria thick films were developed, fabricated & tested as leak detecting sensors of SO_2 (with sensitivity down to 5 ppm). Two machines were designed and developed for automation of critical sensor assembly. Nano-crystalline polymer thin films for detection of carbon monoxide, HCI & NO_x have been prepared. BOD sensors (software, membrane and bioseed) for beverage and dairy waste have also been developed.

II. Industrial waste minimization and clean up

Under this project, it is proposed to dematerialize the resource intensive activities of industries into more appropriate environmental-technological solutions aimed at waste minimization, clean up and remediation. It is also envisaged to develop futuristic, niche and cost-effective technological interventions for at least ten highly polluting categories of industry. The work carried out has resulted in the development of several process technologies at lab scale, such as BFBR technology for insoluble COD removal; blue dust recycling from lance based smelters; microbial deodourisation for pulp & paper wastewater; photocatalytic colour removal for textile wastewaters and recycling of MnO_2 from secondary zinc industry. An enzymatic bioreactor system for pharmaceutical wastes was developed at bench scale.

III. Impact of anthropogenic perturbations on oceanographic-atmospheric processes in and around India in the context of global change

The major objective of this project is to improve understanding of natural variability (from diurnal to decadal) and to develop capability to differentiate anthropogenic influence through long-term time series measurements. As a network project, the result obtained during the year indicated occurrence of alkyl halides in coastal waters of the Candolim time-series section (CaTS) in Goa, where it was found that their abundance varies with oxygen deficient conditions. Experiments reveal that biological processes significantly contribute to the formation of chloroform in seawater. An atmospheric measurement laboratory is being set up at NIO, Goa. A continuous and high quality carbon dioxide measurement facility is being installed to facilitate monitoring of the air quality in the central west coast of India with particular reference to changing environment and climate.

1.5.3. Human Resource Development

C-MMACS

- A six-day training programme on mathematical modelling and computer simulation was organized for Engineers of Kirloskar Copeland Ltd., Karad, Maharashtra.
- An intensive course on inverse methods dealing exclusively with discrete inverse problems with a finite number of parameters was organised.
- A six-day tutorial workshop on atmospheric inverse modeling was organized. Dr. Peter Rayner from LSCE, France, a distinguished inverse modeller in atmospheric transport, delivered lectures in this workshop.

1.5.4. Recognition & Awards

Recognition and awards received by CSIR Scientists in the area of Ecology & Environment are listed below:

Eminent Environmental Engineer Award & Citation for the year 2006 by Institute of Engineering, Nagpur	Dr. A Gupta, NEERI
Environmental Leadership Award presented by USAID - Asia and USAEP	Dr. R Kumar, NEERI
Engineer of the year - 2006 by Government of Andhra Pradesh & Institute of Engineers (India) A.P. State Centre	Dr. RC Reddy , NEERI

1.6. Electronics & Instrumentation

CSIR laboratories of this sector have reported development of several specialized products, notable among them being power quality analyzer, trace moisture analyzer, FBG sensor, etc. Additionally, a knowledge base exists in microwave & traveling wave tubes and klystrons & magnetrons. CSIR's capabilities in semiconductors have provided tailor-made hybrid microcircuits for the Indian space programme and other applications. CSIR's achievements in this area are highlighted in following subsections:

1.6.1. Scientific & Technological Achievements

Silicon carbide Schottky diode

Silicon carbide (SiC) is a wide band gap semiconductor material with higher thermal conductivity, making it viable for high power and high frequency device applications. Among more than two hundreds polytypes of SiC crystal structures, 4H-SiC is the most appropriate for devices, which is available commercially with uniformly low doped epitaxy layers of not more than 50 microns. The quality of the SiC substrate is limited by the presence of unavoidable micropipes. CEERI has developed SiC Schottky diode technology for the first time in the country, by fabricating diodes of varying diameters from 1.2 mm to 2.0 mm and packaged in TO-8 headers for direct applications (Fig. 1.27). Breakdown voltage of more than 700 Volts and reverse leakage currents of 1.0-5.0 nA at 200 Volts are the salient specifications of all the diodes. Ideality factor and the barrier height of the Schottky diodes have been evaluated using forward I-V data, giving rise to the values 1.2 and 1.25 eV respectively. Nickel has been used for the realization of Schottky contact on

Fig 1.27: Packaged SiC Schottky Diode array chip in TO-8 header for detector purposes

Si-face of the wafer carrying about 50.0μm thick epitaxy layer with a doping concentration of $9x10^{14}$ cm^{-3}. The C-face of the wafer of 0.020 Ω–cm resistivity has been deposited with Ti/Pt/Au for ohmic contact metallization. The technology thus developed has novelty in thermal oxidation and subsequent vacuum annealing of the grown oxide and the metal films for proper adhesion to the respective faces of SiC substrate. Application of Plasma Enhanced Chemical Vapor Deposition (PECVD) for passivation and capping of grown oxide on Si-face is an additional uniqueness for improved device characteristics. Field ring and field plate termination techniques have been incorporated in the diode structure to minimize multi-dimensional effects.

High k HfO_2 dielectric thin film

Hafnium oxide (HfO_2) has emerged as the most promising high k dielectric for metal oxide semiconductor (MOS) devices. Deposited sputtered HfO_2 thin films have a large number of defects resulting in increased oxide charge and leakage current. CEERI has investigated the effect of sputtering voltage, bias sputtering and post-deposition thermal annealing. It is found that oxide charge increases with increasing sputtering voltage. Thermal annealing in oxygen reduces the interface/oxide charges and leakage current. It is shown that by applying substrate bias during film deposition, leakage current is further reduced by an order of magnitude. The microstructure of thin film has been examined by Atomic Force Microscopy (AFM). The development of high k dielectric material is a step forward towards advanced gate technology for scaled MOSFET and provides an understanding of the effect of material technology on interface charges and improvement in MIM and MOS device performance.

Smart materials for temperature-sensitive applications

CEERI has developed alumina-based temperature-sensitive smart materials with conductor terminations. These are based primarily on the combination of one or more of the following constituents: piezoelectric materials, glass, conducting oxides, organic binders and minor impurities in different proportions to control the resistivity, viscosity and hardness of the material. The process for development of temperature-sensitive smart materials has been evolved and samples have been fabricated accordingly.

The fabricated samples have been characterized with respect to temperature. They were subjected to different temperatures and the electrical resistance was measured in each case. The initial resistance of fabricated material was in the range of a few MΩ and decreased drastically by several folds with the increase in temperature,

thus indicating fast switching action in the device parameters with temperature. One curve indicated variation in resistance with the increase in temperature while the other indicated variation with the decrease in temperature. The variation of resistance approximately followed the same path in both the cases. The change in the electrical properties with change in temperature of the developed material leading to fast switching action is being examined and could be broadly attributed to phase transformations in the material.

Paper dirt speck analyzer

A paper dirt speck analyzer has been designed and developed at CEERI using image-processing technique, as paper dirt measurement is an important parameter of the paper quality for the pulp and paper industry. The main components of the system are a PC, monitor, illumination system and image processing software for computation of dirt speck on paper. The indigenously developed instrument, using the latest available image analysis techniques, helps the paper maker in analyzing dirt specks on paper, based on physical area as well as EBA computation of the captured image of the sample paper. The instrument has a field of view of about 40 mm x 30 mm sample area with an accuracy of 0.002 mm resolution.

An optoelectronic instrument for determination of sulphite in beverages

An instrument to measure the sulphite concentration in beverages has been designed and developed at CSIO. This selective and sensitive method for determination of sulphite is based on the reaction of pararosanline acid bleached dye with formaldehyde solution, which gives a violet colored complex having absorption maximum at 560 nm. High intensity green light emitting diode (LED) of wavelength 565 nm is used as the light source. A BPW21 photodiode having the relative spectral sensitivity above 90% in the range of 500-600 nm has been used as a detector for the determination of sulphite concentration. The method will lead to the development of a portable device for sulphite measurement in beverages. The instrument can be used in the field and the results are directly displayed on the LCD. There is no interference of various other cations and anions in the test solution.

Optical fiber temperature switching technique

An optical fiber switching technique for insitu monitoring of point temperature of a process remotely, developed at CSIO, is very useful for monitoring temperature in applications involving a harsh environment, which could be corrosive, electromagnetically noisy, chemically explosive and hazardous. It works on the principle of guiding light by means of total internal reflection occurring in a right angled micro prism mounted on a glass capillary tube that contains a liquid in a bulb attached at the bottom.

Monitoring of railway tracks and acceleration of railway vehicles for safety determination

A team of CSIO scientists has developed Oscillation Monitoring System which is an advanced portable instrument to monitor, detect and record the horizontal and vertical acceleration of the railway vehicles (railway coaches, wagons and locomotives, etc.) as well as of the railway tracks. The instrument uses 89C52 low power micro-controller as the main component. The system continuously measures vertical and lateral accelerations at any desired location on the floor of a railway

vehicle and simultaneously measures distance from fixed points of track on real time basis. The system is capable of working in non air-conditioned, harsh environment and withstands vibration of '1 g' in all three orthogonal axes. The system is designed with large storage capacity and displays locations of bad spots along with other required information. The system has been field tried in association with Research, Design and Standards Organisation, Lucknow. The instrument has been installed in Track Recording Coach on the railway routes from Kalka to Ambala & from Ambala to Jalandhar.

Fig. 1.28: Power quality analyser

A low cost power quality analyser for industrial and commercial applications

For most of the power intensive industries, quality of power is important. To meet such a need, CSIO has developed a low-cost power quality analyser (PQA) based on a state-of-the-art digital signal processor (Fig. 1.28). It measures the power quality events along with basic electrical parameters in a three-phase four-wire star connected system. It detects the impulse transients, swells & sags, harmonics, phase sequence, unbalance along with basic electrical parameters like voltage, current, power factor, powers & energies.

1.6.2. Progress made under Network Projects

I. Special electron tube technologies for large scale applications

This ambitious project being coordinated by CEERI aims at technology development for fabrication and characterization of high power electron tubes, their components like RF windows, multistage depressed collectors, high current density cathodes and other components, plasma devices and integrated pulse power systems.

Dispenser cathodes. Technology of graphite to graphite and graphite to alumina brazing has been developed using active alloy brazing. Dispenser cathodes have been developed and are currently undergoing life tests at accelerated temperature. One of the cathodes has logged more than 27,000 hr. of life without any degradation in emission. A prototype thermionic emission microscope has been developed to study the spatial emission distribution. The performance is satisfactory.

Fig. 1.29: Complete alignment set-up for multi-stage depressed collector

Multi-stage depressed collector. An accurate micro-alignment set-up for electrodes in multi-stage depressed collector, to enhance the efficiency of space borne 140 watt Ku band Traveling Wave Tube, has been developed. It initiates development of a generic technology for axial alignment of the four stage sub-assemblies, each containing one hollow conical poco-graphite electrode, an alumina insulator and a monel outer shell, within $\pm 10\Omega m$, which will give enhanced collector efficiency, better than 60%, the present state-of-the-art available in India (Fig. 1.29). A design of high precision mechanical fixture device has been developed for aligning the electrodes at different stages using He-Ne laser source for its coherent and stabilized characteristics in the field of Metrology. The main thrust of the work lies in accurate alignment of the annular hollow conical shaped four sub-assemblies into the MDC.

II. Development of key technologies for photonics and opto-electronics

It is proposed to develop indigenous technology and packaged products for a number of key components and devices, which play vital role in future communication technology and have enormous market potential, e.g., Optical amplifiers, in-fibre Bragg grating, Arrayed Planar Waveguide Components and Organic Light Emitting Diodes (OLED).

Fig. 1.30a: EDFA module in the main studio of Cable Comm, Saltlake, Kolkata

Fig. 1.30b: FBG sensor mounted on a simulated HT (High Tension) line

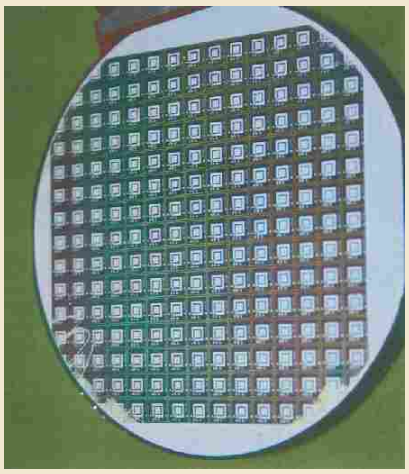


Fig. 1.31: Acoustic sensors on 4" silicon

This project has shown a commercial promise as 40 amplifier modules of C-band optical amplifier for telecom application, each costing around Rs.2.0 lakh, for applications in Cable TV (CATV) network, have so far been sold in the national and international markets. 16 of them have been exported to USA after obtaining the qualification certificate from the competent authority. A few more orders are awaiting delivery. (Fig. 1.30a).

A unique facility for writing Fibre Bragg Grating and Long Period Grating has been set up to cater to the needs of both strategic and civilian sectors of the country. The set up is now being used for producing a number of Fibre Bragg grating sensors (Fig. 1.30b) and filters on a regular basis for supplying to the users. As an off-shoot of this network activity, a sensor has been developed to measure temperature and strain of high tension transmission lines erected by M/s Power Grid Corporation of India. One such sensor has been installed at a testing site in West Bengal. This has been developed under a collaborative project with SINTEF, Norway under an Indo-Norwegian collaboration programme.

III. Developing capabilities and facilities for micro-electromechanical systems (MEMS) and sensors

The project aims at development of MEMS based chemical and biosensors, microstructures for Lab-on-a-chip type application in different chemical and biological fields, and micro-cantilever beam array biosensors. These technologies are to be transferred to industry for commercial exploitation.

Fabrication of zinc oxide based piezoelectric acoustic sensor using MEMS technology of bulk micromachined (100) silicon diaphragm has been completed at CEERI. The sensor is a sandwich structure consisting of two concentric metal electrodes, sputtered zinc oxide layer and a top metal electrode. Two capacitors, formed by the concentric electrodes, when connected in parallel, cancel the pyro-electric response. The device was fabricated on one side of the 4" diameter silicon wafer and an acoustic tunnel was made on the other side of the sensor to maintain sound pressure level inside the cavity below the silicon diaphragm. A Pyrex glass base was bonded on the backside of the device. The acoustic sensor having 5 x 5 mm^2 area, 25µm thick silicon diaphragm and 3µm thick ZnO layer, showed an average sensitivity of 50 µV rms/Pa over a frequency range of 31.5 Hz to 8 kHz (Fig. 1.31).

IV. Electronics for societal purposes

The project with CSIO as the nodal laboratory aims to develop electro-optic systems for sorting, grading, packaging & storage of agricultural products, prosthetic instrumentation and medical instruments calibration and natural hazards mitigation.

During the year, work on several applications continued. A controlled atmosphere system has been developed, integrated with sensors, solenoid valves, nitrogen generator and scrubbers to maintain the level of required parameters. The system is computer-controlled, operated with Lab-View Software. The five parameters - temperature, humidity, oxygen, carbon dioxide and ethylene concentration levels are displayed on the computer monitor and controlled through computer. Performance testing of the system has been checked with different gas concentrations. The system is under performance trial for preservation of different fruits and vegetables. An Off-Line non-destructive quality assessment system based on selective absorption of IR for fingerprinting of different attributes for apples usingfiber optic probe with interference IR filters has also been developed.

The complete system has been developed at a selected field site near Haridwar (Mansa Devi). The system is operational round the clock and is under observation and field data is being collected for further analysis. Test & Calibration Centers for Seismic Instruments & Networks have also been set up.

1.6.3. Human Resource Development

CEERI

- Practical training was provided to students of IIIT Pune and IIT Delhi on "IC Fabrication Technology". Sixty five M. Tech. students and one faculty member attended the training.
- A two-day training programme on 'Practical Aspects of Process Control Instrumentation' was conducted at Udaipur Solar Observatory (USO), Udaipur.

CSIO

- 14th Management Development Programme on Operation, Maintenance and Repair of Bio-medical Equipment was conducted for the third world countries.
- 1st Management Development Programme on Operation, Maintenance and Repair of Optical/Ophthalmic Equipment was conducted for the participants from several developing countries.

1.6.4. Recognition & Awards

Recognition and awards received by CSIR Scientists in the area of Electronics are listed below:

Orissa Young Scientist Award by Orissa Bigyan Academy	Dr. DP Das, CEERI

1.7. Energy

In its early years, CSIR played a major role in the establishment of the coal washeries in the country. It has been working on developing new approaches to coal fines beneficiation and recovery from the washeries, design of mini flotation plants, etc. It has assisted the steel industry in deciding on coke blends; the power industry in evolving washing strategies and the myriad of small and medium sized beehive coke units in the coal belt of India in producing coke efficiently with minimum pollution from inferior coals. It has been a pioneer in the developmental efforts in coal gasification and conversion of coal to liquid fuels. CSIR is synergising its strengths existing in different laboratories by networking to develop technologies/products required by the Indian industry. Some of the achievements are outlined below:

1.7.1. Scientific & Technological Achievements

Sol-gel synthesis of lithium silicate nanoparticles: scope for CO_2 sequestration

Synthesis of nanocrystalline lithium silicate by coupling of sol-gel method in reverse microemulsion has been reported by CFRI, wherein the samples calcined at 800°C give pure phase lithium metasilicate nanocrystallites. X-ray diffraction and transmission electron microscopy confirm the formation of nanocrystalline lithium silicate particles with a narrow size distribution. The nanoparticles prepared in the microemulsion show enhanced CO_2 sorption capacity and shorter retention times at higher temperature (~131 ml/g at STP at 610°C), which are better than the best known results.

Estimation of gross calorific value of coals using artificial neural network

The gross calorific value (GCV) is an important property defining the energy content and thereby efficiency of fuels, such as coals. There exist a number of correlations for estimating the GCV of a coal sample based upon its proximate and/or ultimate analyses. These correlations are mainly linear in character, although there are indications that the relationship between the GCV and a few constituents of the proximate and ultimate analyses could be nonlinear. Using this approach, CFRI has developed a total of seven nonlinear models using the artificial neural networks (ANN) methodology for the estimation of GCV with a special focus on Indian coals. The comprehensive ANN model developed here uses all the major constituents of the proximate and ultimate analyses as inputs while the remaining six sub-models use different combinations of the constituents of the stated analyses. It has been found that the GCV prediction accuracy of all the models is excellent, with the comprehensive model being the most accurate GCV predictor. Also, the performance of the ANN models has been found to be consistently better than that of the linear counterparts.

Density measurement of coal samples by different probe gases and their interrelation

A study which demonstrates that nitrogen, which is cheaper and easily available, can be used gainfully as the probe gas for estimating the true density of coals has been carried out at CFRI. Nitrogen was used instead of the commonly employed helium for the gas displacement pycnometer based density determination of a number of coals of Indian origin. The results show that the nitrogen-based densities are always higher than the helium-based ones. Also, empirical relationships between the helium-based and nitrogen-based coal densities have been developed by two modeling methods, namely, multi-variable regression and artificial neural networks.

Although the two models have fared well, the neural network model exhibits a relatively better prediction accuracy and generalization performance than the regression model.

Effect of gasoline composition (olefins, aromatics and benzene) on exhaust mass emissions from two-wheelers

A study which could be of practical significance was conducted on in-use and new, Indian two-wheelers to study the effect of gasoline composition (olefins, aromatics and benzene) on exhaust mass emissions. Exhaust emissions of benzene were also measured. Six makes of two-wheelers consisting of popular 2-stroke and 4-stroke, mopeds, scooters and motorcycles were tested. Three test fuels, a high olefin gasoline, a high aromatic gasoline and a Euro-III equivalent gasoline were used for the study. Intake system deposit study was also conducted on 4-stroke motorcycles and two-stroke scooters having separate lubrication, using two fuels, i.e., high olefin gasoline and Euro-III gasoline, with and without the use of multi-function additives. The study shows that lowering the benzene content in the fuel would greatly help to reduce exhaust benzene emissions. Multi-functional additives were seen to be very effective in controlling intake system deposits. The studies carried out at IIP will help the oil industry to understand the effect of fuel composition on exhaust emissions from two-wheelers and help the industry in modifying the fuel quality as per the future requirements.

Biodegradable girth gear lubricant

In cement plant, generally girth gears are used for crushing raw materials. Currently, sprayable greases are used as the lubricant of girth gears. The consumption of these greases is about 500-600 metric tons p.a., which are being imported, costing around Rs. 20-30 crores. IIP has developed eco-friendly biodegradable sprayable girth gear lubricant for cement plants at lab scale. The performance of this product is better than that of the existing commercial product, especially with regard to load carrying capacity, and performance properties such as damaged load and wear weight loss. The products developed utilize low value non-edible oil as raw material against imported products, which are based on mineral oil.

Anode supported SOFC technology

A team of scientist at CGCRI has fabricated large numbers of planar-anode-supported single cells of dimension 5 cm × 5 cm × 1.5 mm by using simple, inexpensive and up-scalable fabrication techniques such as tape casting and screen printing (Fig. 1.32). SEM micrograph revealed that the developed cells had the right kind of microstructure with a 20μm thin, gas-tight 8 mole% yttria stabilized zirconia (YSZ) electrolyte sandwiched between a porous anode (NiO-YSZ) support (1.5 mm thick) on one side and a 50 m thick porous Sr-doped $LaMnO_3$ (LSM) cathode layer on the other side.

The electrochemical performance of these cells was tested at Forschungszentrum Jülich (FZJ), Germany. The performance of the cells has been found to be excellent with current density as high as 1.3 A/cm^2 under a cell voltage of 0.7 V at an operating temperature of 800 °C.

The performance of cells made by CGCRI is comparable with that of cells made by other leading international SOFC fuel cell stack developers.

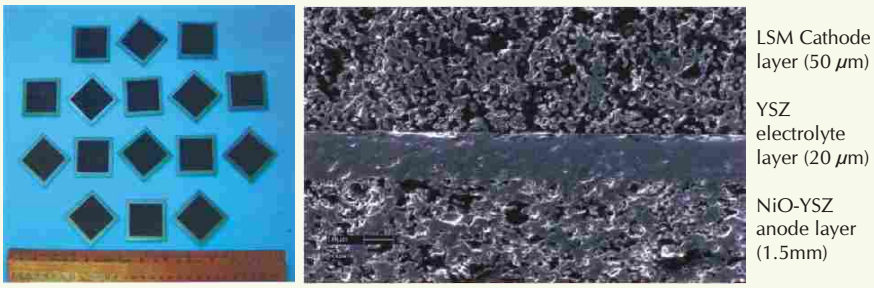


Fig. 1.32: (a) Planar anode-supported SOFC single cells (5 cm X 5 cm X1.5 mm) and (b) SEM micrograph of the cross-section of a typical SOFC single cell

1.7.2. Progress made under Network Projects

I. Coal characterization & resource quality assessment for specific end-users

The project aims at petrographic characterization and coking behaviour of coal, gainful utilization/value addition of North East (NE) coal directly or after suitable blending; developing appropriate technology for carbonization/combustion and/or after sulphur cleaning by suitable processes and also the recovery of precious and rare metals from pyritic wastes, if possible; mathematical modelling for prediction of composition of gas as a function of operating parameters and properties of coal for gasification reactions. During the period of this report, identification of a few precious metals was carried out and recovery process was tried. Pyretic washes collected for further investigative studies and artificial intelligence based models for classifying Indian non-coking coals have been developed.

II. Quality enhancement of coal for its efficient utilisation

The project envisages to identify the optimum beneficiation strategy of non-coking coals to meet the needs of different end users; to assess the effect of blending of coals (indigenous & imported) on efficiency of power generation and evolving strategies of blending of dissimilar coals. Use of Computational Fluid Dynamics (CFD) as a modelling tool of the different sub-processes like spiral, cyclone and flotation for improving the design and performance of existing systems has also been included as an objective.

As this study seeks to assess quality of a wide range of Indian coals, samples have been collected from various sites and are being processed. Detailed full scale washability studies were carried out on two high ash coals from Eastern Coalfields Ltd. (ECL) and two coals from South Eastern Coalfields Ltd. (SECL). Washability studies carried out on two high ash coals from ECL, Rajmahal coal (39.0% ash) and Chitra coal (48% ash), reveal that the theoretical yield at 34% ash is 78% and 68% respectively. Washability studies carried out on two coals from SECL, Kusmunda (33.1% ash, and Baroud (55.0% ash) reveal that for Kusmunda the theoretical yield at 25% ash is 78% while for Baroud the theoretical yield at 34% ash is 29.5%.

Pilot scale jigging studies using Kalinga Coal of Mahanadi Coalfields Limited have been carried out and Ep values were calculated. The tests were conducted on raw coal crushed to 25 mm and it was observed that yield of 40% at about 25% ash content is achievable.

Combustion characteristics of five raw coals (Chitra, Kusmunda, Sonepurzazari, Churi and Baroud) have been studied in Drop Tube Furnace. The burnout efficiency of a few samples was estimated from the chemical analysis of the original coal and the char samples collected from the middle port of Drop Tube Furnace using ash constancy approach.

For the development of Gas to Liquid Technologies for DME and Fischer Tropsch Fuels, SBA-15 support was prepared and characterised by BET SA and XRD crystal phase identification. Cobalt supported SBA-15FT catalysts were prepared by incipient wetness impregnation method with 20% Co loading on support. A series of Cu-Zn supported alumina catalyst were prepared by varying the methods of catalyst preparation.

Hexagonal Mesoporous Silica (HMS) support was prepared and characterized by BET SA and XRD crystal phase identification. Cobalt supported HMS based FT catalysts were prepared by incipient wetness impregnation method with 20% Co loading on support.

In another activity, i.e., Development of Liquid fuels and ethanol production from biomass some significant progress has been reported, viz.,

- A process has been developed for removal of furfural from acid hydrolysate by solvent extraction method.
- Batch fermentation studies with free cells of strain IIPE453 showed ethanol fermentation of the acid hydrolysate after removal of furfural; around 55-60 ml of ethanol (99%) per kg of raw dried bagasse was obtained in 8 hrs. The ethanol productivity was found 0.56 $g.l^{-1}.h^{-1}$.

- Batch fermentation studies on acid hydrolysate of corn cobbe with free cells of IIPE453 showed ethanol fermentation. The overall yield of ethanol was 21% of the sugars obtained from the corn cobbe as feed stock.

1.7.3. Human Resource Development

CFRI

- A training programme of two and a half years duration was conducted on 'Coal Carbonization' for officials of Durgapur Projects Limited in which 300 staff (30 officers and 270 labourers) were trained.
- A four-day training programme on 'Petrographic Analysis of Coal' was conducted for officials of Rashtriya Ispat Nigam Ltd.

IIP

- Four training programmes on "Petroleum Refining and Petroleum Technology" were conducted.
- Training programmes were conducted on: "Petroleum Products: Specifications and their Application"; "Petroleum Refining Technology" for Chemical Engineers of UOP; and on "Vehicular Pollution" for Officers of transport departments of various states.

1.7.4. Recognition & Awards

Recognition and awards received by CSIR Scientists in the area of Energy are listed below:

Shri Khurshaid Lal Science & Technology Award 2005 and 'DOON RATNA' Award.	Dr. A Datta, IIP
CSIR Technology Award: Chemical Technology for developing Comb Type Polymeric Wax Crystal Modifier and Dewaxing Aid Additives for Production of LOBS	IIP, Dehradun (Team members: Dr. AK Chatterjee, Shri UC Agrawal, Shri RC Ghidiyal Dr. VK Bhatia and Shri NN Kulshrestha)

1.8. Food & Food Processing

In the area of food and food processing, CSIR is contributing several novel, cost-effective and easy-to-operate techniques and processes for food grains storage, conservation and processing. CSIR has developed various technologies for low-cost nutritious foods and food preservation, convenience foods, non-conventional foods, spice products, fruit & vegetable preservation, packaging & transportation, besides appropriate and improved designs for a range of machinery for processing, milling, etc. Three network programmes are also being implemented in this area.

1.8.1. Scientific & Technological Achievements

Consortium for degrading DDT

Persistent use of organic pesticides such as dichlorodiphenyltrichloroethane (DDT) and related compounds is of environmental concern because of the toxicity, high persistence and resistance to degradation and liability to bioaccumulation of these compounds. CFTRI has developed a defined microbial consortium, capable of degrading DDT. The microbial consortium consists of ten bacterial isolates, of which of various concentrations of pectin degrading enzymes and starch degrading seven are of pseudomonas species and three are of flavobacterium, vibrio and

Burkholderia species. Degradation parameters were optimized using Response Surface Methodology. The optimized conditions were inoculum concentration: 1500µg protein/mL and temperature: 25°C. pH was varied for different concentrations of DDT. The model has been validated.

Specialty fat powders for use in various food formulations

Fat is an inseparable ingredient of most foods as it imparts desirable textural and organoleptic properties. Fats in natural form have certain disadvantages, mainly in terms of handling and mixing. CFTRI has standardized the formulations and process for preparation of speciality fat powders containing up to 75-80% fat. Casein, whey powder and skimmed milk powder (SKMP) were found to be the desirable encapsulating agents and spray drying was the preferred process. Of these, casein was found to be better in obtaining powders with high fat content. Bulk density of fat powders ranged from 0.30 to 0.47 g/cc. The powder prepared using whey powder was found to have least density and that prepared using casein and SKMP had the highest density.

Enzymatic maceration of jackfruit (Artocarpus heterophyllus) pulp for quality juice production

It is rather difficult to extract juice from jackfruit pulp due to its highly viscous nature and the presence of 2.1 % pectin (as % calcium pectate) and 1.18 % starch. CFTRI has screened enzyme preparations for jackfruit pulp maceration and optimised enzymatic maceration processing conditions of the jackfruit pulp. The combination enzymes have been found to be the best enzyme formulation compared to the individual enzymes such as *Pectinase (CCM), Biotropicase and Trizyme* employed in the jack fruit juice processing. The combinations of various enzymes exhibit different degrees of activity when employed to reduce the viscosity of jack fruit pulp. The combination of pectin degrading and starch degrading enzymes rapidly reduces jack fruit pulp viscosity and facilitates smooth juice extraction, which could be filtered or centrifuged easily. The effects of enzyme concentration, incubation time and their complex interactions on juice yield, viscosity and juice carotene content in the maceration process have been studied by using optimized process conditions. The process has been scaled up at pilot plant level.

Identification of the gene for pungency in chilli

Chilli is a spice known worldover for its pungency as well as its red colour. The pungency is attributed mainly to capsaicin, which has wide applications in food, medicine and as a pharmaceutical. There is worldwide interest to identify the gene responsible for the pungency, but there has been no clear demonstration of the critical step in the formation of capsaicin. CFTRI has done extensive studies on the formation of capsaicin in chilli fruits. The enzymatic condensation of vanilylamine and 8-methyl nanenoic acid leading to capsaicin was carried out using the enzyme capsaicin synthase, which has been purified for the first time and its amino acid composition in the n-terminal determined. Based on this, the gene (csy-1) responsible for pungency has been cloned and sequenced. The functionality of the csy-1 has been demonstrated using expression vector- E. coli, which produces the recombinant enzyme. This has implications in regulation of capsaicin in Capsicum genotypes.

Virgin coconut oil

Virgin coconut oil (VCO), which is colourless and possesses an intense coconut

aroma is what every user looks for. CFTRI has a process ready for VCO, which is rich in lauric fatty acid and contains vitamin E with a peroxidase value of below 1 and less than 0.2% free fatty acid (FFA). It has a long shelf life due to its inherent anti-oxidant properties. It has longer shelf life compared to other vegetable oils. VCO is abundant in medium chain fatty acids, such as C8, C10 and C12, and has a unique role in the diet as an important physiological functional food. It is also used as a hair conditioner. It softens the hair and conditions the scalp. Using the coconut oil as a pre-wash conditioner can rid a person of dandruff better than a medicated shampoo. VCO has been recognized for its quality of strengthening the structure of damaged, devitalized hair. It lubricates and softens the hair shaft through the action of minerals such as magnesium, potassium, calcium and iron. As a "functional food", it acts as antibacterial, antiviral and anti-fungal agent.

1.8.2. Progress made under Network Projects

I. Positioning Indian nutraceuticals and nutrigenomics on a global platform

The project envisages repositioning India's leadership in the area of nutraceuticals and nutrigenomics through study of molecular basis of bioactives for the preventive, curative use and management of several systematic and chronic ailments. The focus is on the health benefits from a variety of plant resources and their ingredients, which may ultimately pave the way for the approach called nutrigenomics.

During the period under report, work continued apace on several distinct yet related objectives. The pentapeptide was chemically synthesized and the later purified by HPLC. The sequence of the peptide was evaluated by amino-terminal sequenceanalysis. About 900 mg of the pure peptide and acetone powder of porcine kidney was prepared for further studies on Angiotensin-Converting Enzyme (ACE) inhibition using human cell lines. Arachin, the major storage protein of groundnut (Arachis hypogeae), was isolated by ammonium sulfate precipitation. The methodology for the isolation of polyphenol enriched fraction from one source and for one product has been standardized. A green processing technology has been developed for the production of steviosides from Stevia rebaudiana dried leaves.

II. Nature, nature-identical or similar biomolecules

India is a country with rich biodiversity and also with established traditions in use of biomolecules for health, nutrition and a host of other useful purposes. In spite of huge demand for such biomolecules throughout the world, their availability is limited and the country even depends on import of a number of biomolecules. The project targets to develop commercially exploitable biomolecules.

As a part of this project, process conditions were optimized for the preparation of radical scavenging conserve from the pruned and coarse tea leaves. The extraction of the waste leaves of Tectona grandis has been carried out using polar and non-polar solvents such as hexane and methanol. Solidification of the gummy extract has been tried using different techniques. The maximum yield (14.80%) of the colouring substance was obtained with methanol solvent system.

An ecofriendly process has been developed for the extraction of vanillin from vanilla pods using microwave & ultrasound processes. A convenient HPLC/GC method has been developed for the quantitative determination of phenolics compounds present in the vanilla extract.

III. Establishment of genetically modified food referral facility

It is imperative for the Government to have testing or referral centers in place with well-developed robust methods to accurately quantitate Genetically Modified Organisms (GMOs) in foods and food ingredients to assure compliance with

threshold levels of GM products and evaluate their safety. The project aims to establish a referral center for food and food products, which will boost export of these items based on their declared absence or presence of the GM component.

An exclusive GMO referral centre of excellence with the state-ofthe-art facilities has been established and it is fully functional. DNA extraction methods from different food matrices and verification of the purity of the isolated DNA by electrophoretic methods and spectrophotometric method were optimized.

PCR-based screening methods including nested PCR for detecting the regulatory elements (CaMV P35S and TNOS3), specific plant species genes soya/maize (Le 1, Zein and invertase), construct specific genes of herbicide tolerant soya and insecticide tolerant maize (CP4-EPSPS and cry1A (b)) have been developed and validated. These methods are being accredited to NABL 17025 standards. ELISA based methods for detection of CP4-EPSPS in herbicide tolerant soya and Cry1 A (b) in insect tolerant maize are in place. Real time-PCR methods using TaqMan probes for quantitation of CaMV 35S in herbicide tolerant soya and insect tolerant maize have been optimized and are in place. The detection limit for all the above methods is 1% GM at > 99% confidence level.

A number of primer pairs were designed to amplify different regions of the transgene both in maize and soya. In total, over 20 different segments of the transgenes of insect tolerant maize (MON 810) and pesticide tolerant soya (RUR soya) have been detected in spiked GM biscuits

1.8.3. Human Resource Development

CFTRI

CFTRI continued to offer M.Sc. Food Technology programme of 2 years' duration; certificate course in milling technology of 1 year duration and training of women entrepreneurs for the establishment or rural bakeries under its programme. Two bakeries were established at Vivekananda Girijana Kalyana Kendra (VGKK), BR Hills and JSS Free Educational School (JSS FES), Suttur. Six women workers each from VGKK and JSS FES were trained at CFTRI and at established bakeries in the production of nutritious bakery products. Trained women are producing bakery products regularly at the bakeries.

1.8.4. Recognition & Awards

Recognition and awards received by CSIR Scientists in the area of Food and Food Processing are listed below:

National Award for Excellence in Consultancy Services 2006- Certificate of Merit	CFTRI
Elected Fellow of National Academy of Science (Allahabad)- 2006	Dr. KSJ Rao, CFTRI
Invited Member of Scientific Advisory Council, McCormick Science Institute, Maryland, U.S.A	Dr. K Srinivasan, CFTRI
Fellow of International Academy of Food Science and Technology (Canada) Fellow of Indian Society of Agricultural Biochemists Prof. S.R. Vyas Memorial Award of Association of Microbiologists of India	Dr. GA Ravishankar, CFTRI

1.9. Health Care, Drugs & Pharmaceuticals

CSIR has developed several cost effective and innovative processes for many generic drugs. Several herbal drugs were standardized and pharmacopeial standards for Ayurvedic drugs were laid. In addition, CSIR is developing cost-effective and commercially viable technologies for a wide range of essential drugs, such as anti-cancer, anti-virals, anti-bacterials, anti-glaucoma, anti-inflammatory, analgesics, and cardio-vascular drugs, among others. This has given much needed fillip to Indian drug industry and allowed it to emerge as the largest producer of generic drugs in the world. CSIR laboratories are working in network mode within themselves and with some pharmaceutical companies. Some of the significant achievements project-wise are given below:

1.9.1. Scientific & Technological Achievements

Apoptosis in liver during malaria: role of oxidative stress and implication of mitochondrial pathway

A team of researchers from CDRI has shown for the first time that malarial infection induces hepatic apoptosis through augmentation of oxidative stress. Apoptosis in hepatocyte has been confirmed by TUNEL assay and caspase-3 activation. Gene expression analysis indicates significant down-regulation of Bcl-2 and up-regulation of Bax expression in liver of malaria infected mice. Confocal microscopy showed translocation of Bax from cytosol to mitochondria in apoptotic hepatocyte, resulting in opening of permeability transition pores, which in turn decreases mitochondrial membrane potential and induces cytochrome c release into cytosol. Generation of hydroxyl radical (-OH) in liver during malaria was significantly inhibited by administration of (-OH) specific antioxidant as well as spin trap, alpha-phenyl-tert-butyl-nitrone in malaria-infected mice suggesting implication of oxidative stress induced-mitochondrial pathway of apoptosis in the pathophysiology of hepatic dysfunction in malaria.

