III. AUTONOMOUS BODIES

III - A. COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH

1. INTRODUCTION

The Council of Scientific and Industrial Research, a multilocational network of national laboratories/institutes, has the mandate to undertake research and development projects in diverse fields of science and technology, with emphasis on applied research and utilization of results thereof. There are at present 38 research establishments including five regional research laboratories. Some of the establishments have also set up experimental, survey field stations to further their research activities and 39 such stations attached to 16 laboratories are functioning at present.

2. S&T CONTRIBUTIONS

CSIR during the Tenth Five Year Plan has undertaken major network projects across CSIR laboratories. The aim of the projects evolved is to synergise the vast competencies developed over the years in CSIR laboratories and to implement them in a network mode. The following sections record some of the significant achievements, both under network and non-network modes.

2.1 Aerospace Science & Technology

NAL is a major player in India's aerospace programmes. Some of the significant achievements project-wise are as follows:

NETWORK PROJECTS

Catering to Specialized 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. Significant progress has been made in developing low cost carbon fibres. Some variants of the pressure sensitive paints have been developed, two of which can withstand 50 blow downs in the NAL high-speed wind tunnel without any performance deterioration.

High Science & Technology for National Aerospace Programmes

Application of pressure sensitive paints as a diagnostic tool for complex and 3D separated flows at high speeds has been found to be very satisfactory. Numerical techniques have been developed for modeling multiple damages in smart composites. Fabrication techniques for manufacture of glass epoxy composites (flat and cylindrical) using combination of braiding and resin injection has been demonstrated. Algorithms for on-line flight data/path reconstruction and parameter estimation, multi sensor and multi target tracking and fusion have been developed. Air Traffic Models have been simulated for Airports like Bangalore International Airport and Cochin International Airport.

Spearheading Small Civilian Aircraft Design, Development & Manufacture

The objectives of the project are to design and develop stretched HANSA; civil aircraft R&D, civil aviation & policy, research & market analysis; indigenous development of critical LRUs with particular relevance to small aircraft; and weight optimization and

other improvements of SARAS to production standards. Configuration of the 4-seater aircraft (HANSA stretched version) has been finalized. Landing gear actuator was designed and fabricated. Assembly jigs for weight optimised structure for SARAS were designed.

NON-NETWORK PROJECTS

Boron Nitride Based Components for Strategic Applications

CGCRI is the only organization in India, which makes hexagonal boron nitride (h-BN) based components starting from the preparation of the raw boron nitride powder and consolidating it in the desired shapes as per the requirements of the end user. h-BN has some special properties including machinability, high thermal conductivity and low electrical conductivity. Composites based on h-BN have very good abrasion resistance properties. Boron nitride-silica components have been supplied to ISRO, Bangalore for application in Hall Effect thruster assembly for space craft propulsion. Boron nitride powder was synthesized in the Institute's pilot plant.

Wind Turbine Blade

NAL has developed fabrication techniques for manufacture of large FRP blades for harnessing wind energy. Fabrication of two blades (one set) for a 300kW wind turbine was completed during the year and blades were under field testing at M/s. Sangeeth Group, Coimbatore.

Domes for Air Combat Simulator

NAL has completed the fabrication and trial assembly for the first of the two domes of HAL's Air Combat Simulator project. These 9m diameter twin domes will be used by IAF for housing Combat Simulators for training of combat pilots under simulated conditions.

Acoustic Test Facility

CARTOSAT I (IRS P5) FM, a remote sensing satellite of ISRO was tested for qualifications at the Acoustic Test Facility of NAL. This satellite has since been launched and is presently in orbit. This constitutes a major input to the Indian Space Programme.

2.2 Biology & Biotechnology

CSIR has emerged as 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, bio markers, bio molecules etc. Some of the major accomplishments are provided below.

NETWORK PROJECTS

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 ultimate goal of its commercial exploitation as a major source of biotechnological products and processes. The technology "Biotransformation of nicotinic acid into 6-hydroxyl nicotinic acid" has been transferred to an industry (M/s Jubilant Organosys Ltd.,). 15 metagenomic libraries have been made and are being screened.