A novel approach for designing antibacterial peptides

A novel approach for designing antibacterial peptides with modulation of toxicity against hRBCs by employing the leucine zipper sequence has been reported by CDRI. However, the original leucine zipper peptides (LZP) and its analogs in which leucine residues at 'a' and/or 'd' position of the heptad repeat were substituted with single or double alanine residues exhibited appreciable and similar antibacterial activity against the tested Gram positive and Gram negative bacteria. Substitution of alanine progressively lowered the toxicity of Leucine Zipper Peptide (LZP) against human red blood cells (hRBCs), as it impaired the binding and localization of LZP to hRBCs, but had little effect on the peptide-induced damage of Escherichia coli cells. Although LZP and its analogs exhibited similar permeability, secondary structures, and localization in negatively charged membranes, significant differences were observed among these peptides in zwitterionic membranes.

Cloning of lysine epsilon-aminotransferase

Yet another significant development from CDRI is the cloning and characterization of lysine epsilon-aminotransferase (LAT), a pyridoxal 5'phosphate (PLP) -dependent enzyme, highly up-regulated in nutrient-starved tuberculosis models. The crystal structures in the un-liganded form, external aldimine with L-lysine, with bound pyridoxamine 5'-phosphate (PMP) and C5 substrate alpha-ketoglutarate has been reported for the first time (Fig. 1.33). The structure reveals a Glu243 'switch' through

which the enzyme changes substrate specificities. The unique substrate L-lysine is recognized specifically when Glu243 maintains a salt-bridge with Arg422, while the binding of the common C5 substrates L-glutamate and alpha-ketoglutarate is enabled when Glu243 switches away and deshields Arg422. This 'glutamate switch' is an elegant solution devised by a subgroup of fold type I aminotransferases for recognition of structurally diverse substrates through the same binding site and provides for reaction specificity. Incidentally the enzyme has been identified as a top-3 drug target against tuberculosis persistence by the international structural genomics consortium (http:www.webTB.org.).

The structure has been used to identify novel inhibitors using virtual screening approaches and these will be evaluated against persistent models of tuberculosis.

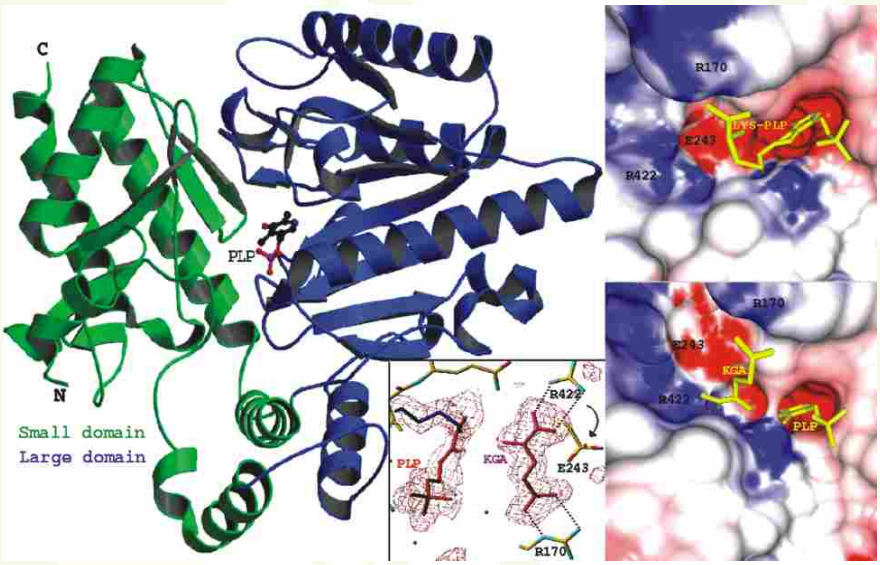


Fig. 1.33: X-ray crystal structures of M. tuberculosis Lysine ε-aminotransferase, a protein upregulated over 40-fold in latent/persistent models of tuberculosis

Progress of candidate drugs in clinical trials

Over the years CDRI has developed many drugs, some of them are under clinical trials, such as:

α,β-**Arteether (antimalarial drug).** Multi-centric clinical trials for pediatric use have been completed in >230 children suffering from P. falciparum malaria. The response has been quite satisfactory.

Compound 80/574 (lipid lowering). Phase III clinical trials are in progress at four medical centers in collaboration with M/s Cadilla Pharma Ltd.

Picroliv (hepatoprotective herbal preparation). Phase III clinical trials are in progress in patients of tuberculosis receiving MDT and in patients suffering from alcoholic cirrhosis.

Compound 97/78 (antimalarial). Pre-clinical studies including pharmacology, toxicology, pharmacokinetics and metabolism in rodents and monkeys have been completed in collaboration with IPCA Labs. Dossier submitted to DCG(I) for permission to initiate Phase I clinical trials and an IND application has been filed during the year.

Molecular and functional analysis of whiB genes of Mycobacterium tuberculosis H37Rv

The whiB genes are present in all the genera of actinomycetes including M. tuberculosis H37Rv and M. leprae. Almost all organisms have multiple whiB like genes and their number may vary among the species. These are small proteins between 9KDa and 19KDa, and amino acid sequence alignment shows that though both N-terminus and the C- terminus of these proteins show strong divergence, the central region is conserved. IMTECH has deciphered the function of two of these genes of M. tuberculosis H37Rv. It has been shown for the first time that the biochemical properties of these proteins are similar to those of thioredoxin like proteins and may be part of the redox network of M. tuberculosis. At least for WhiB1, the in vivo target is known.

Altered expression and glycosylation of plasma proteins in rheumatoid arthritis

During the year, IGIB researchers investigated the changes in the Concanavalin-A(Con-A)-bound plasma proteins in rheumatoid arthritis (RA) patients in comparison to those of the healthy controls. The 2-D PAGE analysis of the Con-A-bound plasma samples showed a large number of protein spots, a few of which were differentially expressed in the RA patients. Some unidentified proteins were also detected in the RA patients, which were absent in the controls. The study enunciates the role of carbohydrates as well as that of the acute phase response in the disease pathogenesis.

Evidence of linkage and association at 18p11.2 for psychosis

The genetic basis of bipolar disorder (BPD) and schizophrenia (SCZ) has been established through numerous clinical and molecular studies. Although often considered separate nosological entities, evidence now suggests that the two syndromes may share some genetic liability. Several chromosomal regions are reported to be shared between these syndromes (18p, 6q, 10p, 13q, 22q). IGIB has reported a positive linkage and association finding at 18p11.2 for psychosis. Two-point linkage analysis performed on a series of 52 multiplex pedigrees with 23 polymorphic markers yielded a LOD score of 2.02 at D18S37. An independent set of 159 parent offspring trios was used to confirm this suggestive finding. The TDT analysis yielded support for association between the marker D18S453 and the disease allele. This region has been implicated by several studies on BPD. The findings provide an independent validation of the above reports, and suggest the presence of susceptibility loci for psychoses in this region.

A small cationic protein from a marine turtle

The egg white of marine turtle Caretta caretta contains a small cationic protein, but lacks lysozyme. IICB has sequenced the protein by a combination of sequential Edman degradation, carboxypeptidase digestion, nuclear magnetic resonance (NMR) and electrospray ionization tandem mass spectrometry. The protein contains 36 amino acid residues of which six are half-cysteines. The three-dimensional structure of the protein was deduced from two-dimensional NMR experiments and was observed to be similar to that of vertebrate beta-defensins. However, disulfide connectivity is C1-C6/C2-C5/C3-C4, different from that of the vertebrate beta-defensins. The protein showed strong antibacterial activity against Escherichia coli and Salmonella typhimurium. The protein also showed significant antiviral activity against an enveloped rhabdovirus, Chandipura virus, which is an emerging human

pathogen. This virus is also closely related to the vesicular stomatitis virus, whose growth was also inhibited. This small cationic protein is a part of the innate immunity of this organism and replaces lysozyme in the egg. It has the potential to be developed as an antibacterial and antiviral agent.

Herbal extract and a molecule from Murraya koenigii for the treatment of prostate cancer

A herbal formulation as well as an extract and composition obtained from M. koenigii and Tribulus terrestris have been found to be useful for the treatment and remedy of prostate cancer as per a study reported by IICB. The study also deals with a process for the preparation of the said formulation that contains extract and synergistic effects of the combined extract obtained from the above plants on androgen-dependent and independent prostate cancer cells.

Bioactive fraction from plant *Woodfordia fruticosa*

A molecule isolated from the flowers of *Woodfordia fruticosa* at IICB has been found to be useful as an anti-peptic ulcer. The molecule exhibits a strong gastric proton pump inhibitory activity as well as a good anti-*H. pylori* activity. Such dual property in one molecule is unique and augurs well for managing gastro-deodenal ulcers, since *H. pylori* and hydrochloric acid (HCl) are the two major causes of peptic ulcer diseases. A patent application designating several countries has been filed.

Effect of UV radiation on ciprofloxacin users

Ciprofloxacin is a widely used fluoroquinolone drug with broad spectrum antibacterial activities. Clinical experience has shown incidences of adverse effects related to skin, hepatic, central nervous system, gastrointestinal and phototoxicity. India is a tropical country and sunlight is abundant throughout the day. In this scenario exposure to ambient level of ultraviolet radiation (UV-R) in sunlight may lead to the harmful effects in ciprofloxacin users. An ITRC study shows a time-and concentration-dependent statistically significant ($p < 0.001$) damage. Ciprofloxacin produced reactive oxygen species ROS by Type I and Type II photodynamic reactions, interacted with nucleic acid moiety and inhibited cell viability. Further, UV-induced photo-peroxidation of linoleic acid was in accord with the involvement of ROS in the manifestation of drug phototoxicity. Appearance of ciprofloxacin induced phototoxicity at the ambient level of sunlight is a real risk for the people of India and other tropical countries. It is suggested that sunlight exposure should be avoided (especially in peak hours) during ciprofloxacin treatment.

1.9.2. Progress made under Network Projects

I. Asthmatic and allergic disorders mitigation mission

The emphasis is on exploring the mechanism of actions of the preparations / molecules on specific target sites with a view to understanding biochemical, immunological, genetical and pharmacological aspects, and strengthening the claims for mitigating asthmatic and allergic disorders.

In vivo anti-asthma activity testing of two lead molecules has been carried out. In vivo toxicity studies on these molecules suggest that both the molecules have wide therapeutic window. Preliminary data have already been generated on in vivo anti-asthma activity and toxicity on another lead molecule which appears promising. Pharmacokinetics study on one lead molecule has been completed and studies with

the other molecules have been initiated. Agreement with one corporate house has been made, in principle, to file patent and license out the potent anti-asthmatic molecule.

II. Newer scientific herbal preparations for global positioning

The project aims to develop effective standardized herbal formulations for use as health promoters, or for treating various disorders, adaptogens and immunomodulators, etc. During the year a clinical research organisation (Nicholas Piramal Research Centre, Mumbai) has been identified for undertaking proof of efficacy studies on a few of Positive Health Promoters (PHP) isolated under this project. MoUs have been signed with two hospitals in Mumbai where the proof of efficacy studies are to be undertaken

III. Predictive medicine using single and repeat polymorphism

This project being coordinated by IGIB proposes to build an Indian SNP (Single Nucleotide Polymorphism) database of common diseases and drug response related genes. Such a database is in the larger interest of human health in general and predictive medicine & drug response in particular in the country.

It is known that there are one million genotypings on disease candidate as well as drug responsive genes from 55 distinct populations covering all the major geographical zones representing individuals with different ethnic and linguistic origins (Indo-European, Dravidian, Tibeto-Burman and Austro-Asiatic). This is the first comprehensive analysis of the Indian population with respect to disease predisposition and drug response genes. Analysis of this data has revealed the following:

- contribution of language and ethnicity to genetic heterogeneity in the Indian subpopulations;
- different degree of relatedness of Indian subpopulations to different global populations typed in the International HAPMAP Consortium to the same extent;
- identification of a set of 23 reference populations which cover majority of the genetic spectrum of the Indian population; and
- development of a suite of novel computational programs for large scale variation in data handling and data analysis.

IV. Drug target development using in-silico biology

The project aims to create and develop in-house capability in drug target development using in-silico biology; to design programmes for developing new software, which enables identification of therapeutic targets; to design and develop new tools for predicting toxicity and drug response in-silico; and to generate qualified and trained IT professionals for pursuing research in the area of bioinformatics. During the year, a novel method for human GPCR protein prediction in human genomes has been developed. Also, the non-coding DNA motifs have been validated experimentally as potential targets.

V. Animal models and animal substitute technologies

The project aims to influence the process of new drug development and toxicity/ safety evaluation of drugs/chemicals. It is envisaged to introduce state-of-the-art animal models and animal substitute technologies for new drug development, which

will reduce the average time taken for development of new drugs by 2-3 years from the current average of 12-14 years in addition to providing better understanding of the drug action and targets.

Various approaches were worked on during the period, as elucidated below. Dopamine DA-D2 receptor binding assays were carried out in a human neuroblastoma cell line for neurotoxicity assessment using cypermethrin.

Neuronal and glial cells of rat were cultured and used as *in vitro* tool to study the mechanism of action of deltamethrin induced neurotoxicity. Estrogenic potential of plant origin was evaluated using a cell line by E-assay. Balb/c 3T3 and C3H10T1/2 cell transformation assay was carried out using murine peritoneal macrophages as short term tests for evaluating carcinogenic potential of chromium.

In vitro models for phototoxicity evaluation of the chemicals and industrial effluents were developed and validated. Alternates to animal models (Earthworm, Daphnia, pond snail) were developed and used for ecotoxicity evaluation of heavy metals and pesticides. Growth profiles of different transgenic mycobacterial strains of M. aurum were studied.

Microarray whole-genome expression profiling of central nervous system was carried out at various time-points. Further, 96 well format for GFP assay was standardized for single and multicopy promoter GFP fusion assays. Gene expression profiling of STR4Δ strain exposed to *homocysteine*, *cysteine*, S-adenosyl *Methionine* and *S-adenosyl homocystein*, singly or in combination, has also been carried out.

VI. Advanced facility for the safety evaluation of genetically engineered/ modified drugs

The project aims to identify the available GM food crops using recent DNA based molecular biology techniques, to develop chip-based diagnostics for the detection of GM foods and to assess their safety evaluation.

Methods have been standardized for biophysical analysis of therapeutic proteins, such as recombinant erythropoietin, streptokinase, insulin, interferon, HepB vaccine, etc. Several companies are already making use of this expertise for biophysical analysis of their drugs (batches of drugs already in the market as well as those which are under development) and testing for the presence of known and unknown impurities.

Data have been generated on a few standard materials available in the market, particularly on carbohydrate content, glycosilation and biological activity of different batches and different makes of Erythropoietin.

Procedures for micro-analytical techniques such as protein characterization, tryptic peptide fingerprinting, and N-terminal protein sequencing have been standardized.

Laboratory experiments on cell cultures (mouse fibroblast L929) were carried out for cytotoxicity (growth inhibition/cell death), mitogenic stimulation, receptor binding, inhibition of mitochondrial oxidation, etc., using reference standards. The data will be used as base line response of normal/control cell population for comparison of responses on exposure to model GM-drugs in their safety evaluation. OECD-GLP guidelines # 14 for in vitro testing, as made applicable with effect from December 2004, are used in these studies for their global acceptability.

1.9.3. Recognition & Awards

Recognition and awards received by CSIR Scientists in the area of Drugs & Pharmaceuticals are listed below:

Shanti Swarup Bhatnagar Award 2006 in Biological Sciences P.B. Rama Rao Memorial Award 2006 from the Society of Biological Chemists	Dr. V Bhakuni, CDRI
Young Scientist Award (CSIR) Young Scientist Award (National Academy of Sciences, India)	Dr. Md S Akhtar, CDRI
Triveni Devi Ram Sahai Award for the Year 2005	Dr. A Ghatak, CDRI
Raman Research Fellowship	Dr. SK Rath, CDRI
Ramanna Fellowship of DST J.C. Bose Fellowship, Min. of Science & Technology Elected Fellow, West Bengal Academy of Science & Technology, Kolkata	Dr. AK Misra, CDRI Prof. S Roy, IICB
Elected Fellow, Indian National Science Academy (INSA), New Delhi	Dr. PK Das, IICB
'Sir Gnan Chandra Ghosh Puroshkar-2007' by Science Association of Bengal	Dr. HK Majumder, IICB
Raman Research Fellow, CSIR	Dr. A Bandyopadhyay, IICB
Dr. N.R. Shelat Research Award 2006-07 of the Federation of Obstetrics & Gynaecological Society of India	Dr. SN Kabir, IICB
Stree-Shakti Science Sanman 2006	Dr. C Dutta, IICB
Elected Member, Human Genome Organization (HUGO), London Elected Fellow, West Bengal Academy of Science & Technology, Kolkata	Dr. K Ray, IICB
Elected Member, Human Genome Organization (HUGO), London	Dr. S Roychoudhury, IICB

1.10. Housing & Construction

CSIR has developed techniques and technologies covering the whole gamut of construction activities, right from foundations to construction equipment. Newer and innovative building components developed have greatly helped the building industry to standardize optimal structural elements. In the area of structural engineering, CSIR laboratories have specialized in making design and analysis of special and complex structures, such as high rise, long span, suspended, offshore, ships, etc., as also in the integrity assessment of these structures. CSIR is also known for its contribution to the roads sector through design and construction techniques of rigid and flexible payments using local skills and material resources. CSIR is excelling in these areas, both through network and non-network modes.

1.10.1. Scientific & Technical Achievements

Low cost houses in areas affected by natural disaster

AMPRI has developed low cost houses, especially for areas affected by natural disaster. These houses can cater to the needs of thousands of families affected by natural disasters like earthquakes, floods, tsunamis, storms, etc. The key features of such an house are: weight: 500 kg; fast and easy transportation; easy assembly and transportation of 20 houses at a time; convenient and durable foundations dismantle; fire retardant; cost effective (twin house costs Rs. 42,000 approximately).

Wood substitute from red mud

An R&D application having societal relevance has been the development of a wood substitute using red mud/ fly ash and organic fibre as a reinforcement in polymer matrix by AMPRI. Huge quantity of fly ash generated from thermal power plants can be used as raw material in building components. Composite doors and panels possess properties which are comparable to those of natural wood. Thus, the composite material could be used as a wood substitute for doors, windows, ceilings, flooring, partition and furniture. The cost of product is a lifetime cost, which is inclusive of its maintenance cost.

Alkali-activated, cold-setting fly ash building brick with ash content of more than 80%

Scientists from IMMT have developed a technology to use 80 to 95% (by weight) of fly ash by an alkali-activation process in the manufacture of cold-setting building bricks. The process has been developed to optimize the mix design, preparation of chemical activator and utilization of pond ash and other wastes in the production of building construction bricks and block-like products. The products demonstrate 1350 to 1650 kg/m^3 dry bulk density, 8 to 16% water absorption and crushing strength of 70 to 120 kg/cm^2 in bricks and 150 to 350 kg/cm^2 in block. The alkali-activated fly ash bricks are superior in strength, durability and chemical and heat resistance as compared to other building bricks. The production cost of a brick (230 x 110 x 75 mm^3 size) is estimated to be about Rs.1.45.

Code of practice/standards/specifications

Technical knowhow in preparation of standards and specifications is a niche domain of CRRI. Such standards are got approved by Ministry of Shipping, Road Transport and Highways, and then get implemented onto the field. Following codes have been prepared/developed during the year:

- Specification of Paving Bitumen (IS:73-2006) by Bureau of Indian Standards (BIS).
- Specification for Precast Concrete Blocks for Paving (IS 15658:2006) by Bureau of Indian Standards (BIS).
- Code of Practice for Tack Coat and Prime Coat Applications (Approved by Flexible Pavements Committee of IRC).
- Construction of Slurry Sealing and Micro-surfacing (Revised draft submitted to Flexible Pavements Committee of IRC).

Studies regarding landslide and rockfall on Mumbai-Pune expressway

Country's first expressway, i.e., the Mumbai-Pune express-way, which passes through the mountainous and rugged Deccan trap province faces major problems of rockfalls/landslides. During 2003 and 2004, a significant number of accidents and casualties have been reported because of rockfalls/landslides. The existing rockfall

Fig. 1.34: Landslide and rockfall site on Mumbai-Pune expressway

problem, if not timely and appropriately addressed, may get accelerated in intensity as well as magnitude further causing a lot of damage to infrastructure and may also lead to loss of life and further hardships to the commuters. CRRI in consultation with Maharashtra State Road Development Corporation (MSRDC) has identified thirteen sensitive rockfall/landslide locations, which have already been activated and are prone to further failure (Fig. 1.34). The extensive investigations reveal probable causes and the mechanism of the rockfalls/landslides. Appropriate short term and long-term remedial measures like steel fibre reinforced shot crete, soil nailing, wire mesh, provision of drainage system, etc., have been suggested for specific locations.

Utilization of copper slag as fine aggregate in cement concrete

Copper slag produced as a by-product of metallurgical operations is an inert material with physical properties similar to those of natural sand. A laboratory study was carried out by CRRI to investigate the potential of using copper slag as a partial replacement for sand in cement concrete. Slag was used in Pavement Quality Concrete as well as in Dry Lean Concrete mixes and its influence on workability, compressive strength, and flexural strength was determined. It has been reported that use of copper slag in concrete has no adverse effect on its strength. Blend of copper slag and fine sand with slag up to 40 percent can be used as fine aggregate in pavement quality concrete as well as in dry lean concrete. The study would help in effective handling and disposal of copper slag waste and would save precious land area apart from providing and saving road construction material.

Bridge distress diagnostics system software

A software module of Bridge Distress Diagnostics System, which is capable of taking input of bridge inventory data and bridge inspection data has been developed by a team at CRRI. After analyzing the bridge inspection data, the severity of damage and guidance on non-destructive testing (NDT)/partial destructive testing (DT) to be conducted are provided by the software.

Further, the software is capable of analyzing the NDT/Partial data/results to confirm the cause of distress.

Blending of non-biodegradable plastic wastes for use in road construction

A development which has a great implication for plastic waste disposal and its end-use is utilization of non-biodegradable plastic wastes for the development of modified bituminous mixes in road construction. CRRI has studied the feasibility of using various types of non-biodegradable plastic wastes, viz., polyethylene (PE), polyprophylene (PP) and polyvinyl chloride (PVC) as disperse in bitumen phase. The study shows that PE and PP are partially dispersible in hot bitumen; however, PP needs 20°C higher temperature than PE to have better melting and dispersion. It has also been reported that marshall stability retains stability and indirect tensile strength of modified Bituminous Concrete (BC) mixes is significantly higher than that of conventional BC mixes.

Passive energy dissipation device

A passive energy dissipation (PED) device using SMA wires as energy dissipation elements has been designed and fabricated at SERC. For this PED, SERC has carried out static and dynamic tests on 0.4 mm and 1.2 mm diameter shape memory alloy (SMA) based nickel-titanium alloy wires for evaluating the static and dynamic

characteristics, such as ultimate tensile strength, frequency dependency and number of cycles to failure. The device consists of two concentric pipes that move in mutually opposite directions when subjected to cyclic loading. The test results reveal that SMA based PED devices are effective in providing energy dissipation to reduce the dynamic or seismic deformations. In addition, the re-centering capability combined with large energy dissipation assures good displacement control in the case of strong seismic events, thus validating the developed PED device.

Polymer-modified fibre concretes

Polymer-modified fiber concretes are found to be ideal for seismic applications with their inherent improved ductile characteristics. Enhancement of ductility and the post-peak behaviour are of special interest for the seismic design of structures. SERC has simulated the monotonic response of the natural rubber latex modified fiber reinforced concrete beam, which exhibits improved ductility. Results are compared with the response of normal strength reinforced concrete beam. The flexural behaviour of polymer modified concrete has been investigated experimentally. Analytical modeling of the beam was carried out in user-friendly finite element software (ANSYS) to predict accurately the monotonic behaviour of beams, which is considered to be the envelope of cyclic curve, thus helping the design process. A good agreement has been observed in the strains developed and the force-displacement behaviour, with the theoretical results.

Fatigue crack growth studies on SA 516 Gr. 70 steel in air and sea water environments

A team of scientists from SERC has carried out fatigue crack growth (FCG) analysis of a plate subjected to constant amplitude pure membrane and bending stresses to predict the cycles required for an initial semi-elliptical crack to become a through wall crack. A semi-elliptical surface crack represents a more prototypical fatigue crack than the crack represented by standard specimens such as compact tension C(T), middle tension M(T) and eccentrically-loaded single edge crack tension ESE (T) specimens. As yet there is no exact Stress Intensity Factor (SIF) solution for the problem of a semi-elliptical surface crack in a plate of finite dimensions. The empirical expressions developed by Newman and Raju are generally used. These expressions were used in evaluating the SIF range in the present analysis. Paris crack growth model has been adopted for determining the crack growth rates. C and m values for steels reported in the literature have been used for this purpose. An algorithm was developed and implemented in a spreadsheet.

The spreadsheet gives the number of cycles to through thickness crack and crack growth curves in thickness and length directions.

Remote health monitoring scheme for civil engineering applications

Yet another notable development from SERC is a remote health monitoring scheme for civil engineering structures. The technology provides simultaneous monitoring from a single monitoring station of a number of structures, which are geographically located at different places. The data can be acquired remotely from different type of sensors which are normally used for structural health monitoring in a single platform. Structural health of one prestressed concrete box girder span of a flyover bridge across dumper lines at Visakhaptnam has been monitored periodically. The bridge has been instrumented with vibrating wire strain gauges for measurement of strains.

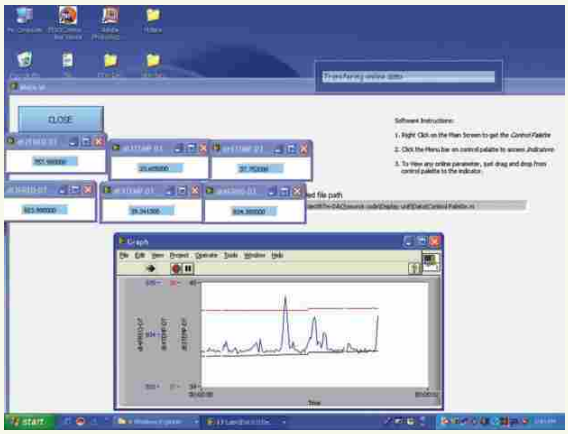


Fig. 1.35: Remote data acquisition from field structures

Experiments were conducted to acquire and transmit data from this bridge to the monitoring station at SERC via GSM network. The performance of the developed remote health monitoring scheme was further tested for long-term health monitoring of structures. Strain, acceleration and wind data were acquired continuously from a remotely located structure using GSM network. The software can be set to acquire data continuously for three days without any supervision. The response of the structure is monitored in real-time in various forms like graphical display, numerical values, etc. (Fig. 1.35). A new feature is added to automatically delete old files when storage memory in PXI at site is full.

Durability- and serviceability-related provisions in IS 456 for design of reinforced concrete structural elements

Very few organizations across the world have the expertise in the areas of durability-based service life design and remaining life assessment of reinforced concrete structural members. SERC has proposed some recommendations, which improve upon the existing durability and serviceability related provisions for the design of reinforced concrete structural elements in IS 456. These recommendations include a revised classification of exposure conditions based on the major environmental parameters influencing the different deterioration mechanisms related to durability of reinforced concrete, separate values of minimum cover thickness for reinforced concrete slabs, explicit specification of service life for structures, equations for characteristic crack width for reinforced concrete flexural members under static and fatigue loading, and procedure for durability based service life design of reinforced concrete flexural members.

1.10.2. Progress made under Network Projects

CSIR is operating three network projects in the area of housing and construction. The achievements under these projects during the year are presented below:

I. Developing new building construction materials and technologies

It is envisaged to develop low cost/ alternative building construction materials such as bricks, blocks, tiles, boards, cement/ concrete products, fibre reinforced composites, wood substitutes, coatings, sealants, paints, pigments, etc., to replace/ supplement the conventional building materials which are in short supply in the country.

This network programme has three distinct yet related components:

Fly ash utilization. A process has been developed for the use of fly ash, pond ash and mill reject coal of thermal power plants to prepare sintered lightweight building material aggregate pellet by down draft sintering. Another process using batch type pot grate sinter strand on 50 kg scale has been developed to optimize the mix proportion, solid fuel, pelletization and sintering conditions of fly ash, pond ash and mill reject coal. This type of sintered fly ash pellet is suitable for mixing with cement and sand in the manufacture of special heat insulation and lightweight concrete of M-20 and M-30 grade for building construction applications. Mill reject coal (low caloric value) and solid carbon bearing waste material are suitable for use as fuel in sintering of fly ash material and economical production of sintered aggregate. Other waste fines generated from metallurgical and chemical plants like red mud, sponge iron dust, gas cleaning and flue dust are useable in the process for production of building material aggregate. It is estimated that production of one ton of sintered fly ash pellet will consume about one ton of fly ash or pond ash. The production cost per ton of sintered fly ash (calculated for a 30t aggregate/day plant) is about Rs. 450. The process is ready for demonstration and knowhow transfer for commercial use.

Interlocking bricks. In yet another significant development, interlocking bricks with provision of semi-circular cavity on each of the sides of brick along length or along width were fabricated from alluvial clay mass of Roorkee through a hand moulding process. The finished bricks have compressive strength above 75 kgf/cm^2 and water absorption below 17 percent.

Coating system. Physico-chemical properties of different coating systems based on epoxy-cardanol and epoxy resins have been determined. 120 days data show that paints based on epoxy-cardanol are superior to unmodified epoxy based paints. The corrosion performance of the developed coating systems, namely, improved acrylic with conducting polyaniline pigment has been evaluated. This coating system was applied on the reinforcement bars and the corrosion resistant property of the coating system has been evaluated by using various techniques.

II. Design analysis and health assessment of special structures including bridges

The project envisages to develop capabilities in health monitoring of structures, which will help in integrity assessment, life management and life enhancement of structures; understanding the behaviour of new materials and retrofitting techniques and in preparing guidelines. During the period under report, many significant achievements were made. Notable among these are software for advanced analysis of steel frames; preparation of design tables for structural steel members and connections as per draft IS 800; instrumentation at nine multi-storeyed buildings located in Delhi to obtain ambient vibration data; passive energy dissipating devices based on visco-elastic materials and SMA. The devices were tested both in element and structure levels; and guidelines for seismic resistant design of framed structures using passive energy dissipating devices and design of prismatic structures under across wind loading have been developed.

III. New and improved road technologies

The project aims to provide the cutting edge technologies for developing the required road infrastructure with reference to construction materials for specific purposes, drainage systems, road management systems, information systems, and models for traffic measurement systems, etc.

Since the objectives encompass a broad mandate, the achievements made are:

- A film has been produced on road safety implications of the use of mobile phones while walking and driving. It is a 20 min film and is being shown at various forums to create road safety awareness.
- The kerb stones presently being used have visibility distance of less than 30 m. A new design improves the distance to about 100 m. It would enhance road safety.
- A net-based software has been developed to facilitate the Driver Licensing Authorities in issuing Driver License more effectively, particularly due to and effective knowledgebase questionnaire. The questionnaire has been demonstrated and administered for over 1000 road users including experts from different organizations.

1.10.3. Human Resource Development

CBRI

- A training and demonstration programme was conducted on "construction of earthquake resistant houses in hills". Engineers and masons from various districts of Himachal Pradesh participated.
- An Orientation Programme was conducted on "R&D facilities on building materials and rural housing". Trainee engineers from various states participated.

SERC

- The 5th Asian Symposium on polymers in concrete (ASPIC-2006) was organized during September 11-12, 2006.
- A one-day Advanced course on "Non-destructive testing on evaluation of concrete structures" was conducted.

1.10.4. Recognition & Awards

Recognition and awards received by CSIR Scientists in the area of Housing & Construction are listed below:

Vice President of Indian Roads Congress (IRC)	Dr. PK Nanda, CRRI
Commemorative Award by International Geosynthetic Society (India)	Shri S Mathur, CRRI
Raman Research Fellow, CSIR	Dr. K Ramanjaneyulu, SERC

1.11. Information Dissemination & Products

Realising the exponential growth in the IT sector and knowledge-based societies powering the current century, CSIR laboratories have evolved strategies to derive the benefits from its rich data and information base. Several initiatives towards that have been taken as under:

1.11.1. Scientific and Technological Achievements

Mutual chaotic synchronization for secure data communication

Chaotic synchronization is one of most amazing phenomenon in physics. CMMACS has proposed the concept of alternately switching mutual synchronization, which possibly can be used for secure communication of information over unprotected channel. This phenomenon can be very well demonstrated on a three variable Lorenz System, where by making only a single state space variable public, two identical

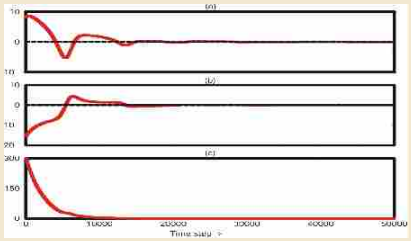


Fig. 1.36: (a) & (b) Error in the undeclared state space variables between the sender and receiver; (c) monotonic decrease of Lyapunov function with time

Chaotic systems can be synchronized. This is proved by the existence of a Lyapunov function which monotonically decreases with time as shown in Figure 1.36(c). Figures 1.36 (a) and (b) show the convergence of the two secret state space variables between the two chaotic systems with time.

Inflow of papers, rejection rate, subscriber base and impact factor

Continuous efforts of NISCAIR towards improving the quality and subscriber base of the journals are yielding very good results. During the year, inflow of papers in all the journals increased substantially. At the same time, as a result of critical evaluation, the rejection rate of papers is found to be between 10 and 63%. There has been a steady increase in the subscriber base (~15% per annum) and many of the NISCAIR journals are covered by the Science Citation Index (SCI) and have an impact factor varying from 0.160 to 0.632.

Science popularization

NISCAIR publishes three well-circulated popular science magazines, Science Reporter (English monthly), *Vigyan Pragati* (Hindi monthly) and *Science ki Duniya* (Urdu quarterly), apart from a number of popular science books with a view to generating awareness about scientific developments and creating a scientific temper among the students and the common public. The institute also focuses on the coverage of R&D activities of CSIR labs through the newsletters 'CSIR News' and 'CSIR Samachar' (Hindi).

S&T for weaker sections and rural areas

NISTADS continued its thrust to support sustainable growth in rural areas, empower weaker sections through imparting knowledge and supporting poverty eradication; supporting artisans (primarily rural); grass-root innovation; and micro-entrepreneurship through policy advocacy.

Mapping knowledge trends and outcomes in S&T Indian & global

NISTADS has done a mapping of knowledge trends of Indian research output in science and technology in the form of research papers and patents, including some leading public health and traditional medicine areas so as to provide policy directions to planners of national S&T.

History and philosophy of science

NISTADS has investigated social and environmental history with particular reference to nineteenth and early twentieth century to develop insights into foundations of current scientific and environmental endeavours in the country. The logical sciences, particularly ontological engineering, were investigated to draw inferences about applications in future areas of computational sciences.

1.11.2. Progress made under Network Projects

I. Traditional Knowledge Digital Library

The project envisages to collect and collate traditional knowledge that exists in public domain by creating a database on this knowledge in five international languages, i.e., English, German, French, Spanish and Japanese and making these available to patent examiners throughout the world to prevent the grant of bad patents. The codified knowledge of the country will be converted into easily accessible and retrievable patent application in digital format.

Unani: 89,500 formulations have been identified; 89,300 formulations have been transcribed and 50,000 formulations scanned from the original texts. Approximately 1 lakh formulations from the identified texts are transcripted, scanned, verified and validated.

Ayurveda Phase II: So far, more than 55,000 formulations have been identified from the Ayurveda texts and checked for the duplicates. Transcription of 38,500 formulations has been completed. Approximately 65,000 formulations are transcripted, scanned, verified, and validated.

Siddha: Traditional Knowledge Resource Classification (TKRC) has been developed for Siddha System of Medicine. 11,500 formulations have been identified and 93000 formulations transcripted.

II.Consortium access to electronic journals

The project aims at providing CSIR S&T staff electronic access to S&T literature worldwide to strengthen the facilities for pooling, sharing and electronically accessing the CSIR information resources; and to nucleate the culture of electronic access with a view to catalysing the evolution of digital libraries.

Agreements were made with four new international publishers as a result of which all CSIR labs are now able to access 4200+ S&T journals vis-à-vis 20 to 200 print journals from 15 publishers. The post-agreement monitoring for all the above 15 publishers is being done regularly. Usage statistics of 15 publishers is being regularly organized and loaded on search interface and monitoring system gateway so that user labs may see it. Users' training and awareness programmes were organized in all CSIR labs during August to October, 2006. In all, 1000+ participants from the various CSIR labs were trained over a period of 45 man days. The average full text download has risen to 3274878 from the average download of 2417547 of the previous year. A format for walk-in-users, registration and feedback was prepared and supplied to all nodal officers/Head of libraries to keep record of walk-in-users with request to their respective laboratories.

III. Mathematical modelling and computer simulation

A central forecast engine (a hierarchical model assembly calibrated for different scales) along with specific components to be integrated in the forecast platform has been developed.

India's first dynamical platform for long-range (> 30 days) high-resolution (~ 50 km) forecast of monsoon rainfall has been developed. India's first and the only dynamical fog forecasting platform with an industrial interface, a cyclone forecast platform, specially calibrated for the Indian seas with extensive validations are a few of the products from this effort.

1.11.3. Human Resource Development

NISTADS

- UNESCO-NISTADS workshop on Bioethics for Indian Society, was organized on 14 December, 2006.
- A workshop on tools and techniques to measure S&T data was organized on 5th March 2007.
- The Third International Workshop on 'Webometrics, Scientometrics, Science and Society' was organized from 6th to 9th March 2007.

1.12. Leather

Central Leather Research Institute is the largest leather-devoted institute in the world. Through inputs of S&T and extension activities it has been transforming the leather industry to a modern, vibrant, environment responsive industry. CSIR's pioneering inputs have been at all stages of the industry's activities starting from techniques for flaying of dead animals to storage of skins, using 'no' or 'less' salt, to appropriate time saving and low pollution tanning and processing techniques, 'low chrome' and 'no chrome' tanning chemicals, to modernization by computerization of net operations in tanning, to new techniques for generating value added specialty leathers, to computer aided designs for footwear, garments, and goods, fashion colour forecasting export certification and, not the least of all, in creating the human resources needed for the leather industry and the R&D in the sector. It had successfully mounted a pioneering Leather Technology Mission for the sustainable development of the Indian leather industry with vast grass-roots coverage. R&D programmes undertaken in network mode address the needs and priorities of the country.

1.12.1. Scientific and Technological Achievements

Fundamental microbiological and engineering aspects of chilling system as a method of preservation of hides/skins were taken up for study as a project by CLRI. The process conditions were standardised. A mobile chiller has been designed and field tested. Trials at commercial scale have also been conducted. The overall cost-benefit that this system offers compared to salt curing has been analyzed and the system is considered as a viable option.

Low salt preservation

CLRI has standardized low salt chemical based system for preserving the skins for a significant span of time. Common salt as low as 5% was used along with MgO and the cured skins could be preserved for a period of not less than 40 days. The quality of leathers was found to be at par with that of the leathers made from conventional salt curing. Commercial scale trials have been conducted.

Sole bonding by microwave heat activation

The bonding process in shoes generally takes place after the adhesive is activated with IR radiation followed by pressing and curing. Many a times, if temperature and time are not controlled properly, it leads to either weak bonding or material disintegration. To overcome this problem, an alternative heat activation technique using domestic microwave oven has been studied. CLRI conducted trials at different energy (wattage) levels and time duration of activation. The study was conducted with commonly used upper and soling materials like thermal plastic rubber, poly-vinyl chloride, poly-urethane and leather sole at different powers and time duration. Microwave heat activation as a method for sole bonding has been found to be effective at 20 seconds heat activation time.

New materials for therapeutic footwear applications

Many viscoelastic materials are used in shoes to replace the shock-absorbing and pressure distributing functions of natural fat pad beneath the foot that is lost due to some conditions such as diabetes, arthritis, age or overuse. CLRI has synthesized segmented polyether polyurethanes and converted these into sheets by blending with commercially available polyester polyurethane. The cushioning and morphological properties of developed materials were studied for application in therapeutic footwear.

Near zero wastewater discharge in leather processing

A unique three-step tanning methodology towards a near zero wastewater discharge leather processing has been developed by CLRI wherein cow hides are dehaired using an enzyme-based dehairing method, employing standard enzymes. Hides were treated with α -amylase and water for a few hours in a drum. Alternatively, the hides were treated with 0.9% sodium hydroxide and water in a drum; duration of treatment was one day. A pickle basification free chrome tanning at pH 5.0 has been developed with and without masking. Speciation studies were carried out during the course of tanning in order to understand the mechanistic pathways associated with the novel processing method.

1.12.2. Progress made under Network Projects

I. Standardization of technologies for bioresources for and from leather

Under this project, which envisages consolidating lead processes and products and developing technologies with commercial applications, use of a few enzymes as derailing agents has been tested and evaluated. Methods for production of animal feed from tannery wastes have been standardized.

II. Environment friendly leather processing

This project aims to design, develop and disseminate through appropriate measures, viable technologies and environment friendly leather processing in India at near-zero environmental risk; to develop technologies for reducing the consumption of water in leather processing; and to secure technology options for reducing the TDS level. A pilot scale plant for zero emission has been commissioned at CLRI. Phytoremediation studies have established the need for cultivation of non-edible plants around tannery sites. A 100 litre/hr RO demonstration plant has been designed & developed and is ready for commercial scale trials. A prototype for treatment of tannery effluent using ceramic membrane has been developed and is ready for testing and evaluation studies. Prototype for nitrification/denitrification has been designed and developed. Eight collagen based products have been developed for application as health care systems. Innovative methodologies for solid waste management have been developed and demonstrated to industry.

1.13. Materials, Minerals, Metals & Manufacturing

CSIR laboratories have played a significant role in the development of special materials for aerospace, defence and sophisticated industrial sectors, viz., electronic materials such as luminescent phosphors for display, piezoelectric materials and devices, high purity alumina, conducting polymers, aerospace materials such as high density carbon-carbon composites, lead-free x-ray shielding materials, high performance industrial materials such as silicon carbide, silicon nitride bonded silicon carbide, silicon carbide whiskers; special glasses for optical fibres, infrared range finders and sol-gel techniques for glass coatings, and superconducting materials.

Significant contributions have also been made in various aspects of mining operations, especially in coal mines (excluding heavy mining equipment), subsidence prediction and control enabling extraction of coal locked up in pillars and underneath surface structures and water bodies, for designing appropriate mine ventilation systems and for the mine disaster management in the country. CSIR is uniquely positioned in this area both through Network and Non-network projects.

The progress achieved is presented in the following paras:

1.13.1. Scientific & Technological Achievements

Non-toxic (lead free) X-ray radiation shielding materials

For the first time in world, AMPRI has developed, under the sponsorship of BARC, Mumbai, a novel process for making non-toxic, highly effective shielding materials for attenuating X-ray and Gamma radiation, utilizing industrial wastes, namely red mud and fly ash (Fig. 1.37). The evaluation of shielding characteristics of the developed materials was carried out at Atomic Energy Regulatory search Board (AERB), Mumbai. AERB has computed half value thickness (HVT) and compared it with that of conventional concrete and lead materials and suggested that shielding materials being developed can be used for the various shielding applications in diagnostic X-ray and CT installations.

Fig. 1.37: Actual Photographs of Non-Toxic Shielding Materials

Development of a trace moisture analyser using sol-gel nanoporous thin film technology

Trace moisture analysers are used for on-line detection of trace moisture present in toxic/non-toxic industrial gases which are used in the nuclear metallurgy, defence, navigation, medicine and food industries. CGCRI has developed a sol-gel based technique which is very cheap compared to the available and conventional technology. It has been estimated that the cost of the CGCRI sensor is five times less than that of an imported sensor. The sensors are not only cheap, they are also pollution free and can be regenerated by cleaning with an organic solvent after prolonged use. The sensor impedance can be matched easily with simple electronic circuit. In view of the low cost of the CGCRI sensors, P.H. Scientific (UK) has purchased six moisture sensors from CGCRI as part of evaluation to market the product (Fig. 1.38) in UK.

Fig. 1.38: CGCRI developed moisture sensors supplied to P.H. Scientific, UK

Corrugated steel strap (WSTRAP)

A development of considerable importance for mining industry is the design and development of a corrugated steel strap (W-STRAP), which is commonly used in underground coal mines and tunnels. The new design would help fabricated roof bolts to enhance safer working. It will also increase production in mines and reduce the injuries and fatalities. Further, it can promote safe and more economic excavation at greater depths. It is flexible and takes up the configuration of mine roof, which is not possible with steel channels. It is easy in transportation as it can be packed in bundles of 20 or 25 at a time. Pre-made holes in the W-strap suit the desired pattern of bolting. In case of emergency, extra bolts can be fixed in the roof after making holes into the roof through the pre-made holes of the strap. Its breaking strength is more than 20 tons and is cost effective compared to steel channel.

Emulsion based explosive and cord system for use in Blasting Gallery (BG) in underground coal mines

CMRI has developed an emulsion based explosive which has met the statutory requirements and is considered suitable for use in BG panels. In order to achieve the required safety against inflammable atmosphere during trials for incendivity studies, flame retardant polyethylene (FRP) tubes were used for the first time in India in designing permitted explosives. This system has a channel in the FRP tube for insertion of detonating cord for proper contact between the explosive and cord, ensuring unfailing, safe and efficient blasting throughout the borehole.

Black box housing for automobiles

CMERI has developed a black box to house the entire circuitry including embedded software and hardware for automobiles. The housing is shockproof, fireproof and waterproof so that the assembly can absorb and withstand shock, impulses and possible escalation in temperature when a vehicle suffers an accident. Centre for Development of Advanced Computing (CDAC) is developing, parallely, the entire system including sensors softwares and related hardware for data acquisition for an Automobile Black Box. After design and first prototype testing, 13 units were handed over to the CDAC for field applications.

Efficient filter press for vegetable oil

Using a filter press constitutes the quickest way of filtering expelled oil. Conventional filter presses available in the market are generally not optimized for efficient performance. CMERI has developed cast aluminium plates for filter presses to render the filtered oil more amenable to food standards. Use of aluminium alloy of 2014 grade reduces the total weight of the filter press from 14 kg to a mere 6 kg, while retaining, and improving upon the other operational parameters. Further, the aluminium press was replaced by a polypropylene filter press which, while retaining all the major design features and advantages of the previous model, improves upon quality of the pressed oil.

National testing facility for general purpose rolling element bearings

Antifriction bearings are very important components of all machines and equipment as their malfunctioning affects adversely the performance of the system. Therefore, understanding and evaluation of the life of rolling element bearings is of great concern. In response to this need, CMERI has established a National Test Facility for General Purpose Rolling Element Bearings at its premises in Durgapur in

collaboration with Tata Bearings, a division of Tata Steel Limited. This facility, a unique one in the country, accommodates ten test rigs designed and developed at CMERI and can carry out accelerated life testing of bearings under controlled conditions. The load and lubricants are chosen in such a manner as to retain a minimum lubricant film thickness to avoid the metal-to-metal contact during the test run.

Graphite from calcined petroleum coke

IMMT has carried out, on 200 g scale, a series of experiments for the production of artificial graphite from calcined petroleum coke (CPC) powder employing catalysts such as B, Ti, Ni, Fe, Cu, Al, Mg, TiO_2, B_2O_3, etc. Results indicate 82 to 92% degree of graphitization and product yield of 90 to 94%. On the other hand, large scale experiments on 1.5 kg basis, have shown physico-electrical properties very close to those of the commercially available pure graphite samples. The electrical power consumption per kilogram of graphite powder produced is around 5.0 kWh. The typical properties of graphite produced using B, Ti and Ni catalysts by static bed plasma heat treatment are: density as 2.0 to 2.2 g/cc, electrical resistivity as 0.019 to 0.02 A Ωcm and d_{002} as 3.369 to 3.37 Å. Experiments were also conducted to produce graphite powders from CPC using above mentioned catalysts by inflight heating at different electrical power input levels and powder feed rates. The heat-treated end product showed density of 2.06 g/cc, electrical resistivity of 0.02 Ωcm and d_{002} = 3.39Å. The electrical power consumption was also much lower (2.5 to 3.5 kWh/kg) compared to that in static plasma heating method.

Low-toxicity environment-friendly gel-casting system for industrial application

Conventionally, toxic acrylamide monomer is used in the gel casting process. IMMT has evaluated several eco-friendly monomers such as albumin, carrageenan, chitosan, etc., for their possible utilization for gelation. The monomers were evaluated for gelling characteristics and kinetics of gelation using rheology measurements at increasing temperature ramps. After establishment of the gelation temperature of each monomer, their yield points have been determined to assess the strength of the gels. Subsequently, actual gel casting of ceramic systems such as alumina has been carried out using these monomers. Dense/porous bodies have been developed (Fig. 1.39) using albumin. Dense bodies developed with chitosan showed 95-96% of theoretical density.

Fig. 1.39: Dense products developed using environment friendly gel casting systema

Fig. 1.40: Demonstration unit for Electrolytic reduction

Electrolytic reduction of iron(III) present in phosphoric acid to iron(II)

Using the electrochemical route, scientists at IMMT have converted Iron(III) present in Merchant Grade Phosphoric Acid (MGPA) to iron(II). The electrochemical process provides better accuracy in control of electrochemical parameters and obviates any possible inclusion of impurities. An engineering package has been prepared for electrochemical reduction circuit for processing 5 l/h of MGPA along with details on equipment size and specifications, critical equipment design, safety aspects, equipment fabricator/manufacturer list, etc. The unit, fabricated and tested at IMMT, has been installed at Heavy Water Plant (HWP), Talcher and is running successfully (Fig. 1.40).

Phytoremediation studies of flyash using aromatic and aquatic plants

Studies on metal uptake from fly ash of Pradeep and NTPC origin and microbial population changes using aromatic grass of palmarosa, jamarosa, lemongrass, citronella, and vertives were taken up at IMMT. For the remediation of ash pond water, four acquatic plants species were used (Fig. 1.41). Studies reveal that the concentration of metal ions per gram of dry matter produced increased with increase in days of harvest. In case of aquatic plants, the highest total metal uptake was observed with Eichhornia sp. due to higher biomass yield. In aromatic grasses, the highest available metals like Co, Cu, Zn, Cd, Cr were taken up by *Citronella sp.* and Ni and Fe by lemongrass. The bacterial load from the rhizospheric region of lemongrass was maximum, whereas the fungal load was maximum in case of palmarosa and jamarosa sp. In addition to this, phytoremediation and phytomining studies were also carried on nickel bearing chromite overburden of Sukinda (Orissa) and copper ore of Malanjkhand (MP) using the same aromatic grasses.

Fig. 1.41: Aquatic plants used for phytoremediation of fly ash

Entrained flow biomass gasifier for thermal applications using powdery biomass

A team of scientists at IMMT has developed a 30 kW_e capacity entrained flow biomass gasifier (Fig. 1.42) for thermal application, for efficient gasification of powdery biomass such as rice husks, saw dusts, coir dusts, etc. L/D ratio (length to diameter of gasifier) of 10 has been adopted to improvise the mixed flow and plug flow reactor characteristics, to ensure full suspension of powdery biomass in a

Fig. 1.42: Prototype of entrained flow biomass gasifier system

vigorous radial mixing condition in the reactor and to achieve high intensity reaction and gasification. The gasifier-reactor attains a temperature of 900-1200^{O} C to take advantages of the kinetics of the process and produce low tar and char formation. By maintaining a pre-estimated equivalent ratio of 0.27, temperature of the partial oxidation can be varied as per requirement. The endothermic steam-induced reactions with a steam injection at the rate of 10-15 kg/hr coupled with the gasification reactions conserve the process heat in the form of more hydrogen and carbon monoxide.

New phosphor materials

New phosphor materials based on alkaline earth rare earth phosphates, which are likely to find practical applications in white light generation, Cathode Ray Tube (CRT) screens and other display devices, have been developed at NIIST. Novel red and green emitting phosphors were synthesized by a solid-state method. X-ray powder diffraction analysis confirmed the formation of xenotime type structure. Photoluminescence results showed that the phosphors can be efficiently excited by near-UV irradiation (396 nm/378 nm) and they give bright red and green emission with good chromaticity coordinates.

Production of synthetic rutile, metallic iron and high purity iron oxide

A newly designed and innovative cold plasma technique for the continuous melting of pre-reduced ilmenite has been found to separate ilmenite into titania slag and metallic iron. This NIIST developed technique has been found to be better than a batch reactor in terms of high throughput and energy efficiency and enables continuous operation.

The process is simple and eco-friendly and results in separation of more than 90% of the iron in pre-reduced ilmenite. A valuable and saleble by-product in the form of pig iron is also separated from the pre-reduced ilmenite. In addition to the metallic iron, the process also ensures a complete recovery of iron values from the leach liquor in the form of high purity iron oxide. The process flow-sheet is completely free from iron containing acidic effluents. The main product obtained, synthetic rutile, is a suitable titanium feedstock for the chloride process of TiO_2 pigment production. The plasma reactor showed the power consumption of 1.2 kWh/kg and productivity 30 kg/hr. Synthetic rutile with more than 93% TiO_2, which is ideally suited for chlorination, was obtained in the pilot plant. Based on this technology, National Mineral Development Corporation is planning to establish a fully integrated pilot plant facility with a capacity of 1.5-2.0 tonnes /hr.

Making computer simulation affordable to the Indian foundry

Virtual Casting, a software for simulation of casting solidification for the Indian market, seeks to help foundry professionals to create virtual environments to test out new designs and process innovations before actually implementing them on the shop floor. The software developed by NIIST makes it possible to shift the trials from the shop floor to the computer, saving time, effort, energy and material. As the casting industry in the country gears up to face the challenges of global competition, Virtual Casting attempts to make casting simulation useful and affordable to the small and medium scale foundry. It can be used, not only for industrial process design, but also in teaching and learning. Students of foundry technology can use the software as a

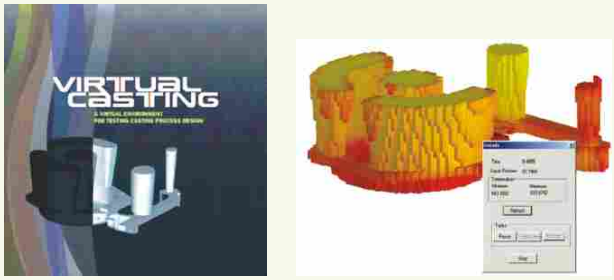


Fig. 1.43: Virtual Casting software

virtual laboratory. By experimenting with different process variables and seeing the impact on the final outcome, they can acquire great insight into the design process. It has been licensed for use to academic and industrial users.

Small capacity rubber sheet driers for marginal farmers

Technologists and engineers of NIIST have developed reverse flow natural convection driers, popularly known as RRLT-NC driers, to help marginal farmers and cottage scale processors for rubber sheet drying. The drier has a capacity to handle 25-30 natural rubber latex sheets per batch, total hold up of 60 rubber sheets and the drying time is 2 days (Fig.1.44). Fire wood /agricultural waste materials are used as fuel for the generation of hot air and smoke needed for curing the drier. The approximate cost of the drier is Rs. 13,000.

Fig. 1.44: A rubber sheet drier

Micropatterning of biological molecules

Patterning of biomolecules with micron and submicron resolution onto different solid surfaces is the key to the development of advanced biosensors, fundamental studies of cell biology and tissue engineering. NPL has used a simple technique based on microcontact printing of hexadecane thiol and polyethylence glycol-thiol to create pattern structures on gold-coated substrate exhibiting high hydrophobicity and high hydrophillicity, respectively. The hydrophobic regions strongly support the adsorption of proteins, while the hydrophilic regions strongly resist the adsorption of proteins.

The patterns of hydrophobic and hydrophilic regions have been further utilized to selectively deposit bovine serum albumin (BSA) tagged with Fluorescein isothiocyanate dyes. Fig. 1.45 shows the selective deposition of BSA-FITC conjugated molecules as seen under a fluorescence microscope. These experiments would form the basis for fabrication of fluorescence based array biosensors for various biological applications.

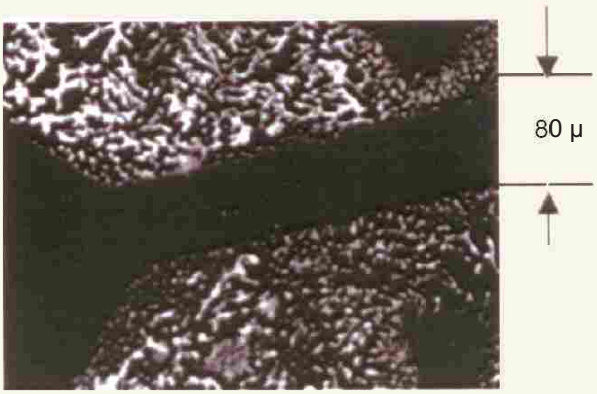


Fig. 1.45: Fluorescence micrographs of selectively deposited BSA_FITC conjugated molecules on HDT coated regions

Micropatterning of alignment layers to produce patterned liquid crystal displays

The planar alignment of liquid crystals takes place only on the area having a bilayer of amino propyl triethoxy silane & cinnamoyl moieties. Area patterned with octyl-triethoxy-silane shows homeotropic alignment of liquid crystals. Alignment direction is governed by the polarization direction of the UV light and can be varied locally. These two independent techniques have been combined to produce samples showing both homeotropic as well as planar alignment of liquid crystals in a single cell. This has given rise to the possibility of creating new storage liquid crystal displays. The technique may also be used to produce patterned liquid crystal displays. Both the alignments have been found to be stable with time and temperature.

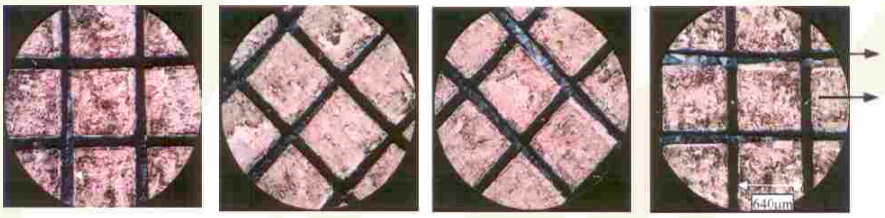


Fig. 1.46: Photographs showing Homeotropic alignment (B)of a liquid crystal cell rotated clockwise between cross polarizers from 0° to 135° at an interval of 45°. Uncoated area shows no preferred alignment (C).

Self-cleaning coatings on glass substrates

An equipment which enables a user to obtain thin films of metal oxides by sol-gel dip coating technique, developed by NPL, is not only cheap as compared to the conventional coating equipment, but is also simple to operate as adjustment of coating parameters can be done by simple knob operation. This equipment generates thin film coating on both sides of the substrate simultaneously. Uniform film thickness can be obtained on a large area substrates (up to 1 meter x 1 meter) with this equipment. The coating solution is partially hydrolyzed metal alkoxide solution with a catalyst. The composition of different constituents is adjusted in such a manner that the solution can be reused for coating for a period up to six months, if stored under sealed conditions. The solid films obtained from this solution are scratch proof and are stable under various environmental conditions.

Simple glass windowpanes coated with films using this technique block up to 30% of IR radiations and allow up to 80% of the visible part of the spectrum. These films absorb ultra-violet radiations to excite electrons from the valence band to the conduction band. Valence band electrons help in dissociating the organic matter which makes the windowpane dirty while valence band holes help adsorb O^{+1} groups on the surface thereby making the surface superhydrophillic. Both these properties are very important from architectural point of view. Such a glass, used as windowpane, reduces the heating and cooling cost of the building and its cleaning requires little labour and less detergents saving on the cleaning costs.

Tungsten oxide films with a novel microstructure for fast-switching smart windows

A group of researchers at NPL has used a potential driven self-assembly of sodium dodecyl sulfate/ tungsten oxide aggregates at the electrolyte-electrode interface followed by template extraction and annealing to prepare mesoporous thin films of electrochromic tungsten oxide (WO_3). This is the first report on hybrid structures comprising nanoparticles and nanorods with a tetragonal crystalline phase of WO_3 with the measured lattice parameters. In addition to pentagonal voids, characteristic of the tetragonal WO_3 phase at the lattice scale, open channels and pores of 5-10 nm in diameter lie between the nanoparticles, which cumulatively promote rapid charge

transport through the film. This results in a large coloration efficiency and higher and faster switching kinetics than previously reported values for mesoporous WO_3 films. Repetitive cycling between the clear and blue states has no deleterious effect on the electrochromic performance of the film, which is suggestive of its potential for use as cathode in practical electrochromic windows (Fig. 1.47).

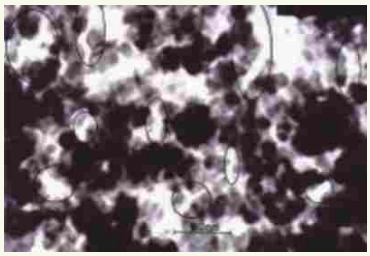
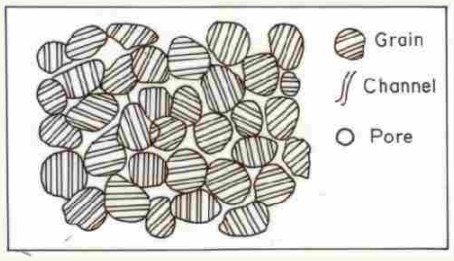
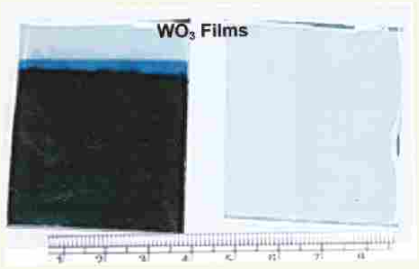


Fig. 1.47: Nanostructured thin film



Schematic of microstructure



Coloured and bleached level

Thiolated gold nano particles for the enhancement of glucose oxidase activity

Biosensors have attracted much attention in recent times because of their potential applications in clinical diagnostics, environmental monitoring, pharmaceuticals, and food processing industries due to their fast response and ease of operation. The stability of enzymes is crucial for the fabrication of biosensors. A number of techniques have been used for the immobilization of enzymes on different substrates to improve the enzymatic activity and stability. Nanostructure materials exhibit interesting properties such as a large surface-to-volume ratio, high surface reaction activity, high catalytic efficiency, and strong adsorption ability that make them potential candidate materials for the fabrication of a biosensor. Glucose oxidase (GO_x) has been covalently immobilized onto chemically synthesized thiolated gold nanoparticles (5-8 nm) via N-ethyl-N'-(3-dimethylaminopropyl) carbodiimide (EDC) and N-hydroxysuccinimide (NHS) by a group of researchers at NPL (Fig. 1.48).

The covalently immobilized GO_x thiolated nanoparticles exhibit a response time of 30 s, a shelf life of more than 6 months, and improved tolerance to both pH and temperature.

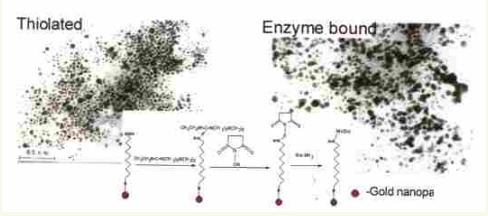


Fig. 1.48: Nanostructured thiolated and enzyme bound gold nano particles

Modelling of crack tip blunting using the finite element method

A study which could help in understanding the blunting process in ductile materials was carried out at NML, through finite element simulation (FEM) of standard fracture mechanics test specimen. From the load-displacement data generated by FEM, the crack tip opening displacement (CTOD) as well as J, an energy parameter of elastic plastic fracture mechanics, and Δ a, the crack extension accompanying the blunting process, have been calculated. The effect of variation of material properties like Young's modulus, E, yield stress, σ_y and strain hardening parameter, n, on the shape and slope of the blunting line has been established. The numerically obtained blunting line has been validated using experimental results. The blunting line is mildly sensitive to the level of flow stress, with the inflection occurring at a lower flow stress and with reduced sharpness as the flow stress is increased. The blunting line slope is higher in low strength materials. The nature of the blunting line is greatly dependent on the work hardening capacity of the material, with the overall slope of the blunting line increasing with increasing hardening behaviour.

Beneficiation of iron ore from Joda (East) using a floatex density separator

In another study, NML has investigated the applicability of Floatex density separator (FDS) in removing alumina from iron ore fines (1.0 mm). Screw classifier feed containing 3.91% alumina was used as the feed for the FDS. Experiments according to a three-factor factorial design revealed that in the single stage processing in FDS, a maximum of 72 % of the feed alumina could be removed. However, a loss in iron value is always associated with the removal of alumina. The recovery of iron under optimum condition was 61% in FDS. A final concentrate containing 1.66 % alumina could be obtained at a yield of about 57%.

Processing of waste printed circuit boards

Recovery of metal values from waste printed circuit boards (PCB) using physical beneficiation techniques based on a combination of dry and wet processes involving desliming, tabling, flotation, multigravity separation, electrodynamic and electrostatic separation was carried out at NML. The process produces a rich concentrate with significantly high recoveries of metals from the ground 0.5 mm PCB powder. A concentrate grade of over 93% total metal at a recovery of over 54% or a grade of 66% total metal at 95% recovery could be achieved. The new process gives a feasible alternative to purely dry processes that have inherent inefficiencies and which may not provide a cost-effective technology for processing electronic scrap. The flowsheet does not warrant any use of sophisticated machinery and relies on time-tested equipment with reasonably good efficiency. Precious metal content was found to be significant in the PCB powder and it calls for development of proper hydrometallurgy based technology to recover them.

Microwave-assisted combustion synthesis of magnetic alloys: nanoparticles and nanowires

Electromagnetic radiation (microwave) plays a role in the decomposition of organometallic complexes, providing a mechanistic pathway for the formation of bulk nano nickel wire bundle and sponge under ambient conditions. During the year, NML has studied, this role. Formation of wire is critically dependent on two factors: the decomposition of complex under continuous exposure to microwave and extensive H-bonding in the *molecule*, which plays an important role in the

decomposition mechanism. The formation of Ni wire is both thermodynamically and kinetically controlled as termination of exposure of the complex to microwaves during decomposition results in an intermediate state (as Ni veins) prior to the formation of Ni wire. The shape and mass of Ni wire formed resemble the solid-state packing of organo metallic complex (bundle shape). On the other hand, pulsed exposure to microwave results in finely divided, highly porous Ni sponge, a disrupted form of Ni wire. Ni wire exhibits a blocking temperature, TB > 300K with the saturation magnetic moment (Ms) of 55 emu/g, which could be suitable for high temperature applications in the field of memory storage. The process would open a new approach to the nano materials synthesis in bulk form.

In-situ generation of stabilized metal nanoparticles in interlamellar spacing and on mesoporous surface of montmorillonite clay

Metal nanoparticles supported on microporous/mesoporous acidic oxide matrix are expected to behave very differently from bulk metals and are likely to act as bifunctional catalysts, i.e., with both metal as well as acid function. Intercalation of metal acetates like $M(CH3COO)_2$ (M= Ag, Ni, Co, Zn, Cu, etc.) into Na-montmorillonite produces intercalated product $M(CH3COO)_2$-M11-montmorillonite(I), which on reduction by polyols (ethylene glycol) method generates in situ the corresponding metal clusters in the form of Mo montmorillonite(II) composite. NEIST has used incipient impregnation technique for deposition of $M(CH3COO)_2$ on the micro/mesoporous clay support and subsequently dialyzed it to obtain composites with the salt loaded clay. The composites were characterized by X-ray diffraction. The supported metal salts were subjected to polyol reduction at ~195°C. It has been observed that in some composites an ordered or channel supported metal nanoparticles are formed.

Propensity for the air/water interface and ion pairing in magnesium acetate and magnesium nitrate solutions

NEIST researchers during the period under report carried out molecular dynamics simulations in slab geometry and surface tension measurements for aqueous solutions of magnesium acetate and magnesium nitrate in various concentrations. The simulations reveal a strong affinity of acetate anions for the surface, while nitrate exhibits only a very weak surface propensity, and magnesium is per se strongly repelled from the air/water interface. $CH3COO^-$ also exhibits a much stronger tendency than $N\bar{O}_3^-$ for ion pairing with Mg_2^+ in the bulk and particularly, in the interfacial layer. The different interfacial behaviour of the two anions is reflected in the opposite concentration dependence (beyond 0.5 M) of surface tension of the corresponding magnesium salts. Measurements, supported by simulations, show that the surface tension of $Mg(NO_3)_2(aq)$ increases with concentration as for other inorganic salts. However, in the case of $Mg(OAc)_2(aq)$ the surface tension isotherm exhibits a turnover around 0.5 M, after which it starts to decrease, indicating a positive net solute excess in the interfacial layer at higher concentrations.

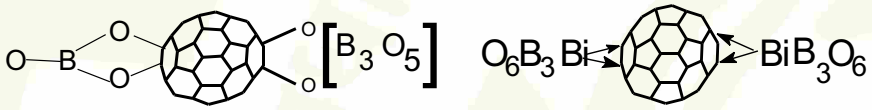
1.13.2. Progress made under Network Projects

I. Custom-tailored special materials

Advanced information and communication technology and ultra-fast processing devices are based on custom-tailored special materials. It is envisaged to build strong knowledgebase and up-to-date expertise by developing new generation materials

like novel non-linear optical materials, bio-molecular electronic materials and functional nano-materials. The knowledgebase would be needed by both the Indian industries and also the strategic sectors to remain globally competitive in terms of technological and financial advantages.

Under this project, Fullerene (C_{60} and C_{70}) doped monolithic bulk glasses for nonlinear applications were studied. Two novel high temperature chemical reactions of C_{60}-fullerene with boron and bismuth have been discovered in the course of development of high concentrations of fullerene glass. The mechanism of chemical reactions has also been proposed. The structures of boron and bismuth complexes were also detected in the mass spectrum (Fig. 1.49).



(a) (b)

Fig. 1.49: Detected structures (a) Boron complex (C60B4O10, Mass =925) and (b) Bismuth complex (C60(BiB3O6)2; Mass = 1397)

Nonlinear optical properties of the fullerene-glass composites reveal that the composites can limit the transmission of high intensity light. An optical-limiter transmits light when the latter is at low intensity, but limits the transmission at its higher intensity, i.e., the efficiency of limiting of light transmission by such material, increases with the increase in intensity of the incident light and, hence, it can function as a protector of laser sensor (Fig. 1.50).

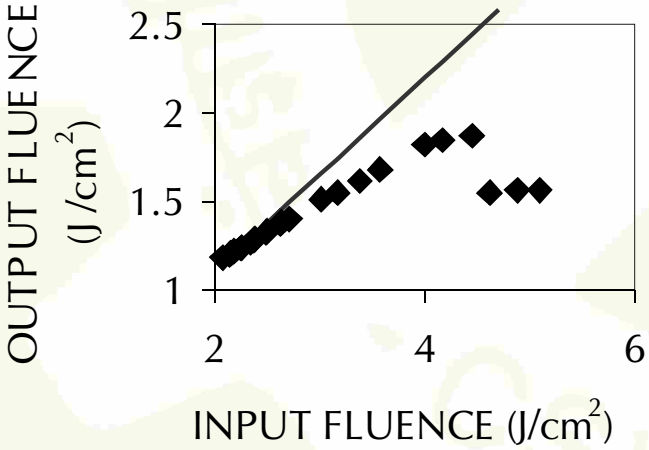


Fig. 1.50: Variation of transmitted intensity with input intensity of 5 ns laser pulses at 532 nm through the glass. The straight line represents the extrapolated linear transmission.

Apart from showing the unique optical properties, these nanocomposites are found to have good electrical conductivity, which may find applications in fabrication of conducting coatings. The processes of preparation and the products have been patented in India and abroad. The nanocomposites have been included in the CSA Materials Research data base with Metadex database, USA.

Developing nanoclusters of semiconductors like metal oxides, chalcogenides doped glassy films is also an objective of this project, wherein quantum confinement

behaviour of indium tin oxide (ITO) nanoparticles was observed in the nanostructured sol-gel ITO films on glass. The excitonic transition due to confinement of electron-hole pair exhibited fluorescence behaviour which decayed in the nano-second to pico-second range. The particle size distribution of the ITO nanoparticles was evaluated by transmission electron microscopy (Fig. 1.51). Detailed analysis of the photoluminescence (PL) bands of nanostructured Mn(II) doped ITO revealed the exciton-phonon interaction. The fluorescence life time measurement showed fast decay in the nanosecond to picosecond range, which suggested that the exciton-phonon interaction did not change the PL life time.

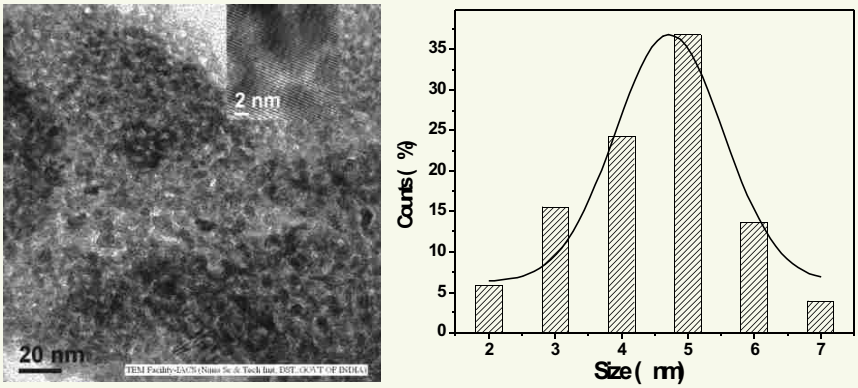


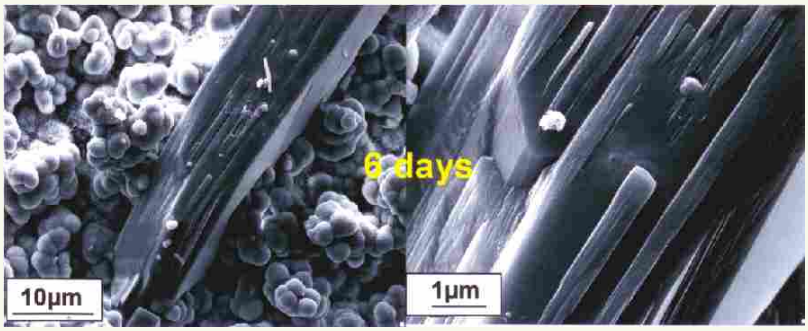
Fig. 1.51 : (a) TEM image of ITO nanoparticles and (b) particle size distribution

Development of ceramic cellular products based on biomorphic route

Silicon carbide (SiC) based materials have been developed through biomorphic route by replicating the cellular morphologies available in woods. Anisotropic structural feature of the cellular or biomorphic Si/SiC ceramic composites may be employed to advantage in various micro-electronic applications such as design of a network of Si/SiC micro/nano-electrical heaters or power generators for micro-electronic circuitry, which can be used in space technology, local communications, small batteries, refrigeration, etc.

A novel synthetic route for biomaterials was taken up with their applications as bio-implants being one of the objectives. The success of the use of metallic bio-implants depends on their bio-compatibility with the surrounding tissues inside the human body. One of the ways to achieve this is to give a Ca-hydroxyapatite coating of suitable morphology. A method for giving a coating of Ca-hydroxyapatite has been developed by using a biomimetic method in presence of protein (Fig. 1.52).

(a)



(b) (c)

Fig. 1.52: (a) Porous and (b), (c) solid HAp rods (~561 µm) developed on αAl_2O_3 by adapting bio-mimetic route.