Developing Cell & Tissue Engineering

A free cell system (Plant systems**)** for induced expression of shikonins has been established for large-scale production of this colorant. A new vector system for the anti-rabies vaccine in tobacco plant has been developed, which

produces a protein that induces a protective immune response in mice. A glass fermentor based growth of *Swertia chirata* and *Rauwolfia serpentina* has been achieved in the lab and the technology is to be transferred to the field. In Animal systems**,** Cybrids of dendritic cells and infected macrophages, and a DNA vaccination system have been developed to obtain protective immune response in experimental animals against Leishmania. A new diagnostic system, using O-AcSG and anti-achetenin-H antibodies, for diagnosis of childhood acute lymphatic leukemia has been developed. Proteomic characterization of side population stem cells from bone marrow of rats and mice has been done and these cells have been transplanted in chronic and acutely damaged liver models.

Toxicogenomics of Polymorphism in Indian Population to Industrial Chemicals for Development of Biomarkers

Transcription profiles, 'molecular signatures' were determined after toxic exposure to the model compounds lead and poly-aromatic hydrocarbons. Single nucleotide poly-morphism was identified in various genes that influence the toxicity of arsenic in the affected population. 'Microsomal epoxide hydrolase' genotypes were identified that are a risk factor for lung cancer in north Indian population. Blood proteomic biomarkers were identified that are significantly altered after exposure to lead or arsenic.

Medicinal Plant Chemotypes for Enhanced Marker and Value Added Compounds

Sufficient genetic base for variability with respect to targeted chemoprofiles for chemovar development has been established/ generated for all the plants except for Commiphora and Swertia. Several new marker molecules have been identified in *Chlorophytum, Podophyllum, Swetia, Andrographis and Bacopa*. Also new bioactive derivatives of major markers have been developed in *Acorus, Picrorhiza and Andrographis*. Chemovars of *Artemisia, Andrographis, Chlorophytum, Bacopa* developed and released for commercial cultivation by Indian farmers/drug industry. Seven pathway/metabolite specific genes have been identified and sequenced in *Catharanthus* and *Picrorhiza* for metabolic engineering work.

Development and Commercilisation of New Bioactives and Traditional Preparation

Around 16000 samples (12000 plants and~ 4000 microbial) have been screened for various diseases. Presently, there are 65 discovery groups on promising entities for 20 disease conditions. Out of 65 discovery groups 13 groups have reached advanced stages of single molecules (9 samples) and herbal preparations (4 samples). The four herbal formulations are for ulcer, dementia and cancer and nine single molecules are for cancer, dementia, hypertension, leishmania, hepatoprotective and immunostimulatory.

NON-NETWORK PROJECTS

Effect of αB-crystallin on Amyloid Fibril Formation

CCMB studied the structure-function relationship of αB-crystallin and the role of phosphorylation in its chaperone activity towards amorphous aggregation as well as ordered amyloid fibril formation of peptides and proteins. The expression of αB-crystallin is known to be elevated in several neurodegenerative diseases including Parkinson's and Alzheimer's diseases. Study showed that αB-crystallin can prevent the fibril formation of Aβ-peptides which are known to be involved in the Alzheimer's disease. Phosphorylation-mimicking muta-

tions of αB-crystallin result in significant increase in its chaperone activity towards amorphous aggregation of proteins, but not towards amyloid fibril formation, indicating phosphorylation-state specific interaction of αB-crystallin.

A Novel Chemoselective Method for the Formylation of Sterols

CIMAP has developed a novel method for the formylation of secondary sterols. Vilsmeier reagent (DMF-$POCl_3$) was used as an efficient formylating agent. The reaction is simple, efficient and in mild reaction conditions (10^oC to room temperature) gives formate esters in good yields (40-91%). Other functional groups such as phenol, aldehyde, acetate and aryl methyl ether were found intact under the reaction conditions. Thus, this reaction may be useful in the synthetic steroidal chemistry where the protection of secondary alcoholic group is required.

Complete Genome Analysis of Lily and Geranium Viruses

IHBT amplified and sequenced the complete genome of an isolate (Ll) of *Cucumber mosaic virus (CMV)* from lily (*Lilium longiflorum*) with the help of internal primers designed using conserved regions of the whole genome. The information on the genome of these viruses will help to develop strategies to combat the viral diseases in lily and geraniums in order to propagate disease-free material for production of quality flowers.

"HIMBALA" and "HIMKACHARI"

IHBT has developed one composite cultivar of *Valeriana jatamansi* "HIMBALA" suitable for cultivation in western Himalaya at locations situated above 1300 m altitude and one cultivar of *Hedychium spicatum* "HIMKACHARI" suitable for locations situated around and above 1300 m altitude. The average yield of dry roots of "HIMBALA" is 1 t/ha 2 years after planting. Roots contain about 4 % valepotriates (dry matter basis) and 0.4% essential oil in fresh roots. The average yield of fresh rhizomes of "HIMKACHARI" is 12 t/ha 2 years after planting. Rhizomes contain 0.75 % essential oil on dry weight basis.