The coating has been characterized to find as to how the morphology and orientation of the coating are affected by the substrate. A detailed microstructural study has shown that the self assembly of protein molecules changes the morphology and orientation of the coatings.

II. Capacity building for coastal placer mineral mining

In spite of having the maximum number of enriched placer deposits, India continues to play a minor role in the marine mineral export compared to other dominating countries that have lesser potential than India. There is great scope to improve the status of Indian placer export market through the development of indigenous mining and processing technology, especially for buried placers and offshore resources. It is aimed to enhance the capability of country's technologies in the field of placer mining. The output of this work would put India as a global leader in this field, besides generating appreciable economic returns from the exports. During the period, deposits of placer mineral available at Poompukar-Karaikal were characterised and pre-monsoon studies were carried out on profiling and sediment assessment including mineralogical studies and sediment budgeting through beach profiling for various seasons. Likewise, about 75 samples were collected along the West Bengal coast of which profiles of 5 have been completed. 65 samples were processed mineralogically and 15 samples were analyzed through SEM. Micro-morphological features were studied. A new set of exploration data up to 3 to 4 m depth at selected locations was created.

III. Developing capabilities in advanced manufacturing

The project aims to explore applications of advanced manufacturing methods and to upgrade the indigenous expertise both in manufacturing automation and near net shape manufacturing in order to promote self-reliance.

The network project has many ambitious goals, one of which, the facility for Virtual Prototyping and Immersive Visualization, has been established. First indigenous AMR Prototype is ready for testing. The technology for tailored stainless steel implants developed through the investment casting route has been transferred to M/s Manish Metals, Jamshedpur for manufacture of ADI crank shafts for automobiles.

IV. Biomineral processing for extraction of metal values from ores and concentrates and wastes

The project aims at bioleaching of low grade copper ores of Malanjkhand (0.3%Cu); bioleaching of uranium (UCIL, 0.026% U); strain improvement; and continuous down-stream processing for recovery of metal values (10 litres/hr capacity). During the year, after standardizing parameters for shake flask and column leaching of copper from lean ores of Malanjkhand, facilities for heap leaching have been established at IMMT, Bhubaneswar to study and demonstrate bioleaching process.

Two bioheap leaching plants of 15 ton and 30 ton capacity have been installed for uninterrupted running. The leach liquor is being processed for continuous solvent extraction and electro winning to get high purity copper (99.98%).

V. Technology for engineering critical analysis

The project aims at development of technology for engineering-critical analysis of the following components: pressure vessels and pipelines of the thermal and nuclear power plants, petrochemical and process industries; airframes and aeroengine Components; infrastructural assets of the transportation industry, e.g., concrete and steel bridges, railway wheels and railway tracks; and offshore structural components. During the period under review, damage resistance of engineering materials was quantified. Experimental quantification of FCGR and fracture behaviour of 304LN SS were used for primary heat transport piping of nuclear power plants.

VI. Upgradation of SI Base Units, National Standards of measurement & creation of a network of calibration and testing laboratories and preparation & dissemination of CRMs

The project has the mandate to upgrade SI Base Units and National Standards of measurements for Mass, Luminous Intensity, Time; and Chemical Metrology. It has also the mandate for upgradation of apex level calibration facilities in the following parameters: Mass, AC Power & Energy, AC Voltage & Current, Length, Force, Temperature, Ultrasonics, Acoustics, and Networking of calibration and test services existing in 12 CSIR laboratories for providing high quality testing and calibration services to users in all parts of the country at a reasonable cost and in a reasonable time. The project has also the mandate for preparation, certification and dissemination of certified reference materials. The work carried out during the year has led to enhancement of capability in Luminous Intensity, Temperature, Time, Current and Length. 21 CRMs were released and CRMs in pesticides, gas metals are being prepared.

1.13.3. Human Resource Development

CGCRI

- A training-cum-demonstration programme was conducted on 'Than Clay Beneficiation' at Thangadh, Gujarat on April 22, 2006 for skill upgradation in designing of ceramics and glazed pottery. The participants were imparted training in blending & beneficiation of clays available in Thangadh and surrounding areas. One hundred participants from the user industry as well as mine owners attended the programme.
- A training-cum-demonstration programme on 'Development of Appropriate Body Mix through part or complete replacement of Ukraine Clay in Body Composition for Granito Ceramic Tile Production' was held on May 25, 2006 at Morbi, Gujarat.

CMERI

During the year four training programmes/courses were conducted, one each on Vibration Analysis for Engineers; Embedded Systems for Faculty Members; Engineering Metrology & NABL Accreditation; and Programmable Logic Controllers.

1.13.4. Recognition & Awards

Recognition and awards received by CSIR Scientists in the area of Materials, Minerals, Metals and Manufacturing are listed below:

Young Scientist Award 2006 by Material Research Society of India (MRSI), Kolkata Chapter	Shri. R Mukherjee, CGCRI
MRSI Medal, 2007 by the Materials Research Society of India	Dr. RN Basu, CGCRI
National Mineral Award 2006	Dr. P Pal Roy, CMRI
IIME Mineral Beneficiation Award 2007 of Indian Institute of Mineral Engineers, India	Prof. BK Mishra, IMMT
Rajiv Gandhi Samman 2006 on the occasion of Rajiv Gandhi Askhay Urja Diwas at Bhubaneswar	Shri S Khuntia, IMMT
Kumudini-Gokulanda Environmental Honor -2007 Instituted by Vigyan Prachar Samiti, Orissa	Dr. SN Das, IMMT
Shri Govinda Gupta Memorial Award and Running Shield - 2006 instituted by Institute of Engineers of Orissa State Centre, Bhubaneswar. SGAT Excellence Award-2006 by Society of Geoscientists and Allied Technologists, Bhubaneswar, Orissa.	Dr. SK Biswal, IMMT
Rajiv Gandhi Sadbhawana Award - 2006 for Orissa state by Rajiv Gandhi Forum, Orissa.	Dr. S Sahoo, IMMT
Prof. R. C. Tripathy Young Scientist Award - 2006 from Orissa Chemical Society (OCS)	Dr. (Ms) DP Das, IMMT
Rashtriya Rattan award and gold medal by International study circle, New Delhi	Prof. TK Chandrasekhar, NIIST
National Mineral Day Award 2005 by Ministry Mines	Shri R Pattathil Raghvan, of NIIST
Shanti Swarup Bhatnagar Prize in Chemical Science	Dr. K George Thomas, NIIST
Thomson Scientific India Laureate Award	Dr. A Pandey, NIIST
Fellow, Indian Academy of Sciences Fellow of Indian National Academy of Engineering (INAE).	Dr. RN Ghosh, NML
Metallurgist of the Year award for 2006.	Drs. A Mitra and R Kumar, NML
Altekar Award for the Best Technology (of 2005) "Design, Drawing of specifications, Installation and commissioning of flotation column (150 tpd) at OSCOM, IREL, Chatrapur"	M/s S Prabhakar, G B Raju, SS Rao, DS Rao and TVV Kumar, NML
IETE-Hari Ramji Toshniwal Gold Medal in 2006	Dr. P Banerjee, NPL
B.D. Bangur Award	Dr. RB Mathur, NPL
Rajib Goyal Young Scientist Prize	Dr. VPS Awana, NPL

CENTRAL MANAGEMENT

2.0. Central Management Activities

CSIR fulfills its mandate through a very active network of 38 laboratories and 39 field/extension centres, which are multi-disciplinary in nature, spread over the length and breadth of India and manned by around 17500 committed S&T and supporting staff. The overall R&D initiatives of CSIR are managed by the Director General, under the guidance of the Governing Body, with the assistance of multi-activity and multi-divisional Headquarters. The policy directions are derived from the CSIR Society, which is headed by the Hon'ble Prime Minister as the President with the Hon'ble Minister for Science & Technology and Earth Sciences as Vice-President.

Following paragraphs present glimpses of the activities under Central Management during the year.

2.1. CSIR Society

A meeting of the CSIR Society, presided over by the Prime Minister, was held on 10th January, 2007 at 7, Race Course Road, New Delhi. The following items were adopted by the Soceity.

- Confirmation of Minutes of the CSIR Society meeting held on 25th May, 2005;
- Consideration and adoption of the Annual Accounts of CSIR for 2004-05, Audit Reports and comments thereon;
- Adoption of CSIR Annual Report 2004-2005; and
- Consolidation of core competencies of Central Mining Research Institute (CMRI) and Central Fuel Research Institute (CFRI) into Central Institute of Mining and Fuel Research(CIMFR).

In his welcome address, the Hon'ble Minister, S&T and Earth Sciences, Shri Kapil Sibal, congratulated the Hon'ble Prime Minister, Dr. Manmohan Singh, for his bold statement made during the inaugural session of the Indian Science Congress 2006 on Government's commitments to invest 2% of Gross Domestic Product (GDP) on Science & Technology during the Eleventh Five Year Plan. He remarked that it is universally accepted that knowledge generation and management is now at the centre of all the developmental activities driving the economic growth. These are a primary source of competition in the world markets. He assured the Hon'ble Prime Minister that the member organizations of the S&T system in the country would join hands to come up to his (PM's) expectations. He further observed that achieving the target of a double digit growth rate at the end of the Eleventh Five Year Plan was possible only through utilization of S&T for solving the problems of the poor sections of the Society as well as for inclusive growth. He then expressed his concern over the declining scientific work force in CSIR and urged that the norms for recruitment of scientists should be different from that for administrative recruitment. He also called for the complete de-bureaucratization of the system, if it had to remain competitive and relevant.

The Hon'ble Minister made a detailed presentation, particularly with reference to CSIR's achievements over the years, its approach to Eleventh Five Year Plan, the new initiatives and the concern of CSIR to remain relevant.

The Hon'ble Prime Minister and President, CSIR Society, started his address by eulogising the leadership provided by Dr. R A Mashelkar, former DG-CSIR, to CSIR. He also complimented Dr. Mashelkar for increasing the interface between the private and public sectors in the R&D activity in the country.

He marked the Government's decision for stepping up funding for Science both as an opportunity and a challenge. He called for raising the ambitions sufficiently High to be able to make good use of the funds available. He further directed CSIR to take a lead in preparing an Action Plan for EFYP period for utilizing the funds and raise the bar for all science departments. He also touched upon the issues related to talent crunch and suggested to make many radical changes. Another important point, he stressed upon, was greater synergy and collaboration between CSIR laboratories and the university system to attract talents (both at younger level and at experienced level). He assured to consider incentives payments related to the research productivity of scientists, measured in terms of a variety of criteria.

He asked CSIR to have greater focus on application of modern science and technology in improving quality of life in rural areas. He concluded his address by saying *"I assure you that our Government will do all that is needed to support the development of Science and Technology in our country. But I also want our academic community and the private sector to respond to the challenges at hand."*

[Full text of the speech by the Hon'ble Prime Minister is at Annexure-VI]

2.2. Governing Body (GB)

The Governing Body of CSIR met twice during the year, i.e., on 21st June 2006 and 8th December, 2006. The GB in its meeting considered several determinative matters and gave directions on the issues.

- On 21st June, 2006, in its 167th meeting, the GB approved: creation of Professional Development Fund, setting up of CSIR off-shore Business Development Units, renaming of Regional Research Laboratories of CSIR, adoption of Annual Accounts of CSIR for the year 2004-05.
- On 8th December 2006, in its 168th meeting, the GB approved: CSIR Annual Report for the year 2005-06, setting up of Special Purpose Vehicle (SPV) in CSIR, creation of IGIB-NCL Joint Research Initiative (JRI) for collaborative research at the interface of chemistry and biology; CSIR Diamond Jubilee Technology Award-2006; Shanti Swarup Bhatnagar Prize-2006; CSIR Young Scientist Award; and CSIR Award for S&T Innovations for Rural Development.

2.3.1. Department-Related Parliamentary Standing Committee

The Department-related Parliamentary Standing Committee on Science & Technology, Environment and Forests considers and recommends the demands for grants of DSIR including CSIR to the Government of India. It also looks into specific topics/subjects of national S&T interest for deliberation from time to time. The Committee considered the demands for grants for the year 2006-07. A background note was prepared highlighting activities, programmes and financial summary. The Committee made certain observations/suggestions on the Background Note, significant ones of these include:

- The Committee emphasized the importance of indigenous technologies and their crucial role in an increasingly globalized world. Cutting edge technologies and patentable innovations are the only hope for wealth generation in a cut-throat competitive environment. The Committee stressed that CSIR has a huge responsibility of training human resource to that effect and creating an enabling environment for such innovations to take place.
- The Committee recommended that there is a need for setting-up a special Technology Dissemination cell in all the CSIR laboratories so that the technology support can be given to SMEs also.

- The Committee appreciated the good work done by the Department in the area of Intellectual Property and was hopeful that more results would follow in future.
- The Committee felt that the Department should make efforts to encourage more participation from the Industry with a good track record for distribution of both risks and rewards. Industry with a rich experience of market can help scientific establishments feel the pulse of the market and make scientific research commercially viable.
- The Committee commented that the research on alternative sources of energy was still in its infancy. It further suggested that a non-conventional source of energy, which is commercially viable and environment-friendly capable of changing the present pattern of fuel consumption, was the only solution in the longer run.
- The Committee suggested a close coordination between different arms of the Government to bring down the costs of the drugs as individual departments cannot be expected to bring the costs down. The Committee felt that innovative ways like distribution of cost by providing cheap insurance to people for diseases have to be devised, as cost of manufacturing of drugs cannot be brought down below a point.
- The Committee opined that in spite of the Department's efforts in formulating Golden Triangle, there was a need for giving further boost to the herbal medicines. The Committee felt that with the abundant resources of medicinal plants all over the country, there was a need to set up a Herbal Research and Development Institute in a location where all the variation of our biodiversity could be tapped.
- The Committee suggested IICB to put the optimum effort to develop the molecule of paan to a final drug stage as soon as possible so that it could be passed on to the pharmaceutical sector for production in the near future thereby transmitting a lot of benefit to medical sector in treating chronic cases of Chronic Myelogenous Leukemia (CML).

2.4. CSIR Foundation Day

Twenty-sixth September is a very auspicious day for CSIR. It was on this day in 1942 that the CSIR came into being. Year after year CSIR, through its constituent laboratories, celebrates the accomplishments of the year gone by and plans for the future to serve the nation with still greater dedication. It is also an occasion to accord recognition to excellence in science through the presentation of awards and prizes.

This year's Foundation Day celebrations were marked by glittering functions organized at Vigyan Bhawan and Hotel Le Meridian. It was, indeed, celebration of best of science and best of technology in the form of presentation of Shanti Swarup Bhatnagar Prizes (2006), CSIR Diamond Jubilee Technology Award (2006), the newly instituted CSIR Award for S&T Innovations for Rural Development, CSIR Young Scientist Awards (2006), CSIR Technology Awards (2006), and CSIR Diamond Jubilee Invention Awards for school children (2006). The Hon'ble Minister for S&T and ES,Shri Kapil Sibal launched "Geno Cluster" a bio-informatics software developed by IGIB and M/s Jalaja Technologies and released a Compendium "Contributions of CSIR to Antarctic Research Collected Reprints", to impress upon the importance of the occasion. 'Science Safari', a film highlighting the innovative and path breaking achievements in science and technology in India an initiative by the Ministry of

Science & Technology and Earth Sciences and the National Geographic channel-was also screened on the occasion.

All the constituent laboratories of CSIR also celebrated this auspicious day with great enthusiasm and zeal. A variety of functions such as invited talks by eminent personalities of the field, observing open day, etc., were held to mark the occasion.

Excerpts from the speech by Shri Kapil Sibal, Hon'ble Minister for Science & Technology and Earth Sciences

The Foundation Day celebrations at the Vigyan Bhavan, presided over by the Hon'ble Prime Minister of India, were largely attended. The Hon'ble Minister of S&T welcomed the Hon'ble Prime Minister of India and President, CSIR Society, Dr. Manmohan Singh to the CSIR Awards Function to do the honours. Shri Sibal appreciated the untiring support of the Hon'ble Prime Minister for the scientific community in its hour of need without any hesitation. He announced institution of another national award for S&T Innovations for Rural Development, in additions to the two existing awards, the Bhatnagar Prizes in science and the Diamond Jubilee Technology Award. He opined that institution of Award for S&T Innovations for Rural Development reflects the enhanced national concern for disadvantaged sections of our society. He congratulated CSIR for accomplishing the desires of Shri Rajiv Gandhi, the then Prime Minister of India and President, CSIR Society in becoming more customer-oriented and generating External Cash Flow. He complimented this achievement, particularly in view of the fact that the investment by Indian Industry in R&D is a dismal half-a-percent or so of their sales turnover. He further made a point in stating the high degree of utility of CSIR's research outputs, particularly with respect to patents and publications.

Shri Kapil Sibal addressing the gathering on the occasion of Foundation Day

He concluded his speech by remarking "Once again, my hearty congratulations to the Awardees for their excellent achievements. You have done the nation proud. We all salute your success". **[Full text of the speech is at Annexure VII]**

Excerpts from the speech of the Hon'ble Prime Minister, Dr. Manmohan Singh

The Hon'ble Prime Minister opened his speech by stating "I am very happy to be here today amongst a galaxy of scientists and each one of you are a nation-builder. I congratulate each of the awardees gathered here, and the staff and employees of the CSIR on the 64th Foundation Day of CSIR. As the President of CSIR Society I am proud of the achievements of CSIR".

Dr. Manmohan Singh addressing the gathering

He stated that Science and Technology should be pace setters in nation's quest for a life of dignity and self respect for all. He congratulated the awardees and emphasized the great prestige that these awards carry. He commended the fact that almost none of the 400 plus Bhatnagar awardees has left the country. He expected the same dedication from this year's awardees for promotion of science and technology in the country.

He stated that Indian S&T, today, has to have a rich supply of skilled scientists and technologists and promote 'technology-led accelerated inclusive growth.' He said that the comparison of the S&T personnel working in India with those in Korea, US and Japan surprised him that in India the work-force was much smaller in comparison to these nations. To overcome this, he announced that the Government was setting up three new Indian Institutes of Science, Education and Research (IISERs).

globally recognized institutes of higher learning. This can be achieved only through the recruitment of the very best faculty, he added. He was also in favour of creation of an environment conducive to the pursuit of excellence. He stated that the real challenge was to get the best minds in India to engage in providing practical and pragmatic solutions to social and economic problems existing in the country.

He further stressed on the need of coordinated international efforts in addressing common technological issues, for example issues related to energy, disease, better education, growing population, etc. Continuing the topic of coordinated international efforts, the Hon'ble Prime Minister stated that it has become imperative for the world community to find more pathways to sustain adequate incentives for the generation of new knowledge and simultaneously to make the fruits of this knowledge available at affordable prices to the poorer countries of the world.

He further stressed the need to initiate measures to evolve concerted strategies to make globalization and the knowledge revolution happen so that they propel the entire human kind to a win-win situation.

The Hon'ble Prime Minister concluded his speech by congratulating the awardees once again and applauding Dr. Mashelkar for his service to the science and to the nation. **[Full text of the speech is at Annexure VIII]**

Dr. Mashelkar thanked the Hon'ble Prime Minister for gracing the function. He also thanked the Hon'ble Minister of S&T and ES for 'bringing new life, energy and hope to science'. He concluded his remarks by mentioning that it was his last public function as DG-CSIR, as he would be stepping down from the office later that year.

As a part of CSIR Foundation Day celebrations, CSIR Diamond Jubilee Technology Award for 2006 was awarded to M/s Tejas Networks India Ltd., Bangalore for the development of Next Generation Optical (SDH/SONET) Networking products and their successful commercialization from India.

This year CSIR instituted CSIR Award for S&T Innovations for Rural Development to recognize those S&T innovations that have helped transform the lives of rural people or alleviated the drudgery of the rural people or have helped in generation of employment. CLRI bagged the first award for the year 2006.

Presentation of Young Scientists and Technology Awards

Later in the day, in a function held at Hotel Le Meridien, the Hon'ble Minister of S&T and ES presented CSIR Young Scientist Award and CSIR Technology Awards, launched 'Geno Cluster' and released the compendium entitled "Contributions of CSIR to Antarctic Research: Collected reprints". 'Science Safari', a film highlighting the innovative and path breaking achievements in Science and Technology in India an initiative by Ministry of S&T and Earth Sciences and the National Geographic channel-was aired for the first time.

In his welcome address, Dr. R.A. Mashelkar appreciated Shri Sibal for his role as an able leader of Science & Technology. He felt proud that three of the Bhatnagar awardees, that year, were from CSIR. He spoke about the emerging concept of the 'Triple bottom line', which in practical terms, means expanding the traditional corporate culture to take into account the environmental and societal performance in addition to financial performance.

Keeping aside his prepared speech, Shri Sibal opted to address from his heart in a articulation that touched the audience deeply with its eloquence.

He opened his speech by quoting Alan Lightman that set the mood for the rest of the evening. He quoted: “All of the scientists I've known have at least one more quality in Common: they do what they do because they love it, and because they cannot imagine doing anything else. In a sense, this is the real reason a scientist does science. Because the scientist must. Such a compulsion is both blessing and burden. A blessing because the creative life, in any endeavor, is a gift filled with beauty and not given to everyone, a burden because the call is unrelenting and can drown out the rest of life."

The Hon'ble Minister showered praises on Dr. R.A. Mashelkar the then Director-General, CSIR and quoted “not intellect but character defines a scientist and there is an abundance of character in this hall today”. While applauding the passion for work, to do science as engrained in scientists, he showed his concern about the autocratic heartless system. He shared his willingness to change the system and to together lay the foundation of a new India. Shri Sibal also shared his experiences of his visit to Antarctica. He quoted “As they say, life is a stage and we play a little role… Some with flying colours and some not.”

He warmly appreciated Dr. Mashelkar for his qualities of head & heart, and also the leadership he provided not only to CSIR but also to the Indian Science as a whole.

2.4.1. Shanti Swarup Bhatnagar Prize - Winners of 2006

- Dr. Vikram Kumar, Director, NPL, proposed the vote of thanks.
- Dr. Vinod Bhakuni, CDRI and Dr. Rajesh Sudhir Gokhale, National Institute of Immunology (for Biological Sciences);
- Dr. Srinivason Sampath, Indian Institute of Science and Dr. K. George Thomas, RRL-Thiruvananthapuram (for Chemical Sciences);
- Dr. Gufram-Ullah Beig, Indian Institute of Tropical Meteorology and Dr. Pulak Sengupta, Jadavpur University (for Earth, Atmospheric Ocean and Planetary Sciences);
- Dr. Ashok Kishsore Lele, NCL and Dr. Sanjay Mittal, IIT-Kanpur (for Engineering Sciences);
- Dr. Vikraman Balaji, Chennai Mathematical Institute and Dr. Indranil Biswas, Tata Institute of Fundamental Research (for Mathematical Sciences);
- Dr. Virender Singh Sangwan, LV Prasad Eye Institute(for Medical Sciences); and
- Dr. Atish Dabhokar, Tata Institute of Fundamental Research and Dr. Sanjay Puri, Jawaharlal Nehru University (for Physical Sciences).

The Shanti Swarup Bhatnagar Prize-winners with Prime Minister Dr Manmohan Singh, Minister of Science & Technology and Earth Sciences Shri Kapil Sibal and CSIR Director General Dr R.A. Mashelkar

HEADQUARTERS


CSIR-INDIA

3.0. HEADQUARTES Activities

The CSIR Headquarters is the focal point of its 38 constituent laboratories, which provides support in diversified areas that include strategic planning; repository of organizational learning; policy guidelines; managing intellectual property; window to the Planning Commission; gateway to international linkages and collaborations; business development; extra mural human resource development, legal handling and advising on vigilance related matters. These tasks are accomplished by various divisions manned by skilled scientific, technical and administrative workforce.

Following paras give a glimpse of a few significant activities carried out by the divisions of Headquarters:

3.1. R & D Planning Division (RDPD)

The nerve centre of CSIR Hqrs. is the R&D Planning Division, which is mandated to carry out activities ranging from regular interactions with Government agencies, conceptualizing & preparing Five Year Plans and Annual Plans, demands for grants and related matters, CSIR Annual Report and various reports for Planning Commission, etc.

It also carries out activities related to organizing Directors' Conference, Research Councils of the labs, matters pertaining to S&T plan projects, data bank of whole CSIR's R&D activity, implementation of CSIR National Innovation Foundation Scheme, execution of New Idea Fund, support for programmes like Golden Triangle Project, and providing assistance to Minister of S&T and ES, etc.

In addition, the Division also has the onus for proper co-ordination externally with Planning Commission, Finance Ministry and other sector-specific departments, and internally with Finance Division and the CSIR laboratories. It also provides technical support to investment Sub-Committee of GB.

3.1.1. Eleventh Five Year Plan

The central planning process of the country is driven by seven regnant policy objectives, viz., growth, social justice & equity, modernization, self reliance, food, productivity and employment. These are once again, the guiding principles of Eleventh Plan which commences on 01-04-2007.

A substantial portion of planning relates to fiscal aspects and physical targets. It must, therefore, be recognized that it encompasses human and natural resources, scientific methods and technologies, enhanced efficiency and entirely new means of doing things. Eleventh Plan would be the vehicle that would position the country as a super power- economically, strategically and scientifically. The overall economy of the country is estimated to grow annually at 8.5% during EFYP as viewed by the Government. Parallel to the high growth rate aiming for improving livelihood support and increasing employment, the EFYP strategy focuses on renewed emphasis on education, health and other socially relevant issues. To become and remain competitive in a globalized world with no trade barriers, an R&D organization like CSIR has to take the challenges head-on.

The Planning Commission constituted a 'Steering Committee on Science & Technology' under the Chairmanship of Dr. R. Chidambaram, Principal Scientific Adviser to Govt. of India. It has constituted a Working Group for CSIR to formulate strategy and approach for EFYP. The Working Group for CSIR has formulated sixteen sectoral and four thematic groups to help it to assess in greater detail the itemized R&D needs of the sectors and themes.

The 16 sectoral groups set up are: Aerospace Science & Engineering; Agro, Food Processing & Nutrition Technology; Biology & Biotechnology; Chemical Science & Technology; Earth System Science; Ecology & Environment; Energy Resources & Technology; Electronics, Photonics & Instrumentation; Engineering Materials, Mining/Minerals & Manufacturing Technology; Pharmaceutical, Healthcare & Drugs; Housing, Road & Construction; Information Technology, Resources & Products; Leather; Metrology; Rural Development; Water & Resources & Technology. The 4 thematic groups are looking into the needs for programmes on Human Resource Development, Intellectual Property Management & Breaking IP Barriers, International Collaboration in Cutting-edge Technologies, and Public-Private Partnership and Enabling Industries.

The Division has facilitated the working of Sectoral Committees on 16 sectors and 4 themes as mentioned above. In consultation with laboratories and divisions of CSIR Hqs., it prepared background papers for the committees of respective sectors, conducted two to three meetings for each sector to prepare sector-specific documents. This document primarily provides sector-specific guidelines as to the direction in which CSIR should move forward in order to achieve excellence. It also covers the list of projects to be implemented by CSIR laboratories through various pathways such as Supra-institutional, Network, Inter-agency and Facility Creation, and their funds requirement.

The Division also organized brain storming session under the Chairmanship of Dr. Mashelkar, DG-CSIR, for the young scientists of CSIR to embark upon 'out-of-box' ideas and invited proposals from them to be implemented during EFYP.

The Division has conducted a couple of Regional Meets for CSIR laboratories to apprise them of the resources available and to discuss various aspects on smooth and speedy implementation of the projects, during EFYP.

3.1.2. Demands for Grants

Financial Year 2007-08

The Division has prepared Demands for Grants of CSIR for the year 2007-08 and submitted these to the Rajya Sabha Secretariat for consideration of the Department-related Parliamentary Standing Committee. The Committee, before recommending it to the Government, raised certain queries which were duly replied to. A presentation was made highlighting the significant achievements of CSIR during the previous year, focus of R&D activity in the coming year, etc.

The Committee has considered the Demands and recommended the same in full to the Government of India.

Financial Year 2006-07

For the Demands for Grants of the year 2006-07, the Committee had made certain observations contained in One hundred fifty one Report. The Division analyzed and prepared the Action Taken Note (based on the inputs provided by concerned division, DSIR, etc.) and submitted it to the Rajya Sabha Secretariat. Based on the Action Taken Note, the Committee made further observations for which ATN was prepared by the Division and submitted to the Rajya Sabha Secretariat within the prescribed time period.

3.1.3. Outcome Budget 2007-08

The Ministry of Finance had introduced a new instrument of governance, the outcome budget, to judge the performance of various Ministries and Departments.

Initially, each and every Ministry/Department had to prepare 'Outcome Budget' and 'Performance Budget' separately. However, beginning this year, Finance Ministry introduced a single document entitled 'Outcome Budget 2007-08' instead of two separate documents 'Performance Budget' and 'Outcome Budget'. The Division prepared 'Outcome Budget 2007-08' with respect to CSIR, which covers physical dimensions of the Financial Budgets indicating the actual physical performance in 2005-06, performance in the first nine months of the year 2006-07 and the targeted performance during 2007-08.

The document was forwarded to Department of Scientific & Industrial Research (DSIR) for preparation of a consolidated 'Outcome Budget 2007-08', which was later submitted to the Ministry of Finance.

3.1.4. Network Projects

The Division facilitated the implementation of 56 Network projects, a key feature of TFYP. It has played a very creative role in monitoring the projects periodically. The Division prepared the different progress reports, viz., half-yearly, yearly, etc., for presentation to different agencies like Planning Commission, Rajya Sabha Secretariat, Ministry of Finance, etc. The majority of the projects have been completed successfully, except sixteen projects which have spilled over to EFYP.

3.1.5. Renaming of Regional Research Laboratories

Abid Hussain Committee recommended the need of renaming of Regional Research Laboratories as the word 'regional' in their names is anomalous, and thus the focus of nationally and internationally relevant R&D being carried out by these labs gets marginalized. Following the recommendation of the Committee, RDPD worked out, in consultation with the respective laboratories, new and relevant names and got these approved by the Governing Body.

The changed names are indicated below:

- RRL, Bhopal: Advanced Materials and Processes Research Institute (AMPRI)
- RRL, Bhubaneswar: Institute of Minerals & Materials Technology (IMMT)
- RRL, Jammu: Indian Institute of Integrative Medicine (IIIM)
- RRL-Jorhat: North-East Institute of Science & Technology (NEIST)
- RRL, Thiruvananthapuram: National Institute for Interdisciplinary Science and Technology (NIIST)

3.1.6. CSIR-NIF Innovation Fellowship Scheme

CSIR, in order to boost the grass root innovations in India, has entered into an MoU with the National Innovation Foundation, Ahmedabad for validation/ value addition to the grass root innovations/ traditional health practices. Four areas, viz., 'Mechanical Engineering', 'Energy Technologies', 'Herbal Value Addition' and 'Food & Nutraceuticals' were identified for providing assistance under the scheme. Accordingly, Sub-Committees were formed on the four areas to consider and recommend the project proposals submitted by CSIR labs. After scrutiny by Sub-Committees, the proposals are placed before the Joint Implementation Committee (JIC) for consideration. JIC then recommends proposals for funding.

The Division convened Sub-Committee meetings, Monitoring Committee meetings and Joint Implementation Committee meeting during the year. The project

proposals were analyzed by the and necessary approvals were obtained for funding. The innovations funded under this scheme include 'Auto Compressor Sprayer' and 'Motor Cycle Driven Plough' under Mechanical Engineering category; 'Jute Match Stick' and 'Energy Efficient Stoves' under Energy Technologies; 'Banana Ripening by Herbal Formulation' under Nutraceuticals; and a number of traditional health practices under Herbal Value addition.

3.1.7. Golden Triangle Project

The Golden Triangle Project (GTP) has been launched as a collaborative Programme with the Department of AYUSH, ICMR and CSIR as three partners to standardize and validate ayurvedic medicines and herbo-mineral preparations by using modern tools and technologies for the Indian and global markets. CSIR is carrying out standardization of the selected ayurvedic formulations as well as chemical analysis, safety and toxicity studies of the identified herbo-mineral preparations under the programme. Seventeen formulations (mostly poly-herbal) for diseased conditions have been taken up for the studies under Phase-I of the project.

During the year four formulations were analyzed for microscopic & macroscopic examination, pharmacognosic studies, microbial contamination, heavy metal content, aflatoxin content and pesticide residues. The presence of the markers of each constituent plant has been determined in these formulations. Three formulations have been evaluated for pharmacological activities. The work on other formulations is in progress. Chemical standardization, finger-printing, toxicity and safety studies of first batch of all eight identified herbo-mineral preparations have been completed. The studies on second and third batches are in progress.

3.1.8. Prof. G.N. Ramachandran Award

CSIR had instituted a Gold Medal in the year 2004, for recognizing excellence in Biological Sciences in the fond memory of Prof. G.N. Ramachandran, pioneer in structural biology research in India. The Gold Medal is awarded every year. The Division facilitates the stringent selection process. The Gold Medal for the year 2006 has been awarded to Prof. T.P. Singh, an eminent and renowned Professor at All India Institute of Medical Sciences, New Delhi. He is a leading figure in the areas of structural biology, molecular biophysics, protein structure and structure based rational drug design.

3.1.9. New Idea Fund Programme

The New Idea Fund has been created for those CSIR scientists, members of the science community of CSIR, who want to dare, take risks and explore ideas with explosive creativity and novelty.

This year, out of seven short-listed proposals, one was selected for support under NIF Scheme. In the year 2005, DG-CSIR had desired to review of the NIF scheme. The report of the Review Committee setup for the purpose was submitted to DG-CSIR. Later on, the recommendations of the report were discussed by the NIF Committee. While commending the Scheme as unique and important to support new ideas, the Committee recommended it to be implemented in a revised form. Accordingly, the Division has prepared a draft guideline to implement the revised scheme, while creating database of names and addresses of CSIR scientists for establishing direct contact to solicit proposals, and developing a panel of experts from various streams of science and engineering for quick evaluation of ideas.

3.1.10. Directors' Conference

The Division, jointly with HRDC, Ghaziabad organized Directors' Conference on 9th & 10th December, 2006. The theme for this year's Directors' Conference was "CSIR: Looking Back & Looking Ahead". The Conference made a number of far reaching recommendations to prepare CSIR for the 21st Century.

3.2. Intellectual Property Management Division (IPMD)

The division is responsible for spearheading IP business of CSIR in India as well as abroad. In tune with the renewed philosophy of CSIR to shift from random patenting to planned patenting, the division has filed 169 patents in India and 650 patents abroad. It also filed 21 copyright applications during the year.

3.2.1. CSIR Diamond Jubilee Invention Award for School Children

Fifth Award (2006) presentation. In order to inculcate creativity amongst school children, CSIR selected six inventions, of which significant ones are "Making new compound using ionic liquid and heteropolyacid", "Cycle boat," and "Water absorbent formulation of bio-degradable organic material and a moulding machine therefore"

Fourth CSIR Award (2005) presentation. On the occasion of CSIR Foundation Day celebrations on 26th September 2006, DG-CSIR presented fourth CSIR Diamond Jubilee Invention Award to the winners of 2005.

3.2.2. Workshop on "Strategic IP Management"

The Division organized a workshop on 'Strategic IP Management and IP Coordinators Meet, through which participants, IP coordinators from CSIR labs, were given exposure to issues related to strategic IP Management, freedom to operate aspects, IP valuation, detection and management of infringement etc. Internationally renowned experts/attorneys were invited to deliver talks and interact with the participants.

3.3. Technology Networking & Business Development

The Division has been mandated to pursue New Millennium Indian Technology Leadership Initiative (NMITLI) as well as CSIR's business development initiatives. It also facilitates functioning of CSIR Unit for Research and Development of Information Products (URDIP). Significant activities carried out during the year are highlighted below:

3.3.1. New Millennium Indian Technology Leadership Initiatives (NMITLI)

Under the Scheme, two categories of projects, viz., Nationally Evolved Projects (NEP), and Industry Originated Projects (IOP) are developed and supported. Besides, a few projects are evolved based on the 'proof of concept' obtained from the earlier/ongoing NMITLI projects.

In the first category, the Division has facilitated conceptualization of project consultation mechanisms, including brainstorming meeting, special expert groups of the leading researchers and diverse stakeholders. The projects launched are: Conversion of Cellulose and Hemi-cellulose into Sugars and Ethanol; Conversion of Bioglycerol into Value-added Chemicals; and Novel Approaches for Production of Hybrid Seeds with Characteristics of Improved Insect Resistance and Higher Yield. In the 'IOP' category, one proposal each in the areas of Biotechnology Drugs & Pharmaceuticals, Engineering & Mechanical, and Information Technology were developed with the help of domain experts. One more proposal, which was short-listed last year, has also been developed. Thus, following four projects have been developed in this category: Development of Next Generation Plasma Display

Technology and a 50 inch High Definition (HD) TV Prototype; Wireless Sensor Network Chipset based on Ultra Wideband Technology; Development of High Throughput Marker-assisted Selection Systems for Improvement of Drought Tolerance and Fibre Quality Related Traits in Cotton; and Novel Method for Development of B-type Natriuretic Peptide (BNP) for Diagnosis and Treatment of Congestive Heart Failure. Another project, 'Mesoscale modeling for Monsoon Predictions-Phase II' has also been developed as a part of ongoing NMITLI project on mesoscale modeling.

NMITLI has helped, in a public-private partnership mode, to develop some new technologies which include globally competitive 'Triple Broadband Technology', 'Environmentally Secure Rare Earth based Colorants for Surface Coating Applications', 'Latent M. Tuberculosis: New Targets, Drug Delivery system', 'Bio-enhancers and Therapeutics', 'Integrated Micro-PCR System with in-situ Identification', 'Novel Molecular Diagnostics for Ocular Infections'.

3.3.2. Business Development and Marketing of Knowledgebase

Several new initiatives were taken in the domain of business development. Major ones are: operationalizing new initiatives recommended by the Sivaram Committee; and enhancing interaction with Indian as well as international companies. The results of these proactive efforts have been felt. The division has negotiated sponsored research agreement and umbrella confidentiality agreement with M/s DuPont; umbrella agreement for research collaboration with M/s Colgate-Palmolive; confidentiality, non-disclosure and limited use agreement and development agreement with Alcoa; and non-disclosure agreement with Qualtran & ChanTest. The relationship with P&G has been building very well and a number of laboratories have got involved into it. The second CSIR-P&G Board Meeting was held at NIO, Goa to review the progress. Also, the Division continued to render proactive assistance to laboratories for business development and marketing of knowledgebase. It maintained organic linkages with national level industry associations and other stakeholders. Over 125 license agreements were executed for CSIR's intellectual property and contract worth Rs. 450 crore for contract R&D and consultancy were in hand during the year.

3.3.3. Implementation of Sivaram Committee Report

The Division has undertaken initiatives for implementation of recommendations of Sivaram Committee, as Phase-II. These initiatives include setting up knowledge alliances between CSIR labs and private industry, setting up incubation centres in CSIR labs, mobility of scientists /technologists/ engineers from CSIR to industry / R&D institutions and vice versa, setting up of special purpose vehicle in CSIR, creation of professional development fund and setting up of CSIR's offshore centres.

3.3.4. Kelkar Committee Recommendations

Kelkar committee recommendations cover a wide range of issues concerning CSIR. Subsequent to the acceptance of the Change Team (CT) report, a detailed time bound Action Plan has been drawn for implementation of the Kelkar committee recommendations. CSIR has constituted an internal Monitoring Committee to closely monitor the implementation of the CT recommendations vis-à-vis time schedule as specified in the Action Plan. The eleventh five year plan (2007-12) of CSIR has been formulated after incorporating major recommendations of Kelkar Committee, which include: substantial transformation of 'competence' in CSIR, exploring uncharted areas in the 'knowledge-market' matrix, intra-organizational impact making projects,

moving CSIR from input-driven to out-put driven organization, to achieve the critical mass needed to realize the desired high value outcomes and shed programmes where such outcomes are not foreseen. CSIR has created enabling mechanisms for setting up of ABU and AFUs as Special Purpose Vehicles.

3.3.5. Security and Sensitivity Clearance

The R&D proposals involving foreign scientists/ agencies were examined and assessed in the Division from the security and sensitivity angle. The proposals covered basically contract R&D. During the year, eighty one such proposals were processed. Some of the clientele covering these proposals included DuPont, Johnson & Johnson, Colgate-Palmolive, Invista, ISIS Pharmaceuticals, Honeywell, Lanxess, Procter and Gamble, GE, D&O Pharmachem Inc. USA, Alcoa Inc., USA, Rasayan Inc., USA, etc. The list also includes clients from France, Sri Lanka, Nepal, Malaysia, Dubai, South Korea, Yemen, Oman, Trinidad, etc.

3.3.6. CSIR Technology Awards 2006

The Division has facilitated the award process from inviting nominations, selection by the designated Committee, to getting approval from the competent authority. There were two awards, namely, Prize for Chemical Technology to Indian Institute of Petroleum (IIP), Dehradun for the "Development of Comb Type"; and Prize for Business Development and Technology Marketing to Central Leather Research Institute (CLRI), Chennai for significantly enhancing the business and markets for its knowledgebase.

3.3.7. CSIR Award for S&T Innovation for Rural Development 2006

The Award recognizes those outstanding S&T innovations that have been implemented at ground level and have helped transform the lives of rural people or alleviated the drudgery of the rural people or have helped in generation of employment. The Division has facilitated the selection process for the award. The first ever award was presented to CLRI during the CSIR Foundation Day-2006 Celebration.

3.3.8. CSIR Diamond Jubilee Technology Award -2006

The Division has also facilitated the award process of CSIR Diamond Jubilee Technology Award for the year 2006, which was bestowed upon M/s Tejas Networks India Ltd. in recognition of their work for development and commercialization of "Next Generation of Optical (FDH/SONET) Networking Products".

3.4. General Administration

General Administration is yet another important wing of the Headquarters, which facilitates the general functioning of all CSIR laboratories. Within itself, it has different arms to assist its day-to-day functioning. Establishment-I (E-I) is the cadre controlling section of all the common cadre officers of CSIR; Establishment-II (E-II) deals with all aspects of the lab administration; while Establishment-III deals with matters of CSIR Central Office.

The Parliament Cell deals with the Parliamentary matters. The Committee Section deals with all aspects of various Committees, Society, Governing Body, Management Agenda/Proceedings of Management Council meetings of CSIR Labs/ institutes. It collects comments from the concerned Sections/Divisions at CSIR Hqrs. and after compiling the same, sends these to the Labs/ institutes. It also convenes meetings of the Governing Body & Society, prepares agenda papers/minutes and takes follow up action on the recommendations of the GB/Society meetings.

3.5. Human Resource Development Group (HRDG)

3.4.1. Raj Bhasha Unit

Raj Bhasha unit deals with the implementation of Official Language Act at CSIR Hqrs. & coordinates with the Labs./institutes of CSIR. Arrangements for visits of the Raj Bhasha Sansdiya Samitis are also made by this Unit.

3.4.2. SC/ST Cell

It deals with the grievances of SC/ST & Physically Handicapped employees and ensures implementation of instructions and provisions made for the welfare of SC/ST & Physically Handicapped employees and also coordinates with the concerned Departments/bodies.

3.5.1. CSIR-UGC National Eligibility Test for JRF and LS

CSIR conducts National Eligibility Test (NET) for Junior Research Fellowship and Eligibility for Lectureship twice a year at 25 centres throughout the country.

The result of CSIR-UGC NET December 2005 examination was announced on 17th April 2006. A total number of 1,081 candidates qualified for CSIR/UGC Junior Research Fellowship & lectureship, and 1271 qualified for lectureship only.

CSIR-UGC National Eligibility Test (NET) June 2006 for Junior Research Fellowship and Eligibility for Lectureship was conducted on 18th June 2006. 74,778 candidates registered for the examination. The result was declared on 20th Nov 2006. A total number of 909 candidates qualified for CSIR/UGC Junior Research Fellowship & lectureship, and 1345 qualified for lectureship only.

The CSIR-UGC NET December-2006 examination was held on 24th December 2006. More than 65,500 candidates registered and 50156 appeared for the examination.

3.5.2 Shyama Prasad Mukherji Fellowship (SPMF)

The SPM fellowship scheme was started in the year 2001 with the objective to nurture budding scientific talent towards pursuit of scientific research. The scheme is open to top 20% CSIR-UGC JRF-NET scholars along with top 100 GATE qualified candidates with percentile 99 and above who have to qualify a specially designed written test followed by an interview to be eligible for the fellowship.

The examination for SPMF for the year 2006 was held on 9th July. Out of 509 candidates called for written examination, 271 appeared and 28 were selected for interview. Five candidates finally qualified for SPM fellowship, two each from Mathematics and Physics streams and one from Chemistry stream.

3.5.3. Senior Research Fellowship (SRF), SRF Extended and Research Associateship (RA)

In 16 subject categories, Selection Committees selected 377 candidates for SRF, 34 candidates for SRF (Ext) and 70 candidates for RA.

3.5.4. Senior Research Associateship (SRA) / Scientists' Pool Scheme

The Senior Research Associateship (SRA ship) is primarily meant to provide temporary placement to highly qualified Indian scientists, engineers, technologists, and medical personnel who are not in regular employment in the country, including those returning from foreign countries. 77 Senior Research Associates were selected.

3.5.5. Junior Research Fellowship for GATE - qualified Engineering Graduates (JRF-GATE)

CSIR introduced a new research fellowship in 2002 for the GATE qualified candidates

with B.E./ B. Tech./ B. Arch./ B. Pharm. degree to pursue research leading to Ph.D. This is known as the GATE qualified Junior Research Fellowship (JRF-GATE). JRFs selected under this scheme get excellent opportunity to work with the CSIR scientists. 119 JRF-GATE Fellows are at present working in different laboratories of CSIR.

3.5.6. Shanti Swarup Bhatnagar Prize

CSIR recognizes scientists for doing outstanding research work in the country, in the form of prizes/awards. The Shanti Swarup Bhatnagar Prize (SSB) for Science & Technology, is given every year to the outstanding scientists in 7 disciplines of S&T. The Prizes for the year 2006 were presented by Dr. Manmohan Singh, the Hon'ble Prime Minister of India & President, CSIR to thirteen outstanding scientists at a glittering function organized at Vigyan Bhawan on 26th September, 2006.

3.5.7. CSIR Young Scientist Award

Young Scientist Award (YSA) is meant for scientists below the age of 35 years, working in CSIR laboratories, to recognize in-house excellence. YSA is given in 5 disciplines of Science & Technology. In the year 2006, six scientists were selected for Young Scientists Awards, one each from Biological and Engineering Sciences and two each from Chemical and Earth, Atmosphere, Ocean & Planetary Sciences. These Awards were presented by Shri Kapil Sibal, Hon'ble Minister of Science & Technology and Earth Sciences at the CSIR Foundation Day function held at Hotel Le Meridien on 26th September, 2006.

3.5.8. Funding of Extra-Mural Research Schemes to Promote R&D

CSIR provides financial assistance to promote research in the field of Science and Technology including Agriculture, Engineering and Medicine. Research grants are given to Professors/ Scientists in regular employment in Universities/ Academic Institutes/ IITs, etc.

Under General schemes, financial assistance was provided to 211 schemes out of a total of 507 proposals considered and 526 renewals were made during the year 2006-07, whereas under the Emeritus Scientists Scheme, financial assistance was provided to 24 outstanding superannuated scientists out of a total of 91 proposals considered and 92 renewals were made during the year. In the Sponsored Scheme category, 15 schemes were sanctioned out of 29 proposals considered and 41 ongoing schemes were renewed. Under the one time grant category, out of 10 proposals received, four were funded.

3.5.9. Travel / Conference Grants

Travel grant is provided by CSIR to young researchers for presenting research papers at International Conferences held abroad. The travel grant committee considered a total of 984 applications out of which 452 cases were recommended. The same committee considered 757 proposals from scientific societies/ institutes, etc., for organizing national/ international conference/ symposium/ workshops, etc., and recommended 632 cases for organizing these events.

3.5.10. CSIR Program on Youth Leadership in Science (CPYLS)

The CPYLS scheme is a unique 'hand holding' program started for school children at secondary level. The scheme was started to attract the meritorious young school children towards science.

During the year, most of the CSIR laboratories organized 2 open days

Programme. There is always an overwhelming response both in terms of participation and appreciation of the scheme.

3.5.11. CSIR Diamond Jubilee Research Interns Award Scheme

CSIR Diamond Jubilee Research Interns Award Scheme is a preparative scheme through which young interns will be trained in the tools and techniques of research under supervision of experienced scientists in CSIR. Selections of interns were held for various divisions of CSIR Hqrs. viz., HRDG, RAB, IPMD, HRDC under this scheme on 29th & 30th May 2006. 76 candidates were called for interview and 10 were selected.

3.5.12. Technological Entrepreneurship Support to Research Scholars

The objective of this scheme is to inculcate the spirit of technological entrepreneurship in research scholars by providing first hand information on elements of entrepreneurship, formulation of business plans, IPR, team work, etc., and to enable them to learn how to take knowledge-based innovation through to a commercial outcome, managing all the major steps on the way. 62 students from various CSIR labs attended the fourth programme organized at CLRI Chennai from Feb 12, 2007 to March 11, 2007.

3.5.13. Faculty Training & Motivational Programme by Adopting Schools and Colleges

The objective of this scheme is to organize training and motivational programmes for selected science teachers from schools and colleges around CSIR labs to upgrade their knowledge-base in new and emerging areas of science thereby raising the standard of science education in selected schools and colleges. It also envisages to promote interaction between science students and CSIR labs, thereby motivating the students to take up science as a career. The scheme is being implemented by almost all the CSIR laboratories. During 2006-07, about 25 CSIR Labs organized training and motivational programmes for science teachers and students.

3.6. Human Resource Development Centre (HRDC)

HRDC continued with training & development activities with the focus on development of skills required for the organization to remain competitive. During the year, 41 training programmes were conducted for different categories of CSIR staff. The programmes were designed specifically to update/ refresh and enhance the functional knowledge/ skills of the CSIR staff to enable them to improve quality and work effectively in performance of their roles. In addition to programmes on functional skills, training programmes were organized on leadership skills development to prepare potential leadership in the organization for the future. The faculty for the programmes was sourced from leading management institutes and S&T and industrial organizations.

3.7. International S & T Affairs Directorate (ISTAD)

In order to achieve its mandate of identifying, facilitating, and promoting international cooperation in the emerging and frontier areas of science and technology, ISTAD's major activities during the current year include the following:

3.7.1. Bilateral Cooperation

CSIR participates in a number of bilateral co-operation programmes with many countries, which seek to further R&D programmes of mutual interests, as under:

Aregentina

Under Indo-Argentine Inter-Governmental S&T collaboration following five collaborative projects were approved under the Indo-Argentina S&T collaboration programme of DST.

- Detection and Identification of Ophio and Varicosaviruses Infecting Important Horticulture and Ornamental Crops (between IHBT, Palampur and Instituto de Bioquimica Biolgia Molecular, IBBM, Argentina).
- Polydimethylsiloxane Bed Bioreactors and Electronic Tongue-Nose Methodology Applied to Polluted River Bioremediation (between National Institute of Interdisciplinary Science and Technology (NIIST) Thiruananthapuram & University of Buenos Aires).
- Biocatalysts Novel Approach for the Production of Pharmaceuticals (between National Institute of Interdisciplinary Science and Technology (NIIST) Thiruananthapuram & Belgrano v pasaje Caseros, Argentina).
- Innovative Environmental Catalysis: Novel Catalysts for Abatement of Volatile Organic Compounds (between IICT, Hyderabad & Instituto de Investigaciones en Catalysis V Petroquimica, Argentina).
- Probiotic Lactic Acid Bacteria as Anti-cholera Oral Edible Vaccine to be Used as a Functional Food (between CFTRI, Mysore & Instituto de Biologia Molecular Cellular de Rosario, Argentina).

Austria

A 5 year collaborative project entitled "Integrated Analytical Application to Assess Indicators of the Effectiveness of Pesticide Management Practices at a Catchment Scale" (CFTRI, Mysore & International Atomic Energy Agency (IAEA), Vienna, Austria.

China

CSIR-NSFC Joint workshop on global change. As a follow up of the signing of Working Programme of Scientific and Technological Cooperation between CSIR and NSFC, China for 2006-2008 at NSFC in Beijing, a CSIR- NSFC workshop on "Global Change: Ocean Atmosphere Land Interactions Driven by Monsoon" was organized at NIO, Goa during 4-6 December, 2006.

Projects. Following five joint projects have been approved for joint funding/ implementation by CSIR-NSFC:

- Evolution of Model Configuration for Regional Climate over Monsoon Asia (between C-MMACS, Bangalore & Institute of Atmospheric Physics, CAS, Beijing).
- Influence of River Discharges on Shelf and Deep Sea Biogeochemical Processes (between NIO, Goa & Key Laboratory of Estuarine and Coastal Research, East China Normal University, China).
- Indian Ocean-Atmosphere Interactions at Intraseasonal to Interannual Scale (IndOAI) (between NIO, Goa & First Institute of Oceanography, SOA, China).
- Late Quaternary Paleoceanographic Changes in the Northeast Indian Ocean and South China Sea using Isotopic and Trace Elemental Proxies from the Deep-Sea Sediment Cores (between NGRI, Hyderabad & School of Ocean and Earth Sciences, Tongji University, Shanghai, China).
- Asian Rivers: Changes in Sedimentological and Geochemical Characteristics of Sediments from Source to Sink (between NIO, Goa & Ministry of Education Key Laboratory for coastal and Island Development, Nanjing University, China).

Japan

MoU between CSIR, India & AIST, Japan. CSIR, India & National Institute of Advanced Industrial Science & Technology (AIST), Japan signed an MoU on 12 February, 2007 to strengthen the cooperation between AIST and CSIR on S&T and to promote R&D and utilize the results of joint R&D by commercialization in areas of mutual interest. Areas identified for co-operation include: clean coal; biomass utilization; nanotechnology; bioinformatics and genomics. Joint projects in these areas, like Computer Controlled Scanning Electron Microscopic Analysis of Typical Indian Coal Samples, Co-gasification of Coal and Biomass, Solvent Extraction Cleaning of High Ash Non-coking and Coking Indian coals for its Specific End Uses, and Glycogenomics & Population Polymorphism are being prepared.

Project. A collaborative project entitled "Protein Hydrolysates from Marine Sources with Special Reference to their Physiological Functions" between CFTRI, Mysore & Laboratory of Biofunctional Material Chemistry, Hokkaido University, Japan - was approved.

Norway

Project. A joint project entitled "Development of Health Indicators for Indian Coastal Waters" of NIO, Goa and International Institute of Stavanger (IRIS), Norway was approved.

South Korea

India-Korea joint committee meeting on S&T. The 2nd Meeting of the India-Korea Joint Committee on Science & Technology was held in New Delhi on 8th November, 2006. Three specific areas, viz., Nano Science & Technology, Bio-Technology, and Information Technology were identified for co-operation between the two countries.

Korea has proposed the establishment of a Korea-India Innovation Industry Partnership, for which CSIR has been identified as the Managing Partner of the Centre from the Indian side and the Korea Institute of Industrial Technology (KITECH) from the Korean side. This Center proposes to cover joint research coordination, mutual exchange of technology, technological consultation to Small and Medium Sized Enterprises (SMEs), and other technology-related matters.

Thailand

Thailand joint committee meeting on S&T. The 2nd Meeting of the Joint Committee on Science & Technology Cooperation between Thailand and India was held in New Delhi on November 8, 2006.The areas identified for cooperation between the two countries were Natural Rubber and its Products, Metrology, Bio-Technology including Agricultural Biotechnology, Advanced Materials, Solar Energy, Peaceful use of Nuclear Technology, Space Science & Technology, Science Communication, Health food and Natural Products.

Germany

Bilateral CSIR- FzJ cooperative science programme. * Projects -Following joint projects were approve:

- "Development of Methods for Fatigue and Seismic Resistant Design and Management of Concrete Structures" (between SERC and Universitaet Stuttgart, Germany).
- "Fracture Assessment of Bi-Metallic Pipe Joint" (between NML, BARC and MPA, University of Stuttgart).

- "Density Distribution and Dynamics of the Lithosphere across Active Collision Zones from New Generation Satellite Gravity Mission(s)" (between NGRI and Christian Albrechts University, Institute fur Geowissenschaften, Kiel, Germany).
- "Self Organized Crustal Evolution using Magnetic Data" (between NGRI and Leibniz Institute for Applied Geosciences, Hannover, Germany).
- "Atmospheric Discharges as Pulsed VUV-radiation Source for Water Purification" (between CEERI and University of Erlangen, Germany).
- 'Bioprospecting of Endophytic Micro-organisms for Anti-Cancer Molecules' (between RRL-Jammu and Institute of Environmental Research (INFU), Dortmund, Germany).

* Joint workshop -An Indo-German workshop on "Fuel Cells and Hydrogen Energy" co-piloted by CGCRI and Research Centre Juelisch (FZJ) and funded by CSIR and FZJ was held at CGCRI during Jan 29-31, 2007.

CSIR-Humboldt Reciprocity Research Award. Prof. H. Wiggenhauser, Institute for Material Research & Testing, BAM, Berlin and Prof. BL Mordike, Technical University, Clausthal, Zellerfield, Germany were granted the prestigious Research Award for the year 2006. Their visits to India have resulted in assured long-term research ties between their institutes and the Indian host institutions.

Energy. CSIR was included as one of the Indian partners in the high level Indo-German Energy Forum established by the Indian and German governments for forging and furthering cooperation between India and Germany in energy sector, with an aim to give a push to cooperation of CSIR with Germany in energy sector.

Joint projects for direct cooperation. "Bridging the Basic Applied Science Research Gap: Developing a Pest Protection Strategy for Chickpea Based on Proteinase Inhibitor (PI) Defenses", a joint project of NCL and Dept of Chemical Ecology of MPICE, Max Planck Institute for Chemical Ecology (MPICE), Jena, Germany has been approved at a cost of Rs 15.80 lakh by the Max Planck Society (MPG), Germany.

"Upgradation of Hyderabad Magnetic Observatory to INTERMAGNET Status Refinement of Low-latitude Studies and Re-examination of Secular Variations in Indian Region", a joint project of NGRI and Department of Physics of the Earth, Geo-ForschungsZentrum (GFZ), Potsdam, Germany has been approved.

CSIR-DAAD exchange programme. * Joint workshop - CSIR and DAAD with an aim to mark successful completion of 4 decades of CSIR-DAAD cooperation, jointly funded an Indo-German lecture workshop on behavioural neurobiology at CCMB during September 18-22, 2006, to deliberate on topics such as memory and cognition (in both invertebrates and vertebrates); and consciousness and (theories of) mind in higher vertebrates including humans. Six German scientists and 50 Indian experts/students participated in the workshop. The basic purpose of the workshop was to discuss the current status and encourage young researchers to pursue such challenging research problems.

* Exchange visits-Nominations of six scientists each from CSIR and German institutions were approved for visiting counterpart country under collaborative projects and in addition four nominations from CSIR and 2 from Germany were approved for stand-alone visits during 2007 under the CSIRDAAD exchange Programme.

Russia

Joint workshop. An Indo-Russian Round Table on 'Remediation Technologies for Soil Contamination' was organized at CSIR Science Centre, New Delhi on November 28, 2006 in partnership with the Russian Centre of Science and Culture, New Delhi. Seven Russian experts representing premier Russian institutes participated in the event. The following Memorandum of Understanding were signed between the partners to pen down their consent to cooperate:

- MoU between CSIR and All-Russia Scientific and Research Institute for Irrigation and Farming Water Supply Systems "Raduga" for a period of 3 years.
- MoU between NEERI and Pushcino International Technopark to cooperate on "Bio-remediation of Oily sludge Contaminated Soil in Petroleum Refinery and Petro-chemical Complex".
- MoU between NBRI and Meshchera Scientific Department, GNU VNIIGiM, Russian Academy of Sciences to cooperate on "Phyto-remediation of Toxic Metals from Water Bodies and Industrial Wastes".
- MoU between NEERI and Meshchera Scientific Department, GNU VNIIGiM, Russian Academy of Sciences to cooperate on "Design of Technology for Restoration of Soil Degradation and Pollution".

Approved joint projects under the ILTP DST programme. Following projects were approved:

- "Oxidation of hydrocarbons by Molecular Oxygen and Peroxides" of NCL and Semenov Institute of Chemical Physics, RAS, Moscow, Russia was approved for implementation under DST-ILTP Programme.
- "The Transient Geophysical Processes in areas of Strong Natural and Human-induced Impacts: Field Observations and Physical Modeling" of NGRI & Institute of Physics of the Earth, Moscow.
- "Earthquake Hazard Assessment Study using the GIS Technology" of C-MMACS & Institute of Physics of the Earth, Moscow.
- "Advanced Mathematical Modeling and Artificial Intelligence System in the Analysis of Geophysical Time Series (Earth, Ocean and Atmosphere)" of C-MMACS & Institute of Physics of the Earth, Moscow.

Saudi Arabia

Joint workshop. A Workshop on Metrology "Present Status and Future Perspectives" was organized at the Saudi Arabian Standards Organization (SASO), Riyadh during 03-04 June 2006 as part of the on-going collaboration between CSIR and SASO.

UK

A**greement between the Royal Society, UK and CSIR, India.** The following two programmes have been launched under this Agreement signed on 25th December, 2006.

- The Royal Society/CSIR India - UK Industrial Research Fellowship to support the exchange of scientists and engineers between the two countries to enhance international scientific cooperation, which will be funded jointly by the two sides.
- Visiting scientists to the UK will receive one year's subsistence costs (at fixed levels of £16,200 or £18,000 in London), a contribution towards the University's overhead of the fellowship, travel and research expenses of £ 2000.

- The Royal Society / CSIR India UK joint Project scheme provides funds to cover the mobility costs of joint research projects between established research groups in UK Higher education or research institutes and in research institutes of CSIR, India. Over the course of two years the projects should ensure the continued and combined scientific interaction of the two teams in the investigation of a well-defined scientific and/or technological proposal. The joint project would cover the mobility costs of team members between the UK and India, and a contribution towards consumables.

3.7.2. Multilateral Cooperation

European Union

Projects. Following projects were approved during the year:

- "Environmental Management Reform for Sustainable Farming, Fisheries and Aquaculture", of NIO, Goa;
- "Action to Observe and Understand Different Approaches (AOUDA) of Euro-Indian S&T Cooperation" under the European Commission's INCO specific support action programme (ERA-NET) with ISTAD as a partner;
- "SUSTWATER: Toward Sustainability of Water Management: Implementation of a Groundwater Decision Support Tool" under Asia Eco Programme of European Commission. BRGM, France, Charles University, Czech Republic IWMI, Hyderabad, and NGRI are the participating institutes.

3.7.3. Fellowships

CSIR MCT fellowships

The Division, in association with the Ministry of Science & Technology (MCT), Mozambique, has instituted 20 CSIR-MCT Fellowships of duration of 1-3 years, tenable at CSIR labs, for providing training to postgraduate (science) Mozambican Fellows in the following areas - food processing, aromatic & medicinal plants, ethnobotany, marine sciences, mineral resources, environment & water, cost-effective construction technology and science policy and knowledge management.

Raman Research fellowships

Seven CSIR scientists, one each from CCMB, IICB, NCL, NGRI, NAL, NML and SERC, availed the Raman Research Fellowship for the year 2006-07.

Six CSIR scientists, one each from CGCRI, RRL Bhopal, SERC, NML, CDRI and CSMCRI, were selected for the grant of this award for the year 2007-08.

3.7.4. New Initiatives

The Division has initiated dialogues with several institutes abroad to initiate S&T cooperation in frontier areas and simultaneously to enhance the existing programmes. As a part of this endeavour, several dignitaries have made visits to CSIR. Some of the significant names include: Prof. Tissa Witharana, Minister of Science & Technology, Government of Democratic Socialist Republic of Sri Lanka; Dr. Hsin-Sen Chu, Executive Vice President, and Ms. Amy Lu-Hwa Chou, Deputy Director, Industrial Technology Research Institute (ITRI) of Taiwan; and Mr. Jose Manuel Silva Rodriguez, Director General for Research of the European Commission. Delegations from European Commission (EC), Academy of Finland and Korea have also visited CSIR to strengthen the new initiatives during the year.

3.8. Information Technology Division (ITD)

The mission of the Division is to enable the effective use of IT across the CSIR network, for which it is extending all possible support to CSIR laboratories in moving towards the objective of an e-enabled CSIR.

3.8.1. CSIR website: (http://www.csir.res.in)

The Division has been assuring the continued up-gradation and up-dating of its website on a regular basis. The CSIR website conforms, as closely as possible, to the Minimum-Required-Content as per the guidelines laid down by Ministry of Communications & IT, Government of India and Department of Administrative Reforms and Public Grievances (DARPG), Ministry of Personnel, Public Grievances and Pensions. Joint projects approved**.** UKERI (UK-India Education and Research Initiative) Major Research Award was granted to ITRC to implement the project "Mathematical and Experimental Modeling of the Animal Stress-response Network".

This prestigious award carries a research grant of up to UK £ 500,000/ for the entire duration of the project. CSIR website is fully compliant with the Right to information Act and hyperlinks with all the CSIR laboratories for information on Public Information Officers/Assistant Public Information Officer/Appellate Authority of the laboratories. It also provides updated information on a quarterly basis, as per the requirement of the Central Information Commission (CIC).

As per the Government of India directive, all Ministries/Departments are expected to register information and services, in particular those relating to Acts/ Laws / Rules / Guidelines / Application Forms, etc., to the National Portal of India. CSIR website has shared information under all the relevant categories to the National Portal and also provided a link on its homepage showing the CSIR-related content on the National Portal.

3.9. Unit For Science Dissemination (USD)

The Division is furthering the favorable public image of CSIR as a whole. During the year several image-building activities were executed to achieve the overall objective.

3.9.1. Image Building through Print Media

Publicity efforts

Effective media relations helped in furthering result-oriented relationship with the key press persons covering science in their respective dailies. The Unit has provided appropriate logistics support to all of them. Several features/ stories were published with the support of inputs provided by this Unit. The Unit has facilitated Press coverage of many important events held in CSIR during the year. Significant ones include: Bhatnagar Awards function; media launch of Science Safari film; CSIR Foundation Day celebrations; coverage of new Bt cotton Technology for broader insect resistance; signing of technology licensing agreement between IMTECH and Nostrum Pharmaceuticals, USA; and 4th Biennial National Innovation Foundation (NIF) Awards for the grassroot innovations and outstanding traditional knowledge.

Advertising efforts

The Unit has released special advertisement campaigns exclusively on CSIR events that include: CSIR Award for S&T Innovations for Rural Development (CAIRD); Diamond Jubilee Technology Awards; Bhatnagar Awards and CSIR Foundation Day; IPMD Innovation Awards; and Exhibition-cum-Fair on Rural Technologies- Reaching Technology to Rural India: A Step Towards Rural Transformation.

3.9.2. Image building through Broadcast Media

The Unit has provided all technical help for the production of short films on CSIR

achievements in various theme areas. The following seven films have been completed: Drugs for the Poor; Herbal Therapeutics; Civil Aviation; Jai Jawan, Jai Kisan, Jai Vigyan; Creating & Sowing Jobs; National Drinking Water Security; and Succor to Disaster Mitigation.

3.9.3. Image building through interactive media (exhibitions, etc.)

CSIR participates in the various national/ international exhibitions and other related events with two main objectives: creating awareness about CSIR and its achievements, and supporting its business development efforts.

The Unit made efforts to project an integrated picture of CSIR's overall contribution to the theme areas of each event through extensive coordination with the participating CSIR labs. The Unit organized CSIR pavilion in various events some of which include: "Women Empowerment - Stepping towards Recognition"; "International Conference and Exhibition on Marine Hazards & Opportunities"; "2nd Exhibition-cum-fair on Rural Technologies- Reaching Technology to rural India: A Step towards Rural Transformation" etc.

3.9.4. Publicity campaign on National Geographic Channel

The unit coordinated the successful launch of a campaign on the National Geographic Channel (NGC) on 26th September 2006. This project is a joint venture of different departments under the Ministry of Science and technology, viz., DST, DBT, CSIR and MoES. A 45 minutes Science Safari Film and 15 short films covering different aspects of Indian S&T are being telecast on NGC.

3.9.5. Nation Wide Campaign on All India Radio

The Unit has facilitated launching of a campaign on the achievements of the Ministry of Science & Technology and Earth Sciences, in September 2006. This project is a joint venture of different departments under the Ministry of Science and Technology, viz., DST, DBT, CSIR and MoES. Every week on Tuesdays at 1945 hrs, a special audio programme on topical technologies of relevance to rural India is being broadcast on 40 Vividh Bharti stations of All India Radio in 11 languages throughout the country, under the guidance of this Unit.

3.9.6. Office of the Public Information Officer under Right to Information Act 2005

As the Right to Information Act of Govt. of India has come into force, Head, USD has been appointed as the Public Information Officer, CSIR. All the requests for information (on CSIR) under this Act are being processed by this Unit.

3.10. Recruitment & Assessment Board (RAB)

Assessment Interviews of scientists at the levels up to EII were organized for the scientists eligible for the year 2004-2005 in the areas of Biosciences & Biotechnology, Chemical Sciences & Chemical Engineering, Engineering & Materials; Physical, Earth & Environmental Sciences and S&T Management & Policy Studies. The exercise covered assessment cases numbering 1100.

Selection committees were constituted for recruitment to about 330 posts of scientists in 33 CSIR laboratories. These positions were at entry level and also at certain higher levels.

A full-fledged multimember Recruitment & Assessment Board was set up to replace the hitherto one man Board to seek operational, procedural and policy level advice. The first meeting of the newly constituted Recruitment & Assessment Board was held on May 6, 2007 wherein RAB mission and goal, enlargement of scope of recruitment system and role of RAB in the recruitment process, administrative initiatives taken by RAB, etc., were discussed.


CSIR-INDIA

DATELINE CSIR


CSIR-INDIA

4.0. DATELINE CSIR

Date	Major Events
April 2006	
2nd	**IICB:** Celebrated its Golden Jubilee Foundation Day. Prof. V.S. Chauhan, Director, International Centre for Genetic Engineering and Biotechnology, New Delhi, delivered the XIXth JC Ray Memorial Lecture on the occasion.
4th	**IICB:** Conducted a short course on 'Computational Methods in Aeroelasticity' by Dr. Gautam Sengupta of The Boeing Co., USA.
	IICT: A.V. Rama Rao Research Foundation Award Lecture on 'Harnessing Natural Products and Organic Synthesis for Human Well Being' by Prof. Goverdhan Mehta of I.I.Sc., Bangalore.
5th - 7th	**NPL:** Indo-Chinese workshop organized on 'MEMS and Related Technologies'
12th	**NGRI:** A Brain Storming session on 'Water Security'.
18th	**CGCRI:** Seminar on 'Microwave Processing in Ceramic Industry' (MPCI-06).
21st	**CBRI:** Interactive Meet on 'Manufacture of Cold Setting Fly Ash Brick'
27th	**CSMCRI:** Get together on the usage of low dust writing chalk. District Education Officer and teachers of various schools of Bhavnagar attended the meeting.
May 2006	
11thTechnology Day	**IGIB:** Received National Award 2006 for recombinant human Epidermal Growth Factor (rhEGF) under the Brand name REGEN-DTM-150 for diabetic foot ulcer and REGEN-D-60 developed by Bharat Biotech International Ltd. in collaboration with IGIB. Technology Day celebrations in various CSIR laboratories.
23rd	**CCMB:** Mr. Luis Peral Guerra, Minister of Education, Spain visited the lab for enhancement of S&T collaboration.
27th	**NEIST:** Seminar entitled `Food Processing Industries Prospect Unexplored' jointly with the Federation of Industries & Commerce of North Eastern Region (FINER), Guwahati, NEIST and CFTRI, Mysore.
June 2006	
3rd	**NAL:** Insat 4C tested at NAL's Acoustic Test Facilities successfully. The first HANSA aircraft (VT-HOA), produced by Taneja Aerospace and Aviation Private Limited (TAAL), in partnership with NAL, had its maiden flight.
4th	**NBRI:** Shri Kapil Sibal, Minister of Science & Technology and Earth Sciences, visited the Institute
20th-23rd	**IMMT:** Workshop on 'Analytical Instrumental Techniques Current Trends and Practices'.

23rd - 25th	**CFTRI:** International symposium on "Building Leadership Skills in Food and Nutrition: Essential for National Development'.
July 2006	
6th 7th	**IHBT:** An Orientation Programme entitled "Basic Leadership for Young Scientists" was conducted for young officers of IHBT by Mr. Ian Dean, South Africa. Twenty five Scientists and Technical Officers participated in the training programme.
7th	**CRRI:** Sensitization Workshop organized on "Mobility for All" in collaboration with 'Samarthya'.
10th	IMMT: Workshop on 'Nano Materials'.
13th 20th	**NEERI:** Workshop on 'Air Quality Management Control Strategies'
21st -22nd	**CMERI:** National conference on 'Organizational Excellence through Six Sigma'.
24th 25th	**CMERI:** National workshop on 'Rolling Element Bearings'.
August 2006	
9th 11th	**NEIST:** Three-day workshop on `Scientific and Commercial Cultivation of Flowers'. A total of 24 entrepreneurs participated.
10th	**CSMCRI:** Half yearly Review meeting of DSIR, including CSIR, arranged in the institute under the Chairmanship of Prof. VL Chopra, Member (S&T) Planning Commission. Half yearly Review meeting of DSIR, including CSIR, arranged in the institute under the Chairmanship of Prof. VL Chopra, Member (S&T) Planning Commission.
28th	**CDRI:** Symposium on 'Current Advances in Endocrinology'.
31st	**NEIST:** National seminar on `Materials and Minerals: Past, Present and Future'.
September 2006	
7th	**CGCRI:** A two-year Diploma course in `Designing in Ceramics and Glazed Pottery' started as a joint programme with the University of Burdwan.
11th-12th	**SERC:** 5th Asian Symposium on 'Polymers in Concrete'.
11th 14th	**IMMT:** Participated in '6th International Trade Fair on Minerals, Metals, Metallurgy and Materials', New Delhi.
13th 18th	**NEERI:** Workshop on 'Treatment and Disposal of Municipal Solid Waste'.
14th	**CMERI:** Workshop-cum-training programme on 'Investment Casting Process'.
18th	**IICB:** Alzheimer's Day Celebration organized. Prof. JJ Ghosh, Calcutta University, delivered lecture on 'Therapeutic Strategies for Neurodegenerative Disorder with Special Reference to Alzheimer's Disease'.

26th	**CSIR Foundation Day:** The Foundation day was celebrated with great zeal and enthusiasm by CSIR Headquarters and all the constituent laboratories. In the main function held at Delhi, Hon'ble Prime Minister, Dr. Manmohan Singh gave away Shanti Swarup Bhatnagar awards in the areas of Biological Sciences; Chemical Sciences; Atmospheric, Ocean and Planetary Sciences; Engineering Sciences; Mathematical Sciences; and Physical Sciences in Vigyan Bhawan. The Hon'ble Minister of S&T and ES gave away Young Scientist awards in a glittering function held at Hotel Le Meridian later in the evening.
October 2006	
9th	**IGIB:** A US delegation headed by Dr. George Atkinson, S&T Advisor to US Secretary of State visited the institute in order to increase Indo-US interactions in Science, Technology and Education.
9th -14th	**IGIB:** Workshop on 'Respiratory Allergy Diagnosis & Management.
11th -13th	**CEERI:** Symposium on 'Vacuum Electronic Devices and Applications (VEDA-2006)'.
13th	**NEIST:** Seminar on `Technology Driven Development - Choices for North-Eastern States'.
27th	**CIMAP:** The Third National Interactive Meet (NIM 2006) on 'Medicinal and Aromatic Plants'.
27th 29th	**SERC:** 38th SSBM (Indoor) Zone III Tournament.
November 2006	
4th - 9th	**NEERI:** National workshop on 'Air Pollution Emission Inventory'.
13th - 17th	**NIO:** 5th Asia Pacific Remote Sensing Symposium organized jointly by NIO and SPIE (USA).
15th	**CMRI:** Visit of Indo- US Working Group on Coal to the institute -Workshop on Underground Coal Gasification.
15th	**NPL:** National seminar on 'Acoustics'.
17th	**CDRI:** Seminar on 'Project Management in R&D Organizations'.
22nd -24th	**NPL:** 21st National symposium on 'Cryogenics.'
22nd - 24th	**IICB**: 18th National Congress of Parasitology on 'Advances in Parasitology Research in Tropical Diseases'.
23rd - 25th	**CMRI**: 43rd Annual Convention & Meeting on 'Geophysical Techniques in Mineral Exploration and Exploitation'.
29th	**CDRI:** Workshop on 'Multivariate Analysis and Drug Research data'.
29th -30th	**CRRI:** Workshop organized on 'Deep Foundations (Well/Piles) for Bridges- Optimal Solutions'.

December 2006	
1st - 3rd	**CRRI:** 38th SSBM (Indoor) Final Tournament held. Fourteen competitive events in five Games, viz., Carrom, Bridge, Table Tennis, Chess and Badminton in both men and women categories.
05th-08th	**NPL:** Indo-Italian workshop on 'Force Standards'.
14th	**NISTADS:** UNESCO-NISTADS workshop on 'Bioethics for Indian Society'.
17th - 20th	**ITRC:** International Update on Basic and Clinical Neuroscience Advances.
19th	**IMTECH:** The seventh Prof. B.K. Bachhawat Memorial Lecture by Prof. M. Vijayan, Distinguished Professor, Indian Institute of Science, Bangalore on the topic "Structural Diversity and Carbohydrate Specificity of Plant Lectins".
12th-13th	**CGCRI:** Workshop on `Biomaterials and Biomedical Devices (BMD 2006)'.
15th	**CSMCRI:** Workshop on "Building Institutional Repositories using Open Source Softwares".
21st - 22nd	**CGCRI:** National conference on Sensors & Actuators: Emerging Technological Challenges.
January 2007	
8th-9th	**IICB:** Third International Symposium on' Neurodegeneration & Neuroprotection'.
12th - 13th	**NGRI:** International workshop on 'R&D Challenges in Carbon Capture and Storage Technology for Sustainable Energy Future'.
19th	**CRRI:** Seminar on 'Energy Conservation in Road Transport'.
29th	**NIO:** Public lecture on "Atmospheric Chemistry and Climate in the Anthropocene" by Prof. Paul J. Crutzen, Nobel Laureate, Max Planck Institute of Chemistry, Germany and Scripps Institution of Oceanography, USA.
29th-31st	**CGCRI:** Indo-German workshop on 'Fuel Cell and Hydrogen Energy'.
29th-31st	**IIIM:** Workshop on 'Biosafety and Biosecurity' in collaboration with CCMB.
31st	**CIMAP:** CIM-Utsav 2007 (Kisan Mela) for techno-entrepreneurship opportunities strengthening farmer-industry bond.
February 2007	
1st	**CCMB:** Laboratory for Conservation of Endangered Species (LaCONES) CCMB Annexe-I dedicated to Nation by the Honourable President of India, Bharat Ratna Dr. APJ Abdul Kalam.
7th - 9th	**SERC:** Advanced course on 'Analysis and Design of Structures for Wind and Seismic Loads (ADSWSL)'.

7th-11th	**NAL:** NAL participated in the AEROINDIA 2007 held at Bangalore. NAL put up a stall and displayed exhibits depicting NAL's technologies and products. Both HANSA and SARAS aircrafts took part in the inaugural fly past display and on all days of the exhibition.
14th-16th	**IICB:** International symposium on 'Deconstructing Human Diseases: The Genomic Advantage'.
17th	**CDRI:** 3rd International symposium on 'Current Trends in Drug Development and Search'.
19th	**NGRI:** The Gravity Map of India released. Also, a seminar organized on 'Notable Research in Earth Sciences for Socio-Economic Advances of the Nation'
21st	**CCMB :** Visit of delegation led by Hon'ble Alan Carpenter, Premier Western, Australia
March 2007	
5th	**NISTADS:** Workshop on 'Tools and Techniques to Measure S&T Data'.
6th-9th	**NISTADS:** Third International Workshop on 'Webometrics, Scientometrics, Science and Society'.
8th-9th	**IIIM:** International workshop on 'Intellectual Property Rights for Public R&D Organizations'.
21st-25th	**NAL:** HANSA -3 Aircraft participated in the Australian Air Show held at Melbourne, Australia and flew on all days. This is the first time that an indigenously designed and developed aircraft has participated in an airshow outside India.
22nd-23rd	**CMERI:** Workshop on 'Biofuels: Production, Methodologies, Utilization Techniques & Challenges'.
29th-30th	**CMERI:** Workshop on 'Machining & Machinability of Advanced Materials'.

ANNEXURES

ANNEXURE-I

INTELLECTUAL PROPERTY FROM CSIR DURING 2006-07

Patents

	India		Abroad	
	Filed	Granted	Filed	Granted
AMPRI	0	4	0	1
CBRI	0	2	0	0
CCMB	0	1	4	5
CDRI	5	6	21	16
CECRI	5	9	3	1
CEERI	0	5	0	0
CFRI	0	3	16	5
CFTRI	21	40	86	35
CGCRI	2	12	3	8
CIMAP	2	4	22	25
CLRI	9	8	13	8
CMERI	4	0	6	1
CMRI	9	6	0	0
CRRI	0	1	0	0
CSIO	2	3	21	9
CSIR(SCH)	8	12	2	5
CSMCRI	4	2	89	22
IGIB	7	2	45	5
IHBT	1	1	15	10
IICB	5	0	18	10
IICT	13	18	45	43
IIIM	3	10	8	19
IIP	5	8	12	2
IMMT	3	6	5	3
IMT	2	3	10	6
ITRC	1	0	0	0
NAL	1	5	4	2
NBRI	6	0	50	11
NCL	17	57	81	28
NEERI	6	3	5	1
NEIST	7	7	3	1
NGRI	7	0	5	2
NIO	1	5	10	16
NIIST	4	5	25	5
NMITLI	1	0	3	0
NML	1	11	16	6
NPL	7	3	9	5
Total	**169**	**169**	**655**	**316**

Copyrights

	Laboratory	Nos.
1	CLRI	1
2	CMERI	5
3	IGIB	5
4	IICT	2
5	IMT	1
6	ITRC	2
7	NAL	1
8	NGRI	1
9	NML	1
10	NEIST	1
11	NIIST	1
	Total	21

ANNEXURE-IA

FOREIGN PATENTS GRANTED TO CSIR DURING 2006-2007

Title	Inventors	Patent No.
AMPRI		
A low temperature process for making alkali- free, high surface Area, amorphous, silicon precursor and its application in making advanced ceramic materials such as silicon carbide, mullite	S S Amritphale, N Chandra, E Kroke, R Riedel	DE 19952337
CCMB		
DNA markers for assessing seed Purity	R V Sonti, Y Jamir	PH 1-2002-000216
Indolicidin analogs with anti-microbial activity	C Subbalakshmi, E Bikshapathy, N Sitaram,. Ramakrishnan	US 7115572
DNA markers for assessing seed purity and method of using DNA sequences for assessing seed purity	R V Sonti, Y Jamir	CN ZL01112469.5
Universal primers for wildlife Identification	S K Verma, L Singh	US 7141364
Cholesterol depletion in macrophages by methyl - beta - Cyclodextrin abrogates infection by leishmania donovani: use of methyl - beta - cyclodextrin and related cholesterol - depleting compounds as possible therapeutic agents against leishm	A Chattopadhyay, R Madhubala	US 7186702
CDRI		
Composition useful for the early diagnosis of visceral leishmaniasis and a process for preparing the same	G K Jain, S Tiwari, S Gupta, J C Katiyar	IL 126852
Herbal medicaments for treatment of neurocerebrovascular disorders Amino-functionalized	M Ray, R Pal, S Singh, N M Khanna	EA 7067
1,2,4-trioxanes useful as antimalarial agents and process for preparation There of	C Singh, H Malik, S K Puri	US 7071226
A process for the synthesis of 1-(4-arylpiperazine-1yl) -3-(2-oxopyrrolidin-1-yl) propanes	N Sinha, S Jain, A K Saxena, N Saxena, M P Dubey, G K Patnaik	DE 913397

Methods for preparing 1-[4-arylpiperazine-1-yl]-3-[2-oxopyrrolidin/piperidin-1-yl] Propane	N Sinha, S Jain, A K Saxena, N Anand, R M Saxena, M P Dubey, M Ray, G K Patnaik,	EP 913397
Alpha-substituted naphthyloxy omega-substituted alky /aryl amino-substituted alkane Derivatives as agents for treatment or prophylaxis of diabetes and related metabolic disorders	D Chaturvedi, A Kumar, R Rastogi, A Srivastava, P Tewari	US 7081465
Mycobacterium tuberculosis specific fragment (probe)	R Srivastava, D Kumar, B S Srivastava	EP 945462
Linker based solid support for peptide and small molecule organic synthesis	H Wahajul, S B Katti	EP 1263800B1
Composition useful for the early diagnosis of visceral leishmaniasis and a process for preparing the Same	G K Jain, S Tiwari, S Gupta, J C Katiyar	EP 997734
Inclusion complees of a high potent opioid peptide, pharmaceutical compositions and method of treatment	A K Dwivedi, H Wahajul, R Raghubir, S Srivastava, P Murthy; S Ramchandra, A O Prasad; J Srivastava	EP 1174152B1
Biodegradable, inhalable microparticles containing anti-tubercular drugs	H Sen, S Jayanthi, R Sinha, R Sharma, P Muttil	OA 13318
A process for the preparation of polypeptide useful as antiallergic, antiasthmatic and anticomplementry agent	B E Kundu	EP 1348714
Process for isolation of saponin disogenin penta glycoside	V Lakshmi, K Pandey, R Roy, B S Joshi, K Padmanabhan Madhusudanan, R Chandra, A K Srivistava, D Raina, A K Rastogi	US 7160866
Linker based solid support for peptide and small molecule organic synthesis	W Haq, S B Katti	CN 1800744.9
An improved process for the synthesis of guggulsterones: a pharmacologically active constituent of gugulipid	P R, Singh , R Pal, S Singh	GB GB2412373

Use of primaquine derivative N'-ethylidinotetra hydrofuran - 2-one)- N'-(6-methyl-8- quinodinyl 1,4-pentane diamine as gametocidel Agent	R Pratap ; A Bhaduri	US 7183291
CECRI		
Process for the preparation of lithium metaphosphate	A Subramanian, V Thiagarajan, R Gnagadharan, M S Raghavan	JP 3878940
Process for the production of low ash fuel	P N Sinha, P Sengupta, K S Bhattacharya	PL 191734
CFRI		
Process for the production of fly ash slurry	S K Rao , S K Ghosh, SK Basu, B K Mall, S K Verma, G Singh, S Mazumdar	CA 2442426
A method of extraction of Dimethylphthalate	K C Bit	US 7135588
Process for the production of low ash fuel	P N Sinha, P Sengupta, K S Bhattacharya	JP 3920775
A process for the preparation of a catalyst supported on titanium pillared clay, useful form producing hetroaromatic nitriles	S K Roy, S C Ray, P Dutta, L N Nandi, S N Yadav	KR 697795
CFTRI		
A process for preparation of decorticated finger millet (eleusine coracana)	N G Malleshi	US 7029720
Continuous press for manufacturing biodegradable plates	M K Venkatesh, J Sankaramthadathi, S Mahadevaiah, A Chakravarthi	GB 2412893
Efficient process of obtaining high contents of bound-phenolic acid rich dietary fibre by activating in situ amylases through step-wise increase in temperature	M Gudipati , R S P Rao	US 7037537
Compound as cholinesterase inhibitor and its isolation from fungus sporotrichum species	T Shivanandappa, A Prahalad; D Shereen K Soundar, N K Ganesh	US 7045648
A process for the production of a human platelet aggregation inhibitor with soybean lipoxygenase Inhibition	S A Prahlad, K C S Rao, S Divakar, K N Ganesh; S W Jessie, K T Parth, V Suryanarayana	EP 1409705

Bioactive compound and its isolation and method of treatment for lipoxygenase inhibition and as free radical scavenging agent	A P Sattur, C R Kadiyala, D Soundar, K N Ganesh, T R Shamala, A Rao, A R Gopal	US 7056707
A process for preparing shelf-stable chicken pickle	D N Rao, P P Rajappa, K K S Nair	CN ZL02108250.2
A process for the preparation of soy based low-fat & high protein snack	T C Sindh	SG 95566
A process for preparation of sugarcane juice powder	B Raghavan, K Ramalakshmi, B B R Borse, M N Ramesh, V Prakash	ID P-00200200144
Roasted and oleoresin flavored nut formulation and a process thereof	Latha; Rangasamy, Bhat; Kodangala Koshawa Raghavan; Chitradurga Venkataram	US 7078067
An improved process for preparation of soya protein concentrate with improved functional properties	Swamylingappa, Bhagya	ZA 2004/7725
A process for improver premix for Chapattis and related products	R S Manohar, G V Rao	SG 116822
An improved process for the preparation of protein hydrolysate from legumes	A Haridas, S Majumdar	CN ZL01823171.3
Process for the preparation of high arginine peptides	R Cheruppanpullil, K Govindaraju, S Kanya, T Chikkaraja, T P Kaul, S A Singh	US 7091001
An improved process for the preparation of protein hydrolysate from legumes	A Haridas, S Majumdar	VN 5836
Process of extracting chili (capsicum) oleoresin	S R D Sampathu, M M Naidu, H B Sowbhagya, J P Naik, N Krishnamurthy	US 7097867
A process for the production of soy based supplementary food	S A Singh, Kanya T C Sindhu, T P Kaul, S Bhagya, A Rao, A R Gopala Rao Appu, P Vishweshwariah	ZW 28/2005
Process for the preparation of protein hydrolysate from legumes	A Rao, R GS Rao, K Govindaraju, Harendranath, Ramaswamy Joseph, Johny, V Prakash	US 7112424
A ready-to-dilute sugarcane juice beverage powder and a process for preparing the same	B Raghavan, K Ramalakshmi B B R Borse M Ramesh Mn, Prakash V	ZL2802475.3

An emulsifier system for cakes and a method for making improved quality cakes thereof	R Jyotsna, P Prabhasankar	EP 1505877
A process for preparation of hypoglycemic foods and a formulation thereof	N G Malleshi, U R Singh, S Z Ali	EP 1608235
A process for the preparation of angiotensin converting enzyme inhibitors from glycinin	L R Gowda, A R Gopala Rao, V Prakash	US 7125702
A device useful for continual volumetric dispensing of idli batter and like materials	V D Nagaraju, R Thotadamoole, P K Devaraju, Bharath, K P Rangaswamy	SG 107582
Decaffeinating microorganism and process of bio-decaffeination of caffeine containing solutions	M S Thakur, R B Vegesna, N G Karanth, M C Varadaraj	US 7141411
A process for preparation of hypoglycemic foods and formulation there of	N G Malleshi, U R Singh, S Z Ali	US 7153528
A process for preparation of expanded finger millet	N G Malleshi, U R Singh, S Z Ali	OA 13351
A high energy, high protein food product & process for preparing the Same	S A Singh	CN 2802761.2
A parotta of improved quality-muti-layered parotta of specific physical and sensory characterstics and a method there of	I Dasappa, R Jyotsna, P Prabhasankar, R S Manohar, G V Rao	CN 03121570.X
Emulsifier composition for cakes and method for making improved quality cake thereof	I Dasappa, R Jyotsna, P Prabhasankar, R S Manohar, G V Rao	US 7172784
A continuous circular cutting machine useful for lemon and other similar fruits	K V Murthy, S T G Jayaprakashan, M Shivakumar	CN ZL02108032.1
Flavoured sugarcane juice in aseptic unit packs	B Raghavan, M N Ramesh, K Ramalakshmi, N Krishnamurthy, P M Badgujar, V Prakash	EP 1571927
A medium for clonal propagation of pandanus	N Bhagyalakshmi, T Rudrappa, M S Narayan, G A Ravishankar	US 7189568
Oligonucleotide primers for phosphotidyl inositol in bacillus cereus	B P Padmapriya, A Ramesh, A Chandrashekar, K Nireshwalia, M C Varadaraj	EP 1373560

Process for preparation of protein-hydrolysate from milk protein	B Swamylingappa, J Joseph, K S Murthy, K Shankara, V Prakash, M C S Sastry, Kanya, T C Sindhu	VN 6248
A parotta of improved quality-muti-layered parotta of specific physical and sensory characterstics and a method thereof	I Dasappa, R Jyotsna, P Pichanr, R S Manohar, G V Rao	GB 2400012
CGCRI		
A process of making silicon-silicon carbide ceramic using biopreform derived from monocotyledonous caudex plant stem	O P Chakrabarti, H S Maiti, R Mazumdar	GB 2411897
A synergistic composition useful for making slow-release nitrogen free phosphorous, potasium and sulfur oxide glass and a process of making glass therefrom	N Biswas, K Gour, M Das, K Ghosh	BD 1004384
Process for making rare earth doped optical fiber	T Bandyopadhyay, R Sen, S K Bhadra, K Dasgupta, M C Paul	CN ZL01823008.3
Composition for preparation of silicon carbide powder	S Bandyopadhyay; S Maityi, H Sekhar	US 7109138
Process for manufacture of dense neodymium stabilized .beta.-si.sub. 3n.sub.4 -.alpha.-sialon composite	S Bandyopadhyay; S Maityi, H Sekhar	US 7109139
Process for making rare earth doped optical fiber	T Bandyopadhyay, R Sen , S K Bhadra , K Dasgupta, M C Paul	CA 2436579
A synergistic composition for the preparation of dense neodymium stabilised b-silicon nitride sialon Composite	S Bandyopadhyay; S Maityi, H Sekhar	US 7129191
Process for making rare earth doped optical fiber	T Bandyopadhyay, R Sen, S K Bhadra, K Dasgupta, M C Paul	KR 10-0655480
CIMAP		
Formulation useful as a nitrification and urease inhibitor and a method of producing the same	D D Patra, U Kiran, M Anwar, K Chand, S Kumar	CN CN1248989C
A menthofuran rich unique chemotype plant 'indus' of mentha piperita and harvest management method	S P S Khanuja, N K Patra, A K Shasany, B Kumar, S Gupta, R K Upadhyay	US PP16474

A process for the isolation of compound scopolatin useful as nitric oxide synthesis inhibitor	D C Jain, N Pant, M M Gupta, R S Bhakuni, R Verma, S Tandon, S K Gupta	AU 783951
A novel method for one pot conversion of artemisinin into arteether	R S Bhakuni , A Tewari, T Singh, S P S Khanuja	EP 1567530
Mint plant `kushal` for late Transplanting	S P S Khanuja, S P Singh, A K Shasany, U Yadav, S Dhawan, M P Darokar, J R Bahl, S Gupta, S Pandey	US PP16566
Process for regioselective demethylation of p-methoxy group in phenolic ester and diaryl ketone Moieties	A S Negi, S K Chattopadhyay, S Srivastava, A K Bhattacharya	US 7053218
Use of the root extract of vetiveria zizanioides in curing fluoroquinolone and multi drug resistant bacterial Infections	S P S Khanuja, S P Singh, S K Srivastava, R S Tiruppadiripuliyur, M M Gupta, A K Tripathy, M Singh, J R Bahl	ZA 2004/7490
Citral rich high yielding lemongrass plant `nima` of cymbopogon flexuosus	R K Lal, H O Misra, J R Sharma, N Singh, A K Shasany, B Naqvi, J R Prasad, A Khan	US PP16712
Mint plant mentha spicata L. Var.viridis christened as `GANGA	S Khanuja, P S Kumar, S Shasany, A K Dhawan, S Darokar, M P Tripathy, A K Satapathy, S K Tirupp	US PP16747
A novel method for one pot conversion of artemisinin into arteether	R S Bhakuni, A Tewari, T Singh, S P S Khanuja	ZA 2005/4162
Anti-microbial composition and method for producing the same	S P S Khanuja, S Srivastava, S K Tiruppadiripuliyurranganathan, A K Shasany, D C Jain, Mahendrapandurang Darokar, D Saikia, S Kumar	VN 5804
An improved process for the preparation of vasicine	S K Chattopadhyay, G D Bagchi, P D Dwivedi, S Srivastava	EP 1487837
Process for isolation of withaferin-a from plant materials and products therefrom	R S Sangwan, N D Chaurasiya, L N Misra, P Lal, C U Girish, N S Sang	US 7108870
A process for one pot conversion of artemisinin into artesunic acid and 10-esters of dha	R S Bhakuni, T Singh, A P Kahol, S P S Khanuja	EP 1569940

A process for the simultaneous production of artemisnin and essential oil from the plant artemisia annua	D C Jain, S Tandon, R S Bhakunt, M S Siddique, A P Kahol, R P Sharma, S Kumar	CA 2218444
A method for the screening of mycolic acid biosynthesis inhibitors	S P S Khanuja, S Srivastava, T R S Kumar, A K Shasany, M P Darokar, S Awasthi	CN ZL02828805.X
Gallic acid derivative and process of preparing the same	A S Negi, S K Chattopadhyay, S Srivastava, A K Bhattacharya, A Garg, M Pandurang	US 7135590
A process for the preparation of an extract rich in bacosides from the herb bacopa monniera	A P Kahol, T Singh, S Tandon, M M Gupta, S P S Khanuja	EP 1575603B1
Use of the root extract of vetiveria zizanioides in curing fluoroquinolone .and multi drug resistant bacterial Infections	S P S Khanuja, S P Singh (Lucknow, In); S K Srivastava, R S Tiruppadiripuliyur, M M Gupta, A K Tripathy, M Singh, J R Bahl	EP 1487467
A process for the isolation of compound scopolatin useful as nitric oxide synthesis inhibitor	D C Jain, N Pant, M M Gupta, R S Bhakuni, R Verma, S Tandon, S Kumar, A M Gupta	KR 1174152
Use of phyllocladane diterpenoids for plant growth promotion and Alleviation of growth retardant allelochemicals	A K Singh, G D Bagchi, S Singh, P D Dwivedi, A K Gupta, S P S Khanuja	AU 2002348820
Early maturing, high yielding psyllium (plantago ovata f) variety ' mayuri' with maturity marker	L R Kishori, N Singh, H O Mishra, J R Sharma, J R Bahl, A K Shasany, S P S Khanuja	US PP17505
Pharmaceutical composition containing brevifoliol for use in chemotherapeutic treatment	S P S Khanuja, R S K Tirupadiripuliyur, A Garg, R.K. Mishra, S K Chatopadhyay, S Srivastava, A S Negi	US 7196115
An improved process fro the production of liver protective coumarinolignoids from cleome viscosa and the composition consisting of optimized ratios of the same	S K Chattopadhyay, S Srivastava , A S Negi, A Gupta, S P S Khanuja	GB 2415377
Single pot conversion of artemisinin into artemether	R S Bhakuni, T Singh, A P Kahol, A Tiwari, S Tandon, S P S Khanuja	MY MY-129031-A
CLRI		
A novel transposed process for making leather	Subramani Saravanabhavan, Palanisamy Thanikaivelan, Jonnalagadda Raghava Rao, Balachandran Unni Nair, Thirumalachari Ram	US 7033402

An improved process for the preparation of bio-diesel	Kandukalpatti Chinnaraj Velappan, Subramani Sarvanan, Nagarajan Vedaraman, Paruchuri Gangadhar Rao	SG 119411
Process for making chrome tanned Leathers	Sundar, Victor John (Chennai, In), Muralidharan; Chellapp (Chennai, In)	US 7063728
A novel process for the preparation of aldehyde from a proteinous source for industrial applications	J Kanagraj, G S Rajakumar, S Sadulla	EP 1514890
Process for the preparation of aldehyde from a proteinous source for industrial applications	J Kanagaraj, G S Rajakumar, S Sayeed	US 7115387
Process for the preparation of a formaldehyde-free synthetic tanning agent	M Kanthimathi, P Thanikaivelan, J R Nair, B R Thirumalachari	US 7118603
Process for preparing a synthetic aluminium tanning agent	M Kanthimathi, P Thanikaivelan, J R Rao, B U Nair, T Ramasami	US 7169191
A process for the preparation of a novel synthetic aluminium tanning Agent	M Kanthimathi, P Thanikaivelan, J R Rao, B U Nair, T Ramasami	AU 2002348767
CMERI		
A novel sewing machine for decoratively stitching a cricket ball	H Singh, S S Singh, M N Prasad, B Gopalsamy, U Datta, J Roychoudhury	NZ 538577
CSIO		
Development of new ceramic mixture for thermal / temperature sensor working on the principle of negative temperature coefficient (NTC) at 330 deg. Centigrade + or - 6%	M I Singla, B Raj, V R Harchekar , R P Bajpai	EP 1597738
A new process for controlled blood transfusion with disposable valve Circuit	K D Chattppadhyay, S Verma, P Raj, J Gupta	US 7083587
An improved antiglare device for automobile useful during night Driving	D S Chhabra, P K Rao, B D Sharma, S K Gupta, D S Dodd, V Singh, S Sharma S	CN ZL01801786.X
A new process for lowering the martensitic transformation temperature (as) in the Cu-Zn-Al (6% Al) shape memory alloy for its utilization	V R Harchekar, M l Singla	EP 1436437
A system and method for monitoring properties of a medium by fiber optics	N Singh, S C Jain, A K Aggarwal, R P Bajpai	US 7130061

Multi-fiber optic 2D-array device for sensing and localizing environment perturbation using speckle image processing	H K Sardana, J K Chhabra, S Bandyopadhyaya, P K Goel	IL 158177
Energy efficient data acquisition system and a computer controlled on-line energy monitoring system incorporating the same	R K M Rao, C Selvam, M Chander, D K Moorthy, G S Ayyappan	US 7142994
Improved semi-automatic pick & place machine for assembly Components	V M L Narasimham, R Bhatnagar, B D Sharma, R R Shravanakumar, A K Mediratta	CN ZL01816246.0
A new process for lowering the martensitic transformation temperature (as) in the Cu-Zn-Al (6%Al) shape memory alloy for its Utilization	V R Harchekar, M Singla	US 7195681
CSIR (SCH)		
Activated charcoal filter for effectively reducing parabenzosemiquinone from the main stream cigaratte smoke	I B Chatterjee	US 7025067
Skeletal cell model to screen anti-diabetic compounds	N Kumar, C S Dey	US 7052910
Method and system to build optimal models of 3-dimensional molecular structures from knowledge of their chemical structures	N Gautham, K Vengadesan	US 7158891
Solid state thermal synthesis of lithium hexafluorophosphate	A Subramanian, T Vasudevan, R Gangadharan	DE 10296746
A process for the preparation of novel pharmaceutical composition useful for extended release of drug	S Et Al Garg.	CN 1301706C
CSMCRI		
Process for preparing hydrotalcite and brucite type positive charged Layers	P M Oza, S H Mehta, M V Sheth, P K Ghosh, M R Gandhi, J R Chunawala	US 7022302
A novel device for estimation of brine density in solar salt works from afar	P K Ghosh, K M Majeethia, M R Gandhi , J N Parmar, A M Bhatt, S A Chauhan, V P Mohandas, A U Hamidani	GB 2411963
A process for the preparation of amorphous silica from kimberlite Tailings	R V Jasra, H M Mody, H C Bajaj, R S Somani, J S Chunawala, H Nare	US 7037476

Novel integrated process for the recovery of sulphate of potash (SoP) from sulphate rich bittern	P K Ghosh, K J Langalia, M R Gandhi, R H Dave, H Labhshank	US 7041268
Integrated method for production of carrageenan and liquid fertilizer from fresh seaweeds	K Eswaran, P K Ghosh, A K Siddhanta, J S Patolia, C Periyasamy, A S Mehta, K H Mody, B K Ramavat, K Prasad, R Rajyaguru	EP 1534757
Process for generation of precipitated calcium carbonate from calcium	V J Rakesh, P M Oza, R S lSomani, J R Chunnawala, M V Sheth, V V Thakkar, Y M Badheka, J Ayyer, V B Patel	CN 1257106
Process of preparation of biodegradable films from semi refined kappa carrageenan	P K Ghosh, A Kumar, K Prasad, M Ramavatar, A Bhattacharya	US 7067568
Process for the operation of finely divided calcium carbonate	V J Rakesh, P M Oza, R SlSomani, J R Chunnawala, M V Sheth, V V Thakkar, Y M Badheka, J Ayyer, V B Patel	CN 1272250
Process for the recovery of palladium from spent silica	A B Boricha, H B Chand, J R Vir, P Ghosh, P K Ghosh	CN 7108839
An improved process for the cultivation of algae	R R Chennur, O M Mairh, O M Prakash, G R Kumar, K Eswaran, P D Subba Rao, M K Haresh (In), P K Ghosh	ID ID0015330
An improved process for the cultivation of algae	R R Chennur, O M Mairh, O M Prakash, G R Kumar, K Eswaran, P D Subba Rao, M K Haresh (In); P K Ghosh	EP 1313360
A catalytic process for the preparation of isolongifolene	R V Jasra, B Tyagi, M K Mishra	US 7132582
A process for the recovery of palladium from spent silica	A B Boricha, H C Bajaj, R V Jasra, P Ghosh, P K Ghosh	DE 1576200
An improved process for the single pot synthesis of 2,4,4,6- tetrabromo -2,5-cyclohexadienenone	A V Bedekar, G Ramachanraiah, P K Ghosh	CN 2830096.3
A catalytic process for the preparation of isolongifolene	R V Jasra, B Tyagi, M K Mishra	KR 10-0674626
Preparation of nutrient rich salt of plant origin	P Kumar, M P Reddy, J B Pandya, J Shambhubhai, S M Vaghela, M R Gandhi, R J Sanghvi, V G S Kumar, M T Shan	MX 243499

Process for the recovery of low sodium salt from bittern	R N Vohra	EP 1470077
Preparation of non-hazardous brominating reagents	G Ramachandraiah, P K Ghosh, A S Mehta, Adimuthys, A D Jethva, S S Vaghela	CN ZL02828066.0
Integrated method for production of carrageenan and liquid fertilizer from fresh seaweeds	K Eswaran, P K Ghosh, A K Siddhanta, J S Patolia, C Periyasamy, A S Mehta, K H Mody, B K Ramavat, K Prasad, R Rajyaguru	KR 689982
Process for the recovery of low sodium salt from bittern	R N Vohra	CN ZL02827765.1
A process for recovery of common salt and marine chemicals from brine in integrated manner	R N Vohra, P K Ghosh, P M Vadakke, H L Joshi, H H Deraiya	EP 1440036
A process for the recovery of palladium from spent silica	A B Boricha, H C Bajaj, R V Jasra, P Ghosh, P K Ghosh	CN ZL02830157.9
IGIB		
A process for the isolation and acclimatization of bacteria for lignin degradation	R Kumar, A Kumar	US 7022511
Genetic variants of human transforming growth factor betal (tgf beta1) and prediction of susceptibility for immunological disorders	B Ghosh, S Sharma, K Nagpal	ZA 2005/4795
A biological process for colour reduction of pulp and paper effluent	R Kumar, A Kumar, D K Tiku	ZA 2005/7592
A biological process for removal of total dissolved solids (TDS) from tannery waste water	R Kumar, P Sharma, P Beniwal, D K Tiku	TR 200504584
Biological neutralization of highly alkaline textile industrial waste water	R Kumar, A Kumar	US 7179633
IHBT		
Process for the preparation of 1-propyl-2, 4, 5-trimethoxybenzene from toxic .beta.-asarone of acorus calamus or from crude calamus oil containing .beta.-asarone	A K Sinha	CN ZL0119219.4
Isozyme of autoclavable superoxide dismutase (sod), a process for the identification and extraction of the sod in cosmetic, food and pharmaceutical compositions	S Kumar, R Sahoo, P S Ahuja	US 7037697

A process for the production of herbal wine (palam belle) from ripe fruits of pyrus pashia	H P Singh, B Singh, V S Dhadwal	EP 1263926
A mobile tea shoot preconditioning device for withering during black tea manufacture	S D Ravindranath, G D K Babu, A Kar, P K Maji	LK 13816
A simple process for obtaining beta-aescin from India horse chestnut (aesculus indica)	B Singh	EP 1487847B1
A simple, convenient mini distillation apparatus for the production of essential oils and hydroids	G D K Babu	TR TR200100823B
Efficient method of preventing growth of microbial genetic transformant after transformation	I Sandal, A Bhattacharya, A Gulati, S D Ravindranath, P S Ahuja	US 7145058
A continuous type multi-purpose tea shoot sorter	R S Desikachar, K K Singh	MW 21/2003
A simplified process for purification of aescin from Indian horse chestnut (aesculus indica)	B Singh	DE 1487847
Sterile laminar airflow device	R Thakur, A Sood, P S Ahuja	MY 129354
IICB		
Use of betel leaf extract to induce ifn-gamma production from human peripheral blood t cells and as a th 1 type immunomodulator	S Bandyopadhyay, B Pal, S Bhattacharya, M Ray, M Roy, C Keshab	US 7045157
Antimonocytic activity of betel leaf Extract	S Bandyopathyay, P Bikash, S Bhattacharya, M Ray, K C Roy	CN 1262289C
Two novel GNRHS from Indian murrel brain: highly potential molecules for induced breeding of fish	A Chatterjee, P Ray, S Dasgupta, H Sami	US 7074758
Highly cost-effective analytical device for performing immunoassays with ultra high sensitivity	T K Dhar, A Pal	US 7087389
Anti-leishmanial activity of betel leaf extract	S Bandyopadhyay, B Pal, S Bhattacharya, M Ray, K C Roy	CN ZL00819919.1
Herbal composition for treating Asthma	R Bhadra , B C Pal, K Das, S Bhattacharaya	EP 1331939
A new cell secreting insulin	S Bhattacharya, S Roy, S Dasgupta, M Mukherjee	US 7129211

Anti leishmanicidal activity of betel leaf extract	S Bandyopadhyay, B Pal, S Bhattacharya, M Ray, K C Roy	AP Ap1675
Composition having antibacterial and antifungal properties	A K Bhattacharyya, A Pal, S Bhattacharya	US 7144921
Purified new epididymel forward motility protein and a process for isolation of the said epididymal f orward motility protein useful as a fertility promoter/blocker	G C Majumder, B S Jaiswal	EP 1006125
IICT		
A novel method for chromatographic finger printing and standardization of single medicines and formulations	V K Dadala, K V Raghavan	AU 783898
Process for in situ synthesis of supported heteropoly acids and salts there of	P S S Prasad, K V Raghavan, I Suryanarayana, K N Rao, C S Lakshmi, M S Kumar, K B Reddy	KR 10-0572561
Process for acylation of napthyl ethers	M L Kantam, S Mutyala, M C Boyapati, K S Ranganath, K V Raghavan	JP 3792882
Method for the preparation of stable and reusable biosensing granules	R S Venkata, M S Venkata, P R Shetty, K V Raghavan	DE 10085484
Synthesis of N-substituted ß-amino via the ring opening of aziridines	B M Choudary, K Jeylakshmi, P R Likhar, M I Kantam, B Sreedhar, B Kotamarthi, S Sitha	GB GB2410949
Process for preparing substituted Coumarins	S Palaninappan, V J Rao, C Saravanan, R Chandreshekhar	EP 1462448
A novel method for chromatographic finger printing and standardization of single medicines and formulations	V K Dadala, K V Raghavan	GE P3808
Chemoenzymatic process for stereoselective preparation of r and s enatiomers of 2-hydroxy-3-(2-thienyl) propanenitrile	A Kamal, Gollapalli, R Bhasker, R Khanna, R Maddamsetty, V Rao	US 7045341
Process for the preparation of 2-methyl, 1,4- naptho quinone	S Narayanan, K V V S B Murthy, K M Reddy, P Nandhikonda	EP 1373180
A process for the preparation of alkyl esters from commercial lactic acid	T N Kaimal, P Vijayalakshmi, B Ramalinga, A A Laxmi	AU 2002226670
Layered double hydroxides Supported nanopalladium catalysts, for Heck-Suzuki, Sonogashira-, and Stille type coupling reactions of haloarenes	B M Choudary, S Madhi Chowdari, K M Lakshmi , B Sreedhar	US 7049266

A process for the preparation of 2-chloro-1,1,1-trifluoro ethane (Hcfc-133a)	J M Rao	EP 1268055
Enzymatic process for the preparation of optically active alcohols from ketones using tuberous root daucus Carota	J S Yadav, S Nanda, P R Thirupathi, A B Rao	US 7056540
C8--linked pyrrolo[2,1-c] [1,4]benzodiazepine-acridone/ acridine hybrids	K Ahmed, O Srinivas , P Ramulu, R Gujjar, P K Pogula	US 7056913
Processing of hydrogen by metal ion exchanged montmorillonite	B M Choudary, K V S Ranganath, M I Kantam	GB 2410743
Use of a solid hydrotalcite structure incorporating fluorides for basic catalysis of Michael or Knoevenagel Reactions	F Francois, B Choudary; K Manoranjan, M Lakshmi, N Vattipally, K K Rao	US 7060859
Alpha.-glucosidase inhibitors and their synthesis from a natural source	J M Rao, M Rao, J Rao, U S Kumar, S V Reddy, V Singireddy , A Tiwari	US 7071341
Alpha-glucosidase inhibitors from a natural source	J M Rao, P K Srinivas, A Vummenthala, A K Tiwari, A Z Ali, A Zehra, J S Yadav, K. Raghavan, V. Kondapuram	US 7081260
A novel method for chromatographic finger printing and standardization of single medicines and formulations	V K Dadala, K V Raghavan	VN 5790
4.beta.-1''-[(2''-substituted benzoyl) anilino]podophyllotoxin analogues useful as anticancer agents	K Ahmed, P S Reddy, M Mohan	US 7087641
Process for the enhancement of cycle-life of the zinc chromium based catalyst used in the synthesis of 2-methylpyrazine	P S Saiprasad, K V Raghava, P K Rao, S J Kulkarni, K N Rao, R Gopinath, S Farsinavis, H M Meshram	KR 10-0620789
An improved process for the preparation of ethyl 2,3-dihydrobenzo [1,4] dioxin -2- carboxylate	M Pardhasaradhi, G Kumaraswamy, A K Das, N Jena, C K S Nair	DK 176120
Design and development of molecular imprint for resolution of racemic compounds	B M Choudary, K V S Ranganath, M I Kantam	GB GB2411400
Process for preparing alkylated Dihydroxybenzene	S Narayanan, P Srinivasan, S R Murthy, K V V S Bhaskara	US 7112705
A new eco-friendly process for the preparation of chiral alcohols by asymmetric reduction of prochiral Ketones in water using soaked vigna radiata (green grams)	M Pardhasaradhi, G K Swamy, S Ramesh, C K S Nair, A K Das	EP 1608611

Process for the nitration of xylene isomers using zeolite beta catalyst	B M Choudary, N S K Kantamml, K V Prasad, K V Raghavan	EP 1323705
A process for the production of alkanesulfonic acids from the alkyl mercaptan effluents generated in the chemical industries	B M Choudary, K K Rao, K Mahendar	GB GB2411401
Method for chromatographic finger printing and standardization of single medicines and formulations	V K Dadala, V K Kondapuram	US 7144740
Vitamin B12 biodegradable micro particulate conjugate carrier systems for peroral delivery of drugs, therapeutic peptides/proteins and vaccines	K B Chalasani, V Diwan, K V Raghavan, G J R Jones, S K Jain, K K Rao	AU 2001242732
New alpha-glucosidase inhibitors from a natural source	J M Rao, P V Srinivas, V Anuradha, A K Tiwari, A Z Ali, J S Yadav, K V Raghavan	EP 1562617
New alpha-glucosidase inhibitors from a natural source	J M Rao, P V Srinivas, V Anuradha, A K Tiwari, A Z Ali , J S Yadav, K V Raghavan	FR 1562617B1
Process for the preparation of 2-methyl 1,4- naptho quinone	S Narayanan, V V S B S K Murthy, K M Reddy, P Nandhikonda	JP 3894558
An improved process for the preparation of ethyl 2,3-dihydrobenzo [1,4] dioxin -2- carboxylate	M Pardhasaradhi, G Kumaraswamy, A K Das, N Jena, C K S Nair	CN ZL02827775.9
A process for the preparation of 1,1, 1,2 tetra fluoroethane	J M Rao	KR 676848
A novel method for chromatographic finger printing and standardization of single medicines and formulations	V K Dadala, K V Raghavan	SG 96712
New pyrrolo[2,1-c][1,4] Benzodiazepine-anthraquinone conjugates useful as antitumour agents	K Ahmed, R Rondla, G I Bhasker, R Khanna	US 7173026
Eco-friendly process for the preparation of chiral alcohols	M Pardhasaradhi, G K Swamy, S Ramesh, C K S Nair, A K Das	US 7179624
An improved process for the preparation of quaternary ammonium tribromides	M K Chaudhuri, U Bora, S K Dehury, D Dey, S S Dhar, W Kharmawphlang, B M Choudary , M I Kantam	GB 2412118
Substituted calix (4) pyrroles and process for the synthesis of calix (4) pyrroles over molecular sieve catalysts	K V Raghavan, S J Kulkarni, M R Kishan, N Srinivas	EP 1363915

Novel c2-fluoro pyrrolo[2,1-c][1, 4]benzodiazepine dimers useful as anticancer agents	A Kamal, P S M M Reddy, D R Reddy	US 7189710
A novel chromatographic finger printing of herbal medicines & Formulation	V K Dadala, K V Raghavan	UA 78194
A novel porous vessel bioreactor for reactions with immobilized enzymes and microbial cells	F N Wasantrao (In); S Bankupalli, S Gurrala, K V Madhuri, N Trishool (In)	EP 1570044
(-)-Secoisolariciresinol as an antioxidant obtained from a new natural source namely stereospermum Personatum	J M Rao, A K Tiwari, U S Kumar, J S Yadav, K V Raghavan	CN 1823496.8
IIIM		
Process for isolation of eupalitin from boerhavia	D Mundkinajeddu	CN 257399
Oligonucleotide primers of seg id nos. 1 to 21 and a process for detection	G N Qazi, V Verma, S R U Hassan	US 7041482
Substituted aryl alkenoic acid heterocyclic amides	S C Taneja, S Koul, J L Koul, B Moza, S S Handa	US 7057040
Stereoselective chemoenzymatic process for the preparation of optically enriched phenylglycidates as precursors of taxol side chain	A Naveen, M Kapoor, S C Taneja, S Chandra, S Koul, R L Sharma, G N Qazi	US 7060471
Stereoselective chemoenzymatic process for the oxidation of optically enriched phenylglycidates as precursors of taxol side chain	N Anand, M Kapoor, SC Taneja, S Koul, R I Sharma, G N Qazi	ZA 2005/7524
Bioavailability enhancing of cuminum cyminum and extracts / fraction thereof	Q G Nabi, K Bedi, R K Johri, M K Tickoo , A K Tickoo, S C Sharma, S T Abdullah, O M P Suri, B D Gupta, K A Suri	US 7070814
Method for the extraction of saffron pigments and flavor concentrate	S G Agarwal, R K Thappa, R Kumar, V K Agnihotri, O M Suri, G N Qazi	US 7070823
A process for the preparation of a synergistic hepatoprotective Composition	S S Handa	CN CN1269475C
Antidiabetic activity of argyrolibin Roseum	O P Gupta, Z Ahmad, A Bhagat, K K Gupta, S S Handa	EP 1551432

New plant based agents as Bioavailability/bioefficacy enhancers for drugs and nutraceuticals	G N Qazi, K I Bedi, R K Johri, S C Sharma, M K Tikoo, A K Tikoo, S T Abdullah, K Singh, R Pandita, O P Suri, B D Gupta, K A Suri, N K Satti	ZA 2005/0463
Process for isolation of eupalitin from boerhavia diffusa	D Mundkinajeddu	EP 1485394
Pharmaceutical composition and process for isolation of trans-tetracos-15-enoic acid and method of treatment for hepatotoxicity	S S Handa, B Singh, B K Chandan, A K Saxena , V Bhardwaj	US 7118766
Use of herbal agents for potentiation of bioefficacy of anti infectives	G N Qazi, O P Suri, K Bedi, I A Khan, V Verma, R K Johri, K A Suri, B D Gupta, N K Satti, M K Tikoo, S C Sharma, A K Tikoo	US 7119075
A process of isolation of pteroside from pterocarpus marsupium	R Maurya	CN 289315
Novel chemo-enzymatic synthesis of optically enriched rose-oxides	S C Taneja, V K Sethi, S Koul, S S Andotra, G N Qazi	JP 3873057
A process for the preparation of a synergistic hepatoprotective Composition	S S Handa	EP 1509285
Novel chemo-enzymatic process for the preparation of optical enriched beta-benzyl-gamma-Butyrolactones.	S C Taneja, S Kaul, B Singh, G N Qazi	US 7153983
Synergistic hepatoprotective Composition	V N Gupta, K A Suri, B D Gupta, B S Jaggi, N K Satti, B K Chandan, N Sharma, V Bhardwaj, O P Suri, G N Qazi, J Suri, M Bargotra	EP 1608360
A novel process for the preparation of nerol oxide	V K Sethi, S S Andotra, S C Taneja, P Gupta, G N Qazi	US 7166728
IIP		
A process for the preparation of vanadyl pyrophosphate catalysts with improved structural characteristics for the selective oxidation of butane to maleic anhydride	A Datta, S Dasgupta, M Agarwal	AU 2003200849

A process for the preparation of vanadyl pyrophosphate catalysts with improved structural characteristics for the selective oxidation of butane to maleic anhydride	A Datta, S Dasgupta, M Agarwal	KR 10-0681802
IMMT		
A process for manufacture of high iron hydraulic cement clinker using down draft sintering technique	B Nayak, V N Misra	EP 1487754
A process for cold briquetting and pelletisation of ferrous and non-ferrous ores and mineral fines by iron bearing hydraulic mineral binder for metallurgical application	B Nayak, V N Misra	EP 1579016
A process for the preparation of pencil lead from spent pot-liners of aluminium industries	B Mazumder	EP 1664217
IMT		
Reporter gene based method for the screening of anti-tuberculosis drugs by using essential and regulatory genes of mycobacteria as drug target	P Agrawal, V Soni, L Khadrika	EP 1245683
Novel clot specific streptokinase proteins processing altered plasminogen activation characteristics and a process for the preparation of said proteins	G Sahni , R Kumar, C Roy , R Kammara, D Nihalani, V Sundaram, M Yadav	US 7163817
An efficient and improved method for screening of analytes by microporous filtration based dot immunoassay kit	C R Suri, M Raje, G C Varshney	AU 2002348763
An efficient and improved method for screening of analytes by microporous filtration based dot immunoassay kit	C R Suri, M Raje, G C Varshney	EP 1579211
A process for high cell density fermentative production of intercellular recombinant Streptokinase	V V Vyas, R Govindan, Ramandeep, Kanak Lata Dikshit	US 7189557
Process for the isolation of a nontoxinogenic vibro cholerae strain and a process for preparing cholera vaccine from said vibrio cholerae strain	T Muthukumarappa, A Ghosh, C Sharma, N Gupta, A Mukhopadhyay, H Kole, G B Nair, R K Ghosh	EP 928831

NAL		
A light weight helicopter	P B Ramchandra	AU 2001248731
A light weight helicopter	P B Ramchandra	US 7168656
NBRI		
Antiulcer herbal composition	P Palpu, V Rao Chandana, S Mehrotra, G Raghavan, K N Radhakrishnan	US 7025995
Chimeric cry1e .delta.endotoxin and methods of controlling insects	R Tuli, P K Singh, S V Sawant, C P Chaturvedi	US 7053266
Nontoxic dental care herbal formulation for preventing dental plaque and gingivitis	H M Behl, O P Sidhu, S Mehrotra, S Pushpangadan, P Singh, S Charanjit	US 7083779
Synergistic bioinoculant composition comprising bacterial strains of accession nos. Nrrl b-30486, nrrl b-30487, and nrrl b-30488 and a method of producing said composition thereof	S C Nautiyal, S Mehta, H B Singh, P Pushpangadan	US 7097830
Plant and soil health enhancer using cow urine and application thereof for promoting plant growth and controlling plant pathogenic fungi	C S Nautiyal, S Mehta, H B Singh, S B Mansinghka, S H Dawle, N E Rajhans, P Pushpangadhan	EP 1608606
A process for preparation of herbal colours useful for cosmaceutical applications	P Pushpangadhan, S Mehrotra, A K S Rawat, S Khatoon Sayyada, G Raghavan	US 7128924
A synergistic bioinoculant Composition comprising bacterial strains of accession nos. Nrrl b-30486, nrrl b-30487 and nrrl b-30488 and a method of producing said composition thereof	C S Nautiyal, S Mehta, H B Singh, P Pushpangadhan	EP 1423011
Antiulcer herbal composition	P Pushpangadhan, C V Rao, K N Radhakrishnan, R Govindarajan, S Mehrotra	EP 1575604
Plant and soil health enhancer using cow urine and application thereof for promoting plant growth and controlling plant pathogenic fungi	C S Nautiyal, S Mehta, H B Singh, S B Mansinghka, S H Dawle, N E Rajhans, P Pushpangadhan	NL NL1608606
Development of herbal formulation in treatment of gastrointestinal Disorders	P Pushpangadhan, C V Rao, S Mehrotra, S K Ojha, Amresh, A K S Rawat	US 7172772

Herbal black dye used in beautifying the hair and its applications	P Pushpangadhan, P Mahesh, B S Dixit, R Bannerji, C V Rao	US 7186279
NCL		
A method for the improvement of gas-solid contacting in a bubbling fluidized bed reactor	V R Choudhary, T V Choudhary	US 7022307
Process for simultaneous conversion of methane & organic oxygenate to c2 to c10 hydrocarbons	V R Chaudhary, K C Mondal, S A Mulla	US 7022888
A novel catalytic formulation and its preparation	C R Vitthal, M A Narendra	US 7026266
Process for polymerization of olefins	S Sensarma, S Sivaram	EP 878485
An improved process for the preparation of porous crystalline silicoaluminophosphate, sapo-35 molecular sieve	V Narayanan, S G Hegde	US 7037874
A process for the preparation of an improved copper chromite	R V Chaudhari, J R Chaudhari, S Tukaram, C V Rode	US 7037877
Polyvalent imprinted polymer and Process	M G Kulkarni, J J Khandare	US 7041762
Process for preparing (RS) 3-methyl-1-(2-piperidinyl phenyl) butyl amine	U R Kalkote, M K Gurjar, S V Joshi, S M Kadam, H K Mandkar	US 7041830
A process for preparation on optically active Azabicycloheptanone derivatives	R R Joshi, A A Prabhune, R A Joshi, M K Gurjar	EP 1348765
Plant growth stimulator	N A Sahasrabudhe	US 7053025
A novel catalytic formulation and Its preparation	C R Vitthal, M A Narendra	NZ 528582
A novel catalytic formulation and Its preparation	C R Vitthal, M A Narendra	SG 99227
Process for oxidation of alkanes	R Deshpande, M M Diwakar, R V Chaudhari, VRaghunath	US 7084307
Single step hydrogenation of nitrobenzene to p-aminophenol	V R Chandrashekhar, J V Manisha, R V Chaudhari	EP 1229018
Device for production of hydrogen from effluents of internal combustion engines	S A Mirji	US 7089888
Block copolymers and preparation thereof	M G Kulkarni, J J Khandare	US 7109280

Process for preparing 5, 6-dihydro-4-(s)-(ethylamino)-6-(s) methyl-4h-thieno[2,3b]thiopyran-2-sulphonamide-7,7-dioxide Hcl	M K Gurjar, M N Deshmukh, V Paul, T V Radhakrishnan, G Dhananjay	US 7109353
Process for recovery of pure acrylonitrile	B P Purushottam, G S Madhukar, S R William, G M Yashwant, J C Narayan	US 7128815
Escherichia coli having accession no. Pta 1579 and its use to produce Polyhydroxybutyrate	L H Mahishi, G Tripathi, T V N Ramchander, S K Rawal	US 7135316
An improved process for the synthesis of alpha-substituted acroleins	D R Madhukar, M M Diwakar, R V Chaudhari	US 7141702
A new and efficient process for the preparation of s(-)amlodipine -l(+) -hemi taratarte	R R Joshi, R A Joshi, M K Gurjar	US 7148358
A process for the preparation of encapsulated oxo-bridged organometallic cluster catalysts	D Srinivas, S A Chavan, P Ratnasamy	US 7153806
A process for preparation of conducting polymer electrodes useful for electro catalytic oxidation of alcohols	R Subramaniam, A Arindam	US 7156973
A novel process for the production of hydrogen peroxide from hydrazine hydrate or hydrazine salt	V R Choudhary, C Samanta, J Prabhas	US 7157071
Process for continuous production of carbon monoxide free hydrogen from methane or methane rich Hydrocarbons	V R Choudhary, A M Rajput	US 7160344
A new process for the preparation of free standing membranes	P S Kumar, P S Kannan, A More R Shingte, P W M Sastry	US 7182894
An improved process for the selective liquid phase oxidation of toluene to benzaldehyde	R V Chaudhari, V H Rane, A A Deshmukh, S S Divekar	US 7189882
NCL + CLRI		
A process for the preparation of alkaline protease and its ecofriendly application in the pretanning processes of leather manufacture	R S Laxman, S V More, M V Rele, B S R Rao, V V Jogdand, M B Rao, V V Deshpande, R B Naidu, P Manikandan, D A Kumar, J R Kanagaraj	US 7186546
Preparation of essential oil compositions for potable liquid Disinfection	H J Purohit, M Kulkarni	US 7074439

An improved process for isolation of bioplastic polyhydroxybutyrate (phb) from bacillus mycoides rlj b-017	M Bordoloi, B Borah, P Thakur, J N Nigam	US 7129068
Method for selective recording of sh waves using an array of sensors to filter out all non sh waves	S K Ghosh	US 7079954
Analytical solutions to error bounds on the subsurface temperature depth Distribution	K Srivastava, R Sharma, B Fatima B, R N Singh	US 7130758
NGRI		
Method for selective recording of SH waves using an array of sensors to filter out all non SH waves (US P)	S K Ghosh	US 7079954
A novel method for synthesis of Nono geikielite a mantle oxide	G Parthasarthy, S V Manorama	EP 11611058
Method for analytically obtaining closed form expressions for subsurface temperature depth distribution along with its error bounds	K Srivastava, R Sharma, B Fatima, R N Singh	US 7130758
Method for stable and accurate solution for an ill conditioned system of normal equations associated with a prediction filter whose output is defined as a time advanced version of the input	J B Selvaraj	US 7219115
NIO		
Bioactive molecules from an associated mangrove plant	U Goswami, N Fernandes	EP 1372680
A system for classifying sea floor roughness using an hybrid layout	B Chakraborty, V Kodagali, J Baracho, A Joseph	EP 1485677
Biologically active aqueous fraction of an extract obtained from a mangrove plant salvadora Persica l	U Goswami, N Fernandes	SG 100251
Probes for myctophid fish and a method for developing the same	U Goswami, G Bernardi, S C Goswami, P Johnson, R K Johnson	US 7060434
Baroduric bacterium from Indian Ocean	P A L Bharathi, S Nair, D Chandramohan	US 7063974
Process for the cure and control of diabetes mellitus using natural products from perna viridis	R R Bhonde, A Chatterji	US 7074433
Pressure housing for in-water pressure based systems	E Desa, G P Naik, A Joseph E S Desa, P Mehra, V Kumar, S P Desai, S M Nagvekar	JP 3829137

Process for proliferation and differentiation of rat ascinar cells	P P Bhaskar , A Chatterji	US 7087429
A new muscarine antagonist	U Goswami, N Fernande	AU 2001256651
Biologically active aqueous fraction of an extract obtained from a mangrove plant salvadora persica l	U Goswami, N Fernande	AU 2001256653
Process for removal of polycyclic aromatic hydrocarbons in waste water and other contaminated sites	C Raghukumar, S Srinivasa K Murthy, S Kamat	US 7118906
A method for enhancing levels of polyunsaturated fatty acids in thraustochytrid fungi	S Raghukumar, R Jain	EP 1606413
Sesquiterpene oxides as perfuming and flavoring agents	W Solimabi, G M Babu, P S K Keshav	US 7138368
A method for enhancing levels of polyunsaturated fatty acids in thraustochytrid fungi	S R Kumar, D R Chandramohan, E Desa	KR 10-0680906
A method for enhancing levels of polyunsaturated fatty acids in thraustochytrid fungi	S Raghukumar, R Jain	DK DK1606413
A method for enhancing levels of polyunsaturated fatty acids in thraustochytrid fungi	S Raghukumar, R Jain	AU 2003226626
NIIST		
$Mg_2MM'O6 + X$,(M = Y, rare earth metal, and M' = Sn, Sb,Zr, Hf and Ta) dielectric ceramics and their preparation as nanoparticles	J James, S Senthilkumar, K V Nair	EP 1608595
Viologen linked acridine based molecule and process for the preparation thereof	D Ramaiah, N V Eldho, J Joseph	EP 1373250
A non-visualized permanent information recording system for use as security labels for authentication of documents and products	S Das, R Davis	EP 1487936
Anti-diabetic agent obtained from the plant humboldtia decurrens and a process for preparing the same	J M Rao, S M Achutankunju, G V Nair, A Damodaran, K Rathinam, S Rajagopa, K Das	EP 1359926
Sqruarine based dyes modified with bromine, iodine and acridine, their preparation and use as sensitizers for photodynamic therapeutical & Industrial applications	R Danaboyina, A K Thazhathveetil, S Das	FR 2818987

NML		
A process for the recovery of gallium from Bayer process liquors	P R Rao, P G V Kumar, A Agrawal, I Chattoraj	JP 3828544
A process for extraction of nickel from spent catalyst	K K Sahu, B D Pandey, P Chand	DE 10297680
Single-step simple and economical process for the preparation of nanosized acicular magnetic iron oxide particles of maghemite phase	A Sinha, J Chakraborty, V Rao	US 7087210
A process for the preparation of novel flux useful for hotdip galvanizing of iron and iron based alloys and an improved process therefore using the said flux	D D N Singh, T B Singh, A K Dey	SG 106890
A process for preparation of nanosized iron oxide by biomimetic route	A Sinha, J Chakraborty, S Das, S K Das , V Rao, P R Rao	KR 10-0626096
A process for extraction of nickel from spent catalyst	K K Sahu, B D Pandey, P Chand	EP 1488015
NPL		
Conducting polymer membrane and a process for the preparation of the same membrane	R Singh, S Chandra, H Singh, A K Narula, S Broor	DE 19914200
Formulation for iron chelation, a process for preparing the formulation and a method of treating thalassemia	S A Kumar, K Sudarshan, P Harsh , K S Rattan, D Ghansham	CA 2191664
Polymer coated long duration optical memory device and a method for the development thereof	A M Biradar, S S Bawa, E P Haridas, S Chandra	KR 649054
Polymer based enzyme electrode for estimation of cholesterol	A Kumar, A Chaubey, B A Malhotra, B Daar , R Grover, S Krishan	US 7175746
Copolymer of benzene and substituted benzene	S K Dhawan, K N Modeeparampu, S S Bawa	US 7186793

ANNEXURE II

AREA-WISE RESEARCH PUBLICATIONS (TOP 50 PAPERS) BY CSIR LABS

BIOLOGICAL SCIENCES				
BASED ON IMPACT FACTOR OF THE JOURNALS				
S.No.	**Lab**	**First Author**	**Journal**	**IF**
1.	CCMB	Thangaraj, K	SCIENCE 2006, Vol 311, Iss 5760, pp 470	30.927
2.	IICB	Mahata, B	SCIENCE 2006, Vol 314, Iss 5798, pp 471-474	30.927
3.	CCMB/IICT	Grimaud, C	CELL 2006, Vol 124, Iss 5, pp 957-971	29.431
4.	CCMB	Saxena, SK	NAT MED 2006, Vol 12 Iss 3, pp 269-270	28.878
5.	IICT	Knight, CG	NAT GENET 2006, Vol 38, Iss 9 pp 1015-1022	25.797
6.	CCMB	Schlecker, C	J CLIN INVEST 2006, Vol 116, Iss 6, pp 1668-1674	15.053
7.	NEERI	Tanner, B	J CLIN ONCOL 2006, Vol 24, Iss 26, pp 4317-4323	11.810
8.	CCMB	Pucadyil, TJ	PROG LIPID RES 2006, Vol 45, Iss 4, pp 295-333	11.372
9.	CCMB	Kaur, J	PLANT CELL 2006, Vol 18, Iss 3, pp 545-559	11.088
10.	IGIB	Rawal, P	GENOME RES 2006, Vol 16, Iss 5, pp 644-655	10.139
11.	CCMB	Hussain, T	EMBO J 2006, Vol 25, Iss 17, pp 4152-4162	10.053
12.	IMTECH	Swain, S.L.	IMMUNOL REV 2006, Vol 211, 8-22	8.420
13.	CDRI	Makker, A	MED RES REV 2006, Vol 26, Iss 6, pp 699-746	7.964
14.	IICB	Chakravorty, M	HUM MUTAT 2006, Vol 27, Iss 5, pp 411-419	7.923
15.	IICB	Gupta, A	CLIN CHEM 2006, Vol 52, Iss 8, pp 1611-1612	7.717
16.	CCMB	Mahurkar, S	GUT 2006, Vol 55, Iss 9, pp 1270-1275	7.692
17.	CFTRI	Tawde, P	J ALLERG CLIN IMMUNOL 2006, Vol 118, Iss 4, pp 915-922	7.667
18.	IGIB	Sharma, S	J ALLERG CLIN IMMUNOL 2006, Vol 118, Iss 4, pp 960-963	7.667
19.	IGIB	Scaria V	NUCLEIC ACIDS RES 2006 Jul; 1; 34(Web Server issue):W683-5	7.552
20.	IGIB	Harish N	NUCLEIC ACIDS RES 2006 Jul; 1; 34(Web Server issue):W264-6.	7.552

21.	IICB	Das, BB	NUCLEIC ACIDS RES 2006, Vol 34, Iss 4, pp 1121-1132	7.552
22.	IICB	Ganguly A	NUCLEIC ACIDS RES 2006; Vol 34(21):6286-97. Epub 2006 Nov 10.	7.552
23.	IMTECH	Saha, S	NUCLEIC ACIDS RES 2006, Vol 34, W202-209	7.552
24.	CCMB	Blastyak, A	MOL CELL BIOL 2006, Vol 26, Iss 4, pp 1434-1444	7.093
25.	CLRI	Egli D	MOL CELL BIOL 2006, Vol 26(6), 2286-2296	7.093
26.	CDRI	Guha, M	FASEB J 2006, Vol 20, Iss 8, pp 1224-0	7.064
27.	CCMB	Sirdeshmukh, R	J PROTEOME RES 2006, Vol 5, Iss 11, pp 2879-2879	6.901
28.	CCMB	Chopra, VS	BIOESSAYS 2006, Vol 28, Iss 5, pp 445-448	6.787
29.	IMTECH	Singh, R	TRENDS MICROBIOL 2006, Vol 14, Iss 9, pp 389-397	6.648
30.	CCMB	Manju, K	J CELL SCI 2006, Vol 119, Iss 13, pp 2704-2714	6.543
31.	CCMB	Gupta, V	J CELL SCI 2006, Vol 119, Iss 9, pp 1703-1714	6.543
32.	CFTRI	Bharathi	BRAIN RES REV 2006, Vol 52, Iss 2, pp 275-292	6.402
33.	IMTECH	Wang, H.	J IMMUNOL 2006, Vol 177, 2793-2802	6.387
34.	IICB	Das, BB	MOL MICROBIOL 2006, Vol 62, Iss 4, pp 917-927	6.203
35.	IGIB	Charu, R	THORAX 2006, Vol 61, Iss 11, pp 1011-1012	6.150
36.	NBRI	Kiran, K	PLANT PHYSIOL 2006, Vol 142, Iss 1, pp 364-376	6.114
37.	NCL	Giri, AP	PLANT PHYSIOL 2006, Vol 142, Iss 4, pp 1621-1641	6.114
38.	CCMB	Rajender, S	J CLIN ENDOCRINOL METAB 2006, Vol 91, Iss 10, pp 4028-4036	6.020
39.	IMTECH	Singh, MK	BIOINFORMATICS 2006, Vol 22, Iss 2, pp 253-255	6.019
40.	NCL	Idicula-S. T.	BIOINFORMATICS 2006, Vol 22, Iss 3, pp 278-284	6.019
41.	CCMB	Suhasini, AN	J BIOL CHEM 2006, Vol 281, Iss 18, pp 12201-12209	5.854
42.	CCMB	Shivaswamy, S	J BIOL CHEM 2006, Vol 281, Iss 15, pp 10461-10472	5.854
43.	CDRI	Akhtar, MS	J BIOL CHEM 2006, Vol 281, Iss 38, pp 28336-28344	5.854

44.	CDRI	Ahmad, A	J BIOL CHEM 2006, Vol 281, Iss 31, pp 22029-22038	5.854
45.	CDRI	Shrivastava, A	J BIOL CHEM 2006, Vol 281, Iss 28, pp 19762-19771	5.854
46.	CDRI	Mishra, P	J BIOL CHEM 2006, Vol 281, Iss 11, pp 7143-7150	5.854
47.	IICB	Kundu, P	J BIOL CHEM 2006, Vol 281, Iss 45, pp 34651-34662	5.854
48.	IICB	Chatterjee, S	J BIOL CHEM 2006, Vol 281, Iss 35, pp 25270-25277	5.854
49.	IICB	Goswami, S	J BIOL CHEM 2006, Vol 281, Iss 28, pp 18914-18917	5.854
50.	IMTECH	Kumar, M	J BIOL CHEM 2006, Vol 281, Iss 9, pp 5357-5363	5.854
51.	IMTECH	Thakur, M	J BIOL CHEM 2006, Vol 281, 40107-40113	5.854
52.	NCL	Kumar, RS	J BIOL CHEM 2006, Vol 281, Iss 43, pp 32516-32525	5.854

ANNEXURE II

AREA-WISE RESEARCH PUBLICATIONS (TOP 50 PAPERS) BY CSIR LABS

CHEMICAL SCIENCES				
BASED ON IMPACT FACTOR OF THE JOURNALS				
S.No.	Lab	First Author	Journal	IF
1.	NCL	Pandey, G	CHEM REV 2006, Vol 106, Iss 11, pp 4484-4517	20.869
2.	NIIST	Nair, V	ACCOUNTS CHEM RES 2006, Vol 39, Iss 8, pp 520-530	13.141
3.	IICT	Sharma, GVM	ANGEW CHEM INT EDIT 2006, Vol 45, Iss 18, pp 2944-2947	9.596
4.	NIIST	Ajayaghosh, A	ANGEW CHEM INT EDIT 2006, Vol 45, Iss 20, pp 3261-3264	9.596
5.	CSMCRI	Lakshmi narayanan, PS	ANGEW CHEM INT EDIT 2006, Vol 45, Iss 23, pp 3807-3811	9.596
6.	NCL	Tiwari, S	ANGEW CHEM INT EDIT 2006, Vol 45, Iss 29, pp 4824-4825	9.596
7.	NIIST	Ajayaghosh, A	ANGEW CHEM INT EDIT 2006, Vol 45, Iss 3, pp 456-460	9.596
8.	NIIST	Kumar, NSS	ANGEW CHEM INT EDIT 2006, Vol 45, Iss 38, pp 6317-6321	9.596
9.	IICT	Sharma, GVM	ANGEW CHEM INT EDIT 2006, Vol 45, Iss 48, pp 8207-8210	9.596
10.	NIIST	Ajayaghosh, A	ANGEW CHEM INT EDIT 2006, Vol 45, Iss 7, pp 1141-1144	9.596
11	NIIST	Ajayaghosh, A	ANGEW CHEM INT EDIT 2006, Vol 45(46):7729-7732	9.596
12	IGIB	Kumar, N	J AM CHEM SOC 2006, Vol 128, Iss 1, pp 14-15	7.419
13	NIIST	Jisha, VS	J AM CHEM SOC 2006, Vol 128, Iss 18, pp 6024-6025	7.419
14	NIIST	Ajayaghosh, A	J AM CHEM SOC 2006, Vol 128, Iss 22, pp 7174-7175	7.419
15	NIIST	Praveen, VK	J AM CHEM SOC 2006, Vol 128, Iss 23, pp 7542-7550	7.419
16	NIIST	Abraham, S	J AM CHEM SOC 2006, Vol 128, Iss 23, pp 7692-7698	7.419
17	IICT	Satav, SS	J AM CHEM SOC 2006, Vol 128, Iss 24, pp 7752-7753	7.419
18	NCL	Satav, SS	J AM CHEM SOC 2006, Vol 128, Iss 24, pp 7752-7753	7.419
19	NCL	Matmour, R	J AM CHEM SOC 2006, Vol 128, Iss 25, pp 8158-8159	7.419
20	CSMCRI	Nair, V	J AM CHEM SOC 2006, Vol 128, Iss 27, pp 8736-8737	7.419

21	NIIST	Nair, V	J AM CHEM SOC 2006, Vol 128, Iss 27, pp 8736-8737	7.419
22	CSMCRI	Lakshminarayanan, PS	J AM CHEM SOC 2006, Vol 128, Iss 30, pp 9600-9601	7.419
23	NCL	Hotha, S	J AM CHEM SOC 2006, Vol 128, Iss 30, pp 9620-9621	7.419
24	NIIST	Neelakandan, PP	J AM CHEM SOC 2006, Vol 128, Iss 35, pp 11334-11335	7.419
25	NCL	Bansal, V	J AM CHEM SOC 2006, Vol 128, Iss 36, pp 11958-11963	7.419
26	NCL	Bansal, V	J AM CHEM SOC 2006, Vol 128, Iss 43, pp 14059-14066	7.419
27	IICT	Sharma, GVM	J AM CHEM SOC 2006, Vol 128, Iss 45, pp 14657-14668	7.419
28	NIIST	Ipe, BI	J AM CHEM SOC 2006, Vol 128, Iss 6, pp 1907-1913	7.419
29	NIIST	Misra, R	J AM CHEM SOC 2006, 20 Dec ,128(50):16083-16091;	7.419
30	CDRI	Singh, C	J MED CHEM 2006, Vol 49, Iss 24, pp 7227-7233	4.926
31	NCL	Salunke, DB	J MED CHEM 2006, Vol 49, Iss 8, pp 2652-2655	4.926
32	CDRI	Singh, C	J MED CHEM 2006, Vol 49, Iss 9, pp 2794-2803	4.926
33	NIIST	Balan, B	CHEM-EUR J 2006, Vol 12, Iss 25, pp 6701-6710	4.907
34	NCL	Sudrik, SG	CHEM-EUR J 2006, Vol 12, Iss 3, pp 859-864	4.907
35	NCL	Kumar, P	CHEM-EUR J 2006, Vol 12, Iss 5, pp 1397-1402	4.907
36	NCL	Varughese, S	CHEM-EUR J 2006, Vol 12, Iss 6, pp 1597-1609	4.907
37	NIIST	Sankar, J	CHEM-EUR J 2006, 18 Dec, 13(1):105-114	4.907
38	NIIST	Dias, A	CHEM MATER 2006, Vol 18, Iss 1, pp 214-220	4.818
39	CSMCRI	Ballabh, A	CHEM MATER 2006, Vol 18, Iss 16, pp 3795-3800	4.818

40	NCL	Parthasarathy, M	CHEM MATER 2006, Vol 18, Iss 22, pp 5244-5252	4.818
41	CSMCRI	Trivedi, DR	CHEM MATER 2006, Vol 18, Iss 6, pp 1470-1478	4.818
42	CSMCRI	Kureshy, RI	J CATAL 2006, Vol 238, Iss 1, pp 134-141	4.780
43	NCL	Choudhary, VR	J CATAL 2006, Vol 238, Iss 1, pp 28-38	4.780
44	NCL	Basu, S	J CATAL 2006, Vol 239, Iss 1, pp 154-161	4.780
45	NCL	Srivastava, R	J CATAL 2006, Vol 241, Iss 1, pp 34-44	4.780
46	NCL	Vijayaraj, M	J CATAL 2006, Vol 241, Iss 1, pp 83-95	4.780
47	NCL	Sarkar, BR	J CATAL 2006, Vol 242, Iss 1, pp 231-238	4.780
48	IICT	Kirumakki, SR	J CATAL 2006, Vol 242, Iss 2, pp 319-331	4.780
49	NCL	Maity, N	J CATAL 2006, Vol 242, Iss 2, pp 332-339	4.780
50	NCL	Reddy, AS	J CATAL 2006, Vol 243, Iss 2, pp 278-291	4.780
51	NCL	Vijayaraj, M	J CATAL 2006, Vol 243, Iss 2, pp 376-388	4.780
52	NCL	Shylesh, S	J CATAL 2006, Vol 244, Iss 1, pp 52-64	4.780
53	CSMCRI	Sebastian, J	J CATAL 2006, Vol 244, Iss 2, pp 208-218	4.780

ANNEXURE II

AREA-WISE RESEARCH PUBLICATIONS (TOP 50 PAPERS) BY CSIR LABS

PHYSICAL & EARTH SCIENCES				
BASED ON IMPACT FACTOR OF THE JOURNALS				
S.No.	**Lab**	**First Author**	**Journal**	**IF**
1	NPL	Yadav, HK	PHYS REV LETT 2006, Vol 97, Iss (8) : Art No. 085502	7.489
2	NPL	Bhagavannarayana, G	J APPL CRYSTALLOGR 2006, Vol 39, Iss 0, pp 784-790	5.248
3	IGIB	Kainthan, RK	BIOMATERIALS 2006, Vol 27, Iss 31, pp 5377-5390	4.698
4	NPL	Kaur, S	APPL PHYS LETT 2006, Vol 88, Iss (12): Art. No. 122905	4.127
5	NPL	Chand, S	APPL PHYS LETT 2006, Vol 88, Iss (21): Art. No. 213506	4.127
6	NCL	Sharma, J	APPL PHYS LETT 2006, Vol 88, Iss 19, : Art. No. 193103	4.127
7	NCL	Ramgir, NS	APPL PHYS LETT 2006, Vol 88, Iss 4, Art. No. 042107	4.127
8	NPL	Haranath, D	APPL PHYS LETT 2006, Vol 89, Iss (17): Art. No. 173118	4.127
9	NPL	Saxena, K	APPL PHYS LETT 2006, Vol 89, Iss (6): Art. No. 061124	4.127
10	NCL	Murugana, AV	APPL PHYS LETT 2006, Vol 89, Iss 12, Art. No. 123120	4.127
11	NAL	Barshilia, HC	APPL PHYS LETT 2006, Vol 89, Iss 19, Art No. 191909	4.127
12	NCL	Rajagopal, R	APPL PHYS LETT 2006, Vol 89, Iss 2, Art. No. 023107	4.127
13	NCL	Deka, S	APPL PHYS LETT 2006, Vol 89, Iss 3, Art. No. 032508	4.127
14	NPL	Haranath, D	APPL PHYS LETT 2006, Vol 89, Iss (9): Art. No. 091903	4.127
15	NGRI	Manikyamba, C	GEOCHIM COSMOCHIM ACTA 2006, Vol 70, Iss 18, pp 4663-4679	3.897
16	NCL	Khan, M	OPT EXPRESS 2006, Vol 14, Iss 1, pp 424-429	3.764
17	CGCRI	Dhar, A	OPT EXPRESS 2006, Vol 14, Iss 20, pp 9006-9015	3.764
18	NPL	Singh, RK	NEW J PHYS 2006, Vol 8, Art. No. 112	3.585
19	IICT	Reddy, TJ	J MASS SPECTROM 2006, Vol 41, Iss 1, pp 59-70	3.574

20	CDRI	Madhusudanan, KP	J MASS SPECTROM 2006, Vol 41, Iss 10, pp 1322-1333	3.574
21	IICT	Bhaskar, G	J MASS SPECTROM 2006, Vol 41, Iss 12, pp 1608-1614	3.574
22	CDRI	Madhusudanan, KP	J MASS SPECTROM 2006, Vol 41, Iss 8, pp 1096-1104	3.574
23	IICT	Reddy, PN	J MASS SPECTROM 2006, Vol 41, Iss 8, pp 1105-1108	3.574
24	NGRI	Gahalaut, VK	EARTH PLANET SCI LETT 2006, Vol 242, Iss 39145, pp 365-374	3.434
25	NGRI	Tiwari, VM	EARTH PLANET SCI LETT 2006, Vol 247, Iss 39084, pp 61-69	3.434
26	NGRI	Gahalaut, VK	EARTH PLANET SCI LETT 2006, Vol 249, Iss 39084, pp 39-46	3.434
27	NGRI	Ray, L	EARTH PLANET SCI LETT 2006, Vol. 251, pp. 241-253, doi: 10.1016/j. epsl. 2006.09.010	3.434
28	NGRI	Rao, VV	EARTH PLANET SCI LETT 2006, Vol 251, Iss 39084, pp 90-103	3.434
29	NML	Srivastava, AK	ACTA MATER 2006, Vol 54, Iss 7, pp 1741-1748	3.430
30	NPL	Deepa, M	ACTA MATER 2006, Vol 54, Iss 0, pp 4583-4595	3.430
31	NIIST	Ananthakumar, S	ACTA MATER 2006, Vol 54, Iss 11, pp 2965-2973	3.430
32	NPL	Srivastava, AK	ACTA MATER 2006, Vol 54, Iss 0, pp 1741-1748	3.430
33	NIO	Chang, P	J CLIMATE 2006, Vol 19, Iss 20, pp 5122-5174	3.402
34	NPL	Awana, VPS	PHYS REV B 2006, Vol 73, Iss (1): Art. No. 014517	3.185
35	NAL	Kenichi, T	PHYS REV B 2006, Vol 73, Iss 22, Art.No. 224119	3.185
36	CGCRI	Das, N	PHYS REV B 2006, Vol 74, Iss 1, pp 014410-15	3.185
37	NCL	Deka, S	PHYS REV B 2006, Vol 74, Iss 3, Art. No. 033201	3.185
38	CGCRI	Mandal, P	PHYS REV B 2006, Vol 74, Iss 9, pp 094421-26	3.185
39	NIIST	Durkut, M	J CHEM PHYS 2006, Vol 124, Iss 15, Art. No. 154704	3.138
40	NCL	Tanwar, A	J CHEM PHYS 2006, Vol 125, Iss 21, Art. No. 214304	3.138
41	NCL	Tanwar, A	J CHEM PHYS 2006, Vol 125, Iss 5, Art. No. 056101	3.138

42	IICT	Lakshmi, VVS	RAPID COMMUN MASS SPECT 2006, Vol 20, Iss 14, pp 2209-2214	3.087
43	NCL	Kulkarni, MJ	RAPID COMMUN MASS SPECT 2006, Vol 20, Iss 18, pp 2769-2772	3.087
44	IICT	Ramanjaneyulu, GS	RAPID COMMUN MASS SPECT 2006, Vol 20, Iss 19, pp 2990-2994	3.087
45	IICT	Gerbaux, P	RAPID COMMUN MASS SPECT 2006, Vol 20, Iss 2, pp 151-156	3.087
46	IICT	Reddy, PN	RAPID COMMUN MASS SPECT 2006, Vol 20, Iss 22, pp 3351-3360	3.087
47	CDRI	Suryawanshi, S	RAPID COMMUN MASS SPECT 2006, Vol 20, Iss 24, pp 3761-3768	3.087
48	IICT	Kumar, MK	RAPID COMMUN MASS SPECT 2006, Vol 20, Iss 6, pp 1045-1048	3.087
49	IICT	Lakshmi, VVS	RAPID COMMUN MASS SPECT 2006, Vol 20, Iss 6, pp 981-986	3.087
50	IICT	Kumar, MK	RAPID COMMUN MASS SPECT 2006, Vol 20, Iss 6, pp 987-993	3.087

ANNEXURE II

AREA-WISE RESEARCH PUBLICATIONS (TOP 50 PAPERS) BY CSIR LABS

ENGINEERING SCIENCES				
BASED ON IMPACT FACTOR OF THE JOURNAL				
Rank	**Lab**	**First Author**	**Journal**	**IF**
1	ITRC	Dhawan, A	ENVIRON SCI TECHNOL 2006, Vol 40, Iss 23, pp 7394-7401	4.054
2	CLRI	Saravanabhavan S	ENVIRON SCI TECHNOL 2006, Vol 40, Iss 3, pp 1069-1075	4.054
3	NIIST	Preetha, CR	ENVIRON SCI TECHNOL 2006, Vol 40, Iss 9, pp 3070-3074	4.054
4	NPL	Arora, K	BIOSENS BIOELECTRON 2006, Vol 21, Iss 0, pp 1777-1783	3.463
5	CFTRI	Chouhan, RS	BIOSENS BIOELECTRON 2006, Vol 21, Iss 7, pp 1264-1271	3.463
6	NPL	Deepa, M	NANOTECHNOLOGY 2006, Vol 17, Iss 0, pp 2625-2630	2.993
7	NCL	Ramgir, NS	NANOTECHNOLOGY 2006, Vol 17, Iss 11, pp 2730-2735	2.993
8	NCL	Abyaneh, MK	NANOTECHNOLOGY 2006, Vol 17, Iss 16, pp 4129-4134	2.993
9	NCL	Sunny, V	NANOTECHNOLOGY 2006, Vol 17, Iss 18, pp 4765-4772	2.993
10	NCL	Thomas, S	NANOTECHNOLOGY 2006, Vol 17, Iss 22, pp 5565-5572	2.993
11	NCL	Karmakar, S	NANOTECHNOLOGY 2006, Vol 17, Iss 23, pp 5895-5902	2.993
12	NCL	Singh, A	NANOTECHNOLOGY 2006, Vol 17, Iss 9, pp 2399-2405	2.993
13	CDRI	Prathipati, P	J CHEM INFORM MODEL 2006, Vol 46, Iss 1, pp 39-51	2.923
14	CDRI	Prabhakar, YS	J CHEM INFORM MODEL 2006, Vol 46, Iss 1, pp 52-56	2.923
15	CDRI	Prabhakar, YS	J CHEM INFORM MODEL 2006, Vol 46, Iss 1, pp 86-92	2.923
	IICT	Prabhakar, YS	J CHEM INFORM MODEL 2006, Vol 46, Iss 1, pp 86-92	2.923
16	CDRI	Gupta, MK	J CHEM INFORM MODEL 2006, Vol 46, Iss 1, pp 93-102	2.923
17	NCL	Karthikeyan, M	J CHEM INFORM MODEL 2006, Vol 46, Iss 2, pp 452-461	2.923
18	IICB	Sharma, P	J CHEM INFORM MODEL 2006, Vol 46, Iss 4, pp 1763-1774	2.923
19	CDRI	Pandey, G	J CHEM INFORM MODEL 2006, Vol 46, Iss 6, pp 2579-2590	2.923
20	NML	Sawaguchi, T	SCRIPTA MATER 2006, Vol 54, Iss 11, pp 1885-1890	2.228

21	NCL	Banerjee, I	SCRIPTA MATER 2006, Vol 54, Iss 7, pp 1235-1240	2.228
22	NML	Chowdhury, SG	SCRIPTA MATER 2006, Vol 54, Iss 9, pp 1691-1696	2.228
23	CGCRI	Sagar, SP	SCRIPTA MATER 2006, Vol 55, Iss 2, pp 199-202	2.228
	NML	Sagar, SP	SCRIPTA MATER 2006, Vol 55, Iss 2, pp 199-202	2.228
24	NCL	Sato, T	J SUPERCRIT FLUID 2006, Vol 37, Iss 1, pp 87-93	2.144
25	CLRI	Bhattacharya, M	AICHE J 2006, Vol 52, Iss 11, pp 3707-3721	2.036
26	NCL	Khopkar, AR	AICHE J 2006, Vol 52, Iss 5, pp 1654-1672	2.036
27	CECRI	Boovaragavan, V	CHEM ENG J 2006, Vol 117, Iss 3, pp 213-221	2.034
28	NCL	Choudhary, VR	CHEM ENG J 2006, Vol 121, Iss 39116, pp 73-77	2.034
29	CLRI	Padmesh, TVN	CHEM ENG J 2006, Vol 122, Iss 39084, pp 55-63	2.034
30	NEERI	Sandhya, S	CHEM ENG J 2006, Vol 122, Iss 39084, pp 87-92	2.034
31	NGRI	Ertl, A	AM MINERAL 2006, Vol 91, Iss 39398, pp 1847-1856	2.011
32	NEERI	Kumar, R	AEROSOL SCI TECH 2006, Vol 40, Iss 7, pp 490-502	1.935
33	ITRC	Singh, KP	CHEMOMET INTELL LAB SYST 2006, Vol 83, Iss 1, pp 1-12	1.770
34	CFRI	Khomane, RB	CHEM ENG SCI 2006, Vol 61, Iss 10, pp 3415-3418	1.735
35	IICT	Das, PK	CHEM ENG SCI 2006, Vol 61, Iss 11, pp 3705-3713	1.735
36	IICT	Venkateswarlu, C	CHEM ENG SCI 2006, Vol 61, Iss 17, pp 5560-5574	1.735
37	CLRI	Bhattacharya, M	CHEM ENG SCI 2006, Vol 61, Iss 19, pp 6273-6301	1.735
38	NCL	Khopkar, AR	CHEM ENG SCI 2006, Vol 61, Iss 9, pp 2921-2929	1.735
39	CDRI	Rawal, RK	J MOL MODEL 2006, Vol 13, 155-61	1.670
40	CDRI	Shagufta	J MOL MODEL 2006, Vol 13, 99-109	1.670
41	NML	Mishra, SK	J VAC SCI TECHNOL B 2006, Vol 24, Iss 3, pp 1311-1317	1.626

42	CBRI	Chakraverty, S	COMPUT METH APPL MECH EN 2006, Vol 195, Iss 0, pp 4194-4202	1.553
43	AMPRI	Saxena, M	J HAZARD MATER 2006, Vol 129, Iss 39085, pp 50-57	1.544
44	NML	Agrawal, A	J HAZARD MATER 2006, Vol 133, Iss 39085, pp 299-303	1.544
45	NCL	Talawar, MB	J HAZARD MATER 2006, Vol 134, Iss 39085, pp 8-18	1.544
46	ITRC	Mohan, D	J HAZARD MATER 2006, Vol 135, Iss 39085, pp 280-295	1.544
47	NML	Lakshmipathiraj, P	J HAZARD MATER 2006, Vol 136, Iss 2, pp 281-287	1.544
48	NBRI	Gupta, AK	J HAZARD MATER 2006, Vol 136, Iss 2, pp 371-378	1.544
49	NML	Mishra, T	J HAZARD MATER 2006, Vol 137, Iss 1, pp 299-303	1.544
50	CLRI	Swarnalatha, S	J HAZARD MATER 2006, Vol 137, Iss 1, pp 304-313	1.544
51	ITRC	Mohan, D	J HAZARD MATER 2006, Vol 137, Iss 2, pp 762-811	1.544
52	NML	Agrawal, A	J HAZARD MATER 2006, Vol 137, Iss 2, pp 915-924	1.544
53	ITRC	Mohan, D	J HAZARD MATER 2006, Vol 137, Iss 3, pp 1545-1553	1.544
54	AMPRI	Asokan, P	J HAZARD MATER 2006, Vol 137, Iss 3, pp 1589-1599	1.544
55	CLRI	Aravindhan, R	J HAZARD MATER 2006, Vol 138, Iss 1, pp 152-159	1.544
56	IICT	Park, KH	J HAZARD MATER 2006, Vol 138, Iss 2, pp 311-316	1.544

ANNEXURE-III

Members of the CSIR Society (2003-2006)

1. Hon'ble Prime Minister of India
   Dr. Manmohan Singh
   Prime Minister's Office
   South Block
   New Delhi 110 011

2. Minister of Science & Technology
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   Office of the Vice-President, CSIR
   Council of Scientific & Industrial Research
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   New Delhi 110 001

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   (Shri P. Chidambaram)
   North Block
   New Delhi- 110 001

4. Minister of Commerce & Industry
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   Department of Industrial Policy & Promotion
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   Udyog Bhavan
   New Delhi 110 001

5. Chairman, CSIR Advisory Board

6. Member (Science)
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   (Dr. V.L. Chopra)
   Yojana Bhavan, Sansad Marg
   New Delhi 110 001

7. Principal Scientific Adviser to
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   (Dr. R. Chidambaram)
   Room No. 319
   Vigyan Bhavan Annexe
   Maulana Azad Road
   New Delhi 110 001

8. Chairman
   Science Advisory Council to PM
   (Prof. C.N.R. Rao)
   Chairman, CPMU & Linus Pauling
   JN Centre for Advanced Scientific Research
   Jakkur, Bangalore-560064

9. Chairman
   (Prof. Sukhdeo Thorat)
   University Grants Commission
   Bahadur Shah Zafar Marg
   New Delhi-11002

10. Ms. Kiran Mazumdar Shaw
    20th KM Hosur Road
    Electronics City
    Bangalore-560100

11. Shri N.R. Narayana Murthy
    Chief Mentor
    Infosys Technologies Ltd.
    Hosur Road
    3rd Cross, Electronics City
    Bangalore-561229

12. Shri B. Muthuraman
    Managing Director
    Tata Iron & Steel Company Ltd.
    Jamshedpur-831001

13. Chairman, ICICI
    (Shri K.V. Kamath)
    ICICI Bank Limited
    ICICI Tower
    Bandra, Kurla Complex
    Mumbai 400 051

14. Prof. P. Balaram
    Director
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19. Secretary
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20. Secretary
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21. Director General*
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22. Dr. Adarsh Kishore*
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Ministry of Finance
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23. Dr. Lalji Singh*
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24. Dr. S.R. Shetye*
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*Also member of CSIR Governing Body

ANNEXURE-IV

LIST OF NETWORK PROJECTS WITH NODAL LABS

1. Spearheading small civilian aircraft design, development & manufacture (NAL)
2. Exploration and exploitation of microbial wealth of India for novel compounds and biotransformation process (IMT)
3. Molecular biology of selected pathogens for developing drugs targets (CDRI)
4. Study of mesozoic sediments for hydrocarbon exploration (NGRI)
5. Pollution monitoring mitigation systems and devices (NEERI)
6. Asthmatic and allergic disorders mitigation mission (IICB)
7. Newer scientific herbal preparations for global positioning (IIIM-JAMMU)
8. Special electron tube technologies for large scale applications (CEERI)
9. Environment friendly leather processing technology (CLRI)
10. Comprehensive traditional knowledge digital documentation library (NISCAIR)
11. Catering to specialised aerospace materials (NAL)
12. Developing cells & tissue engineering (CCMB)
13. Toxicogenomics of polymorphism in Indian population to industrial chemicals for development of biomarkers (ITRC)
14. Designing animals and plants as bio-reactors for proteins & other products (CIMAP)
15. Development of catalysis & catalysts (NCL)
16. Developing green technologies for organic chemicals (IICT)
17. Acquisition of oceanographic research vessel (ORV) (NIO)
18. Impact of anthropogenic perturbations oceanographic-atmospheric processes in and around India in the context of global change (NIO)
19. Development of key technologies for photonics and opto-electronics (CGCRI)
20. Developing capabilities & facilities for microelectromechanical systems (MEMS) and sensors (CEERI)
21. Coal characterisation & resource quality assessment for end users (CFRI)
22. Developing new generation fuels & lubricants (IIP)
23. Positioning Indian nutraceuticals and neutrigenomics in a global platform (CFTRI)
24. Setting up a world class drug research institute (CDRI)
25. Predictive medicine using repeat and single nucleotide polymorphisms (IGIB)
26. Drug target development using in-silico biology (IGIB)
27. Animal models and animal substitute technologies (CDRI)
28. Developing new building construction materials and technologies(CBRI)
29. Mathematical modelling and computer simulation (C-MMACS)
30. Technologies for standardization of bioresources for and from leather (CLRI)
31. Custom tailored special materials (CGCRI)
32. Capacity building for coastal placer mineral mining (CMRI)
33. Upgradation of SI base units, national standards of measurements & apex calibration facilities (NPL)

34. Developing & sustaining high science & technology for national aerospace programmes (NAL)
35. Medicinal plant chemotypes for enhanced marker and value added compounds (CIMAP)
36. Globally competitive chemical processes and products (IICT)
37. Development of novel polymeric materials (NCL)
38. Development of techniques and methodologies for exploration, assessment and management of ground water in hard rock areas (NGRI)
39. Tectonic and oceanic processes along Carlsberg-central Indian ridge system and back arc basins (NIO)
40. Electronics for societal purposes (CSIO)
41. Industrial waste minimization and clean up (NEERI)
42. Quality enhancement of coal for its efficient utilization (CFRI)
43. Natural, nature identical or similar biomolecules (CFTRI)
44. Infectious diseases handling, storage and research facilities (CCMB)
45. Design analysis and health assessment of special structures including bridges (SERC)
46. New and improved road technologies (CRRI)
47. Establishing National science digital library (NISCAIR)
48. Consortium access to electronic journals (NISCAIR)
49. Establishing genetically modified foods referral facility (CFTRI)
50. Establishing advanced facility for safety evaluation of genetically modified/engineered drugs (CCMB)
51. Development of comprehensive technology for disaster prevention & management for Jharia coalfield (CMRI)
52. Biomineral processing for extraction of metal values from ores and concentrates (RRL-BHUB.)
53. Developing capabilities in advanced manufacturing technology (CMERI)
54. Technology for engineering critical assessment (NML)
55. Discovery, development and commercialization of new bioactives and traditional preparations (CSIRHQ.)

ANNEXURE-V

CAG Report

Unfruitful expenditure

Regional Research Laboratory (RRL), Bhubaneswar proposed to procure a High Temperature Contact Angle measuring system with molybdenum disilicide as heating elements. A German supplier quoted for the system with molybdenum silicon dioxide as the heating element instead of molybdenum disilicide. However, RRL did not notice the change in the quotation and placed the order on the firm for the system with molybdenum silicon dioxide as heating element in January, 2004. On receipt of the system in July, 2004, it was noticed that the heating system supplied by the firm was neither molybdenum disilicide nor molybdenum silicon dioxide but molybdenum oxide. RRL requested the supplier in October, 2004 to replace the equipment, which the latter refused to do. Neither had the matter been resolved with the supplier nor had RRL initiated any legal action against the supplier, with the result that the system costing Rs 24.04 lakh was lying uninstalled.

Avoidable expenditure

The Central Mechanical Engineering Research Institute (CMERI) identified its two units, Mechanical Engineering Research and Development Organisation (MERADO) at Chennai and Pune as poor performers and recommended their closure to the Council of Scientific and Industrial Research (CSIR) in August, 2001. However, on CMERI's instruction a purchase order for SMART-300 X-ray machine at a cost of Rs 17.17 lakh was placed in December 2001. CSIR instructed closure of MERADO Chennai and Pune in April, 2002. MERADO Pune also had a SMART-300 X-ray machine. The newly procured machine of MERADO Chennai was transferred to CMERI, Durgapur. CMERI did not explore the possibility of its utilization which led to avoidable expenditure of Rs 17.17 lakh.

ANNEXURE-VI

Full Text of the speech by Hon'ble Prime Mister of India and President, CSIR Society, Dr. Manmohan Singh during CSIR's Society meeting held on 10.01.07

"I am delighted to be with you today. Let me at the very outset pay tribute to the leadership provided by Dr Mashelkar to CSIR. Under his dynamic leadership, CSIR has been re-energised as an institution and the research record of CSIR institutions has improved. I must also compliment Dr Mashelkar for increasing the interface between the private sector and public sector in the R&D activity in our country. I hope CSIR's new leadership will further strengthen our country's R&D base.

One of Dr Mashelkar's contributions was to increase the number of patents filed by CSIR institutions. I compliment CSIR for this. However, we have a long way to go in catching up with other newly industrializing countries, especially China and the Republic of Korea, in IPR acquisitions - both quantitatively and qualitatively. CSIR must constantly review the quality, content and utility of its IPR holdings.

As I had indicated at the Science Congress last week, our Government is committed to increasing the spending on science in India. However, as Rashtrapathi Dr Abdul Kalam reminded the Science Congress the following day, we have to also improve the quality of spending and our ability to spend what is provided for.

Our decision to step up funding for science in India is both an opportunity and a challenge. We must be able to raise our ambitions sufficiently high to be able to make good use of the funds at our disposal. As the apex science body in the country, CSIR must take a lead in preparing an action plan for the Eleventh Plan period for utilizing the funds and raise the bar for all science departments. CSIR must also mobilize private funds. It is a matter of concern that internal receipts have virtually remained stagnant over the years. They need to pick up.

I am aware of the talent crunch facing Indian science in general and CSIR in particular. We must look at how CSIR can become more "market friendly" and "stakeholder friendly". If CSIR has to survive as a major force in civilian technology development, many radical changes are still required. Indeed, CSIR's charter itself requires a re-look. Interaction and collaboration with industry, especially private industry, has to become very much easier and simpler.

I also believe that we must strengthen CSIR's links with Universities. A greater synergy and collaboration between CSIR laboratories and the University system is absolutely necessary. These two parallel systems have largely remained disconnected. This must change. I do believe that our scientific enterprise and research activity should be rooted in the university system. The center of gravity of science and research in India has to move back closer to universities. However, for this to happen, our university system must also be reformed, restructured and rejuvenated. Universities must be more open to the free flow of talent so that research and teaching activity can develop together.

Both CSIR laboratories and our universities can benefit from a managerial reform that improves the efficiency of both administration and academic work. Good academics and scientists need not be good administrators and managers, and vice versa. We must be able to de-link administrative responsibility from leadership in R&D and academic work in all our research institutions.

CSIR must prepare itself to make the best use of new opportunities. Talent in today's

world is very mobile. Many leaders in the science and technology community are concerned about the loss of their scientists and engineers at all levels to private industry.

The questions before us are: how do we alter incentive systems and organizational structures to deal with this? How do we encourage younger talent to acquire a stake in our institutions? How do we de-bureaucratise and rid our institutions of academic feudalism? While hierarchies are inherent to organizations and necessary for efficient management, we must devise ways in which younger scientists and researchers feel free to pursue their work and secure remuneration without being hindered by administrative constraints. We can consider incentive payments related to the research productivity of scientists measured in terms of a variety of criteria. I believe there are already some arrangements in place for handling consultancy projects or selling intellectual property rights. Their efficacy can also be reviewed. This is an important issue that merits urgent consideration by our scientific community, the Government and domestic private sector companies.

I have often spoken of the need to take science to rural areas. I think we have a tremendous opportunity to leap frog in the race to development. Modern science and technology have much to offer in improving quality of life in rural areas. CSIR should have a special focus on this. I know that much work has been done in the area of water use, energy and bio-technology. We need to do much more to develop better water management technologies, both for domestic as well as agricultural use. These technologies should address the need for efficient and economical use of water at affordable costs. We also need to focus on achieving fresh breakthroughs in food production and improving food processing. As our incomes rise, there will be a rising demand for food products which we need to cater to. Same is the case for energy. We need new and innovative ways of meeting our energy needs. And not just on a pilot scale. But on a scale that matches the needs of vast, growing country like ours.

Finally, I am seriously concerned about widening regional disparities in the development of science and technology. We have tried to reduce this by funding new research institutions in States that are lagging behind. However, there is only a limited amount that the Union Government can do. What we need is massive investment at the bottom of the pyramid, not just in financial terms but in organizational and social terms, in the states lagging behind. This is a challenge for all.

I assure you that our Government will do all that is needed to support the development of science and technology in our country. But I also want our academic community and the private sector to respond to the challenges at hand."

ANNEXURE-VII

Full Text of the speech by Hon'ble Minister Science & Technology and Earth Sciences during CSIR's Foundation Day celebrations held on 26.09.06

"It is indeed a privilege for me to welcome our respected Prime Minister to the CSIR Awards Function to do the honours. He has never hesitated to support the scientific community in its hour of need and has always recognized the centrality of science & technology in developmental processes. Thank you Sir for being with us today and thank you for your encouragement. This time around, the CSIR has introduced one more national award that is for S&T Innovations for Rural Development reflecting the enhanced national concern for the disadvantaged sections of our society. The award is in addition to the two ongoing prestigious awards, the Bhatnagar Prizes in Science that are hailed as India's Nobel Prizes and the Diamond Jubilee Technology Award.

My hearty welcome to all the awardees and their associates and friends. I see in front of me a galaxy of luminaries from the Indian S&T community my sincere thanks to you for bestowing upon CSIR your blessings and good wishes. I also wish to welcome my friends from the media, who spread the much needed message of science and the achievements of our scientists, to our people.

Sir, it was exactly twenty years ago, in 1986, that Rajiv Gandhi, as President of CSIR labs was concerned with the disconnect between CSIR laboratories and the utilisation of their outputs. He, therefore, ordered a review of the functioning of CSIR and its laboratories. As a result, Rajiv Gandhi directed CSIR to be more customer oriented and to raise one third of its expenditure from outside of government grants. This was meant not only to enhance earnings but to inculcate financial accountability and make CSIR responsive to customer needs. Rajivji also hoped that this would motivate other scientific establishments to the discipline of commercial accountability.

Sir, I must congratulate CSIR for realising in ample measure this expectation of Rajiv Gandhi. Today, we find that CSIR's external cashflow exceeds Rs. 340 crore per annum of which nearly one-third is derived from the private sector. Sir, you will concede that CSIR's performance is all the more creditable in view of the fact that the investment by Indian industry in R&D is a dismal half-a-percent or so of their sales turnover. Who brought about this transformation? The credit for this goes to Dr. Mashelkar and the CSIR family. It all started with his pioneering report on 'Marketing of CSIR knowledgebase' submitted while he was still with NCL. Taking over as Director General, CSIR he implemented it with vigour and single-minded zeal. He successfully persuaded others to embrace the ideas of 'market responsiveness' and 'customer satisfaction' across the entire Indian S&T community. Today scientific institutions and agencies are vying with each other for raising external financial resources. A remarkable turnaround for Indian S&T.

As regards the utility of CSIR's research outputs, it enjoys an enviable position globally amongst all publicly funded institutions, particularly with respect to patents. I understand that its portfolio of over 1000 domestic and foreign live patents each is the highest in the world achieved by any publicly funded institution. Moreover, CSIR alone accounts for more than one third of all of the US patents granted to Indian inventors so far.

The credit for elevating CSIR to a position of such primacy must go to the painstaking efforts and perseverance of Dr Mashelkar who has over the years brought about patent literacy, competence building and management of IP. The turnaround commenced ten years ago with Dr Mashelkar enunciating the first ever Intellectual Property Management Policy, by any publicly funded R&D. Then came the victory for CSIR in the now famous 'Haldi (ghati) battle' at the USPTO; and more recently, with the international success in having 'Traditional Knowledge' included in the International Patent Classification System.

Remarkably, the transformation of CSIR to a 'market responsive' organisation has not been at the cost of excellence in science, as has occurred with most other publicly funded organisations in Europe, Australia & Africa. In the past decade, CSIR's science output as reflected by the number of publications has more than doubled with the quality of papers also improving from the average impact factor of 0.85 in 1995 to over 2 in 2005, comparing favourably with the best of Indian academic institutions. This is no mean achievement.

Sir, what has surprised me even more is the bagging of the first ever CSIR Award for S&T Innovations for Rural Development by the Central Leather Research Institute of CSIR. Dr Ramasami is unable to be here amongst us, nonetheless I congratulate him and his erstwhile team of committed and dedicated scientists at CLRI who have helped the disadvantaged sections of our society to vastly enhance their earnings and improve their quality of life. This brings to light a little known facet of CSIR's work for the common man.

There is no doubt Sir, that with these all-round accomplishments CSIR is a much admired research organisation both in India and internationally. However, the nation has still higher expectations from CSIR. We would like to see CSIR being challenged to rise to much greater heights and excel its own performance. This is enunciated by Dr. Mashelkar in his path setting White Paper on "CSIR 2021 : Vision & Strategy". The nation would like to see the external cash flow of CSIR to reach the level of Rs. 700 crore/annum with earnings of $ 40 million/year from foreign sources before the end of the Eleventh Five Year Plan. With committed leaders like Dr Mashelkar this is not beyond our grasp.

Once again, my hearty congratulations to the Awardees for their excellent achievements. You have done the nation proud. We all salute your success."

ANNEXURE-VIII

Full Text of the speech by Hon'ble Prime Minister of India and President, CSIR Society, Dr. Manmohan Singh during CSIR's Foundation Day celebrations held on 26.09.06

"I am very happy to be here today amongst a galaxy of scientists and each one of you are a nation-builder. I congratulate each of the awardees gathered here, and the staff and employees of the Council for Scientific and Industrial Research on the 64th Foundation Day of CSIR. As the President of CSIR Society, I am proud of the achievements of CSIR.

India can attain its rightful place in the comity of Nations and become a major pole of the evolving global economy only on the basis of a firm commitment to reason and rationality and the inculcation of what Jawaharlal Nehru used to describe as the scientific temper. Science and technology, therefore, have to be pace setters in our Nation's quest for a life of dignity and self respect for all our people and for us to attain our rightful place in the comity of Nations. I congratulate the winners of our most coveted science prize, the Shanti Swarup Bhatnagar Award. Since 1961, when Prime Minister Jawaharlal Nehru gave away the first of these prizes, these awards have acquired great prestige within the community of scientific researchers in our country.

I am heartened to learn that of the four hundred plus Bhatnagar prize winners, hardly any one have left the shores of our country and seeking employment abroad. This is indeed really commendable. I hope this year's awardees will also dedicate themselves to the service of India through their commitment to the promotion of science and technology in our country.

I also take this opportunity to congratulate Tejas Networks and the Central Leather Research Institute. I understand that CLRI's work has influenced the livelihoods of about 1.4 million people in the Indian leather sector. May your example prove a pace setter in using science and technology to serve our Nation's goals and objectives.

What are the big challenges that Indian science & technology face today? On the supply side, we have to enhance the supply of skilled scientists and technologists. This needs to be done through a judicious balancing of 'expansion', 'inclusion' and 'excellence'. On the demand side, we have to promote 'technology-led accelerated inclusive growth'. Let me elaborate on these challenges.

Numbers is the first issue. I understand that we have only 157 scientists and engineers per million people involved in Research & Development. Korea has 50 times more and United States and Japan have over 30 times more! Quality and output is yet another issue. In ten years, I have been told China has overtaken India in the number of scientific research papers published in the internationally peer reviewed journals. In fact they publish three times our numbers.

Our Government is determined to ensure an expansion of supply, demand and productivity in the area of Science & Technology. After a gap of a hundred years, we are now setting up three new Indian Institutes of Science, Education and Research (IISERs). Each of these institutes will be unique in terms of integration of science education and research.

Our best minds are not turning to science, and those who do, do not remain in science. This is a common refrain whenever I meet with the Scientific Advisory Committee to the Prime Minister. We must therefore find ways and means of making these disciplines more attractive to our children and to our young. We have to

redesign school and college education to build on the natural curiosity of our children. We must also maintain the excellence of current institutes of higher learning, who have already been recognized globally. This can be achieved only through the recruitment of the very best faculty. We must create an environment conducive to the pursuit of excellence. It might appear that expansion, inclusion and excellence are mutually contradictory objectives. I do not think so. With determination and with some innovation, I am sure we can harmonize these objectives and this we must do.

The process of expansion must also be inclusive and relevant. Our real challenge seems to be to get the best minds in India to engage in providing practical pragmatic solutions to our many fold social and economic problems. Can you imagine the impact if we had a good vaccine for malaria? Can we imagine what impact a breakthrough in low cost fuel cells and photovoltaics for decentralized power supply can have on the life of our people? We must therefore find ways and means by which the best scientific minds in India could be ignited to tackle these basic societal challenges. Science & Technology have an enormous potential to enable us to meet the basic human needs of our people. We have therefore to make determined efforts to harness the vast latent potential in full measure.

It's often said that we live today in an increasingly interdependent world in which science and technological knowledge is growing at an unprecedented pace. International cooperation in science and technology development therefore offers exciting opportunities in this globalised world that we live in. We need therefore coordinated international efforts to address common technological issues. Countries could cooperate in meeting the energy needs of the world; in tackling disease; in using technology for better education; and in meeting the food requirements of the growing population of the world. These are only illustrative examples. There could be many more. We need to explore mechanisms for making cooperative global efforts possible and relevant.

We ought to take note also of the growing privatization of science and technology in the advanced developed countries. Multinational corporations are playing today an increasing role in the generation of new knowledge in areas such as biotechnology, pharmaceuticals, information technology and energy. The challenge before the world community therefore is to find more pathways to sustain adequate incentives for the generation of new knowledge and simultaneously to make the fruits of this knowledge available at affordable prices to the poorer countries in the world. We need global action to harmonize these twin requirements.

In this context, the international system for the protection of intellectual property rights needs to be adequately sensitive to both these concerns. Advances in science and technology have made a powerful contribution to globalization of the world economy. The challenge ahead is to ensure that the evolving global economy is so managed that it promotes the interests of all countries, rich and poor. Time is ripe to evolve concerted strategies to make globalization and the knowledge revolution that is propelling it a win-win situation for the entire humankind. India ought to be in the forefront of intellectual efforts to find meaningful and purposeful solutions to these global concerns.

wish to congratulate once again all the award winners who have distinguished themselves in their respective fields. I hope they will continue to be inspired to scale new peaks of excellence.

To Dr. Mashelkar, I have to say you have served our country and the cause of science and technology with the greatest distinction. On behalf of our people and our Government, I wish to convey to you our grateful regards. We all are proud of your achievements but I conclude by expressing the hope and prayer that perhaps we have not seen the best of you still - the best is yet to come. May your life and work continue to inspire generations of scientists and technologists in our country."

CSIR ESTABLISHMENTS

AMPRI	Advanced Materials and Processes Research Institute, Bhopal -462 026, www.ampri.res.in
CBRI	Central Building Research Institute, Roorkee -247 667, www.cbri.org
CCMB	Centre for Cellular and Molecular Biology, Hyderabad-500 007, www.ccmb.res.in
CDRI	Central Drug Research Institute, Lucknow -226 001, cdriindia.org
CECRI	Central Electrochemical Research Institute, Karaikudi -623 006, www.cecri-india.com
CEERI	Central Electronics Engineering Research Institute, Pilani -333 031, www.ceeri.res.in
CFTRI	Central Food Technological Research Institute, Mysore-570 020, www.cftri.com
CGCRI	Central Glass and Ceramic Research Institute, Kolkata -700 032, www.cgcri.res.in
CIMAP	Central Institute of Medicinal & Aromatic Plants, Lucknow -226 015, www.cimap.res.in
CIMFR	Central Institute of Mining & Fuel Research, Dhanbad -828 108, www.cmriindia.org
CLRI	Central Leather Research Institute, Madras -600 020, www.clri.org
CMERI	Central Mechanical Engineering Research Institute, Durgapur -713 209, www.cmeri.org
CRRI	Central Road Research Institute, New Delhi -110 020, www.crridom.org
CSIO	Central Scientific Instruments Organisation, Chandigarh -160 030, www.csio.nic.in
CSMCRI	Central Salt & Marine Chemicals Research Institute, Bhavnagar -364 002, www.csmcri.org
IGIB	Institute of Genomics & Integrative Biology, Delhi -110 007, www.igib.res.in
IHBT	Institute of Himalayan Bioresource Technology, Palampur -176 061 (HP), www.ihbt.org
IICB	Indian Institute of Chemical Biology Jadavpur, Calcutta -700 032, www.iicb.res.in
IICT	Indian Institute of Chemical Technology, Hyderabad -500 007, www.iictindia.org
IIIM	Indian Institute of Integrative Medicine, Jammu Tawi -180 001, www.iiim.org
IIP	Indian Institute of Petroleum, Dehradun -248 005, www.iip.res.in
IMMT	Institute of Minerals and Materials Technology, Bhubaneshwar -751 013, www.rrlbhu.res.in
IMTECH	Institute of Microbial Technology, Chandigarh -160 036, www.imtech.res.in
ITRC	Indian Toxicological Research Centre, Lucknow-226 015, www.itrcindia.org
NAL	National Aerospace Laboratories Bangalore -560 017, www.nal.res.in
NBRI	National Botanical Research Institute, Lucknow -226 001, www.nbri-lko.org
NCL	National Chemical Laboratory, Pune -411 008, www.ncl-india.org
NEERI	National Environmental Engineering Resarch Institute, Nagpur -440 020, www.neeri.nic.in
NEIST	North-East Institute of Science and Technology, Jorhat -785 006. www.rrljorhat.org
NGRI	National Geophysical Research Institute, Hyderabad -500 007, www.ngri.org.in
NIO	National Institute of Oceanography, Goa -403 004, www.nio.org
NIIST	National Institute for Interdisciplinary Science and Technology, Thiruvananthapuram -695 019, www.niist.csir.res.in
NISCAIR	National Institute of Science Communication And Information Resources , New Delhi-110012, www.niscair.res.in
NISTADS	National Institute of Science Technology and Development Studies, New Delhi-110012 ,www.nistads.res.in
NML	National Metallurgical Laboratory, Jamshedpur-831 007, www.nmlindia.org
NPL	National Physical Laboratory, New Delhi -110 012, www.nplindia.org
SERC	Structural Engineering Research Centre, Chennai -600 113, www.sercm.org

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