Targets for Human Encoded Micrornas in HIV Genes: A Bioinformatics Approach

IGIB has reported, for the first time, screening of HIV-I genome computationally using human micro RNAs for identifying targets. MicroRNA expression profiles from microarray-based experiments have shown that these potential antiviral human microRNAs are expressed in T cells, the normal site of infection of HIV-I virus. These mRNAs also showed differences in expression from person to person implying that these levels could predict susceptibility to the virus. Human micro RNAs can target crucial HIV-1 genes including the *nef* gene, which plays an important role in delayed disease progression.

BOD Biosensor

IGIB has developed biochemical oxygen demand (BOD) sensor, which determines BOD in 10 minutes and provides a novel and quick estimation of biochemical oxygen demand of wastewater. BOD measurement of wastewater using this process is rapid, reproducible and effective as compared to conventional titration based method.

Trichoderma Harzianum as Biopesticide and Biofertilizer

NBRI has developed a formulation of *Trichoderma harzianum*, which can be used as biopesticide and biofertlizers. The

formulation not only controlled most of the soil borne diseases but also increased the yield of several test crops like sunflower, mustard, soybean, chrysanthemum etc. In addition, the biochemical characteristics of mustard also showed a significant improvement over control treatments.

Withania Somnifera: Hybridization of Contrasting Morpho- & Chemo- types

RRL-Jammu has incorporated desired traits like higher leaf biomass and *Withaferin*-A in a few F_1 hybrids produced in which 300 crosses between two contrasting elite accessions of *Withania somnifera* (AGB002 x AGB025). Reproductive effort (RE2) exhibited higher value in cultivated morphotype AGB 025 (24.52%) than the wild morphotype AGB 002 (11.75). In this highly self-pollinated crop, differences in percent fruit set, seed set and germination between autogamy and xenogamy were found to be statistically significant ($P<0.01$). Tissue culture procedure has been standardized for recovery of putative hybrids. The procedure developed was utilized for recovery of plantlets via axillary shoot proliferation. The regenerated plants were transferred to soil after hardening under Green house conditions.

New chemotypes of Cymbopogon Flexuosus

RRL-Jammu has reported for the first time, two novel pharmacologically active chemotypes of *Cymbopogon flexuosus* (Nees ex Stend.) Wats namely RRL(J)CF HSR and RRL(J)CF HP rich in (+)-1- bisabolone (30-40%) and isointermedeol rich (20-30%). Essential oil as well as isolated (+)-1-bisabolone from RRL(J)CF HSR exhibited strong antibacterial activity (*in-vitro*) against Gram positive bacteria such as *Bacillus ceresus*, *B.subtalis* and *Straphylococcus aureus*. Essential oil as well as pure isolated isointermedeol from RRL(J)CF HP exhibited anticancer activity.

Remediation and Management of Coal Mining Waste Land of North Eastern Coalfields of Margherita

RRL-Jorhat has undertaken the i*n-situ* remediation study of overburden dumping site due to coalmine activity of North Eastern Coal Fields, Margherita. Herbaceous plant species (*Axonopus compresus*), Monocot species *Eupetorium*, some wild bamboo species, essential oil bearing plants Citronella and lemon grass, *Lianes Mimosa*, *Mugo, Dhanshya* and Tree species *Gomari* (*Gmelina arborea*), Sisso (*Delbergia sisso*) were screened to cultivate in coalmine overburden dumping site. It was observed that the plant growth promoting rhizobacteria (PGPR) mediated plant growth and survival was enhanced. The population density and microbial biomass of the experimental plot were also enhanced.

2.3 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. Some of the significant achievements in network and non-network projects are presented below:

NETWORK PROJECTS

Development of Catalysis and Catalysts

A novel catalyst system has been developed for converting epoxides (like ethylene oxide, propylene oxide styrene oxide) and CO_2 to cyclic carbonates. The work has been scaled up to bench level.

Developing Green Technologies for Organic Chemicals

Extraction and isolation of Artemsinin in 5Kg batch was achieved. Development and demonstration of process for organoflouro compounds such as Trifluoroethanol, Heptafluoropropane (FM200), 1,1,1-trifluoro-2-2- dichloroethane (HFCFC- 123) and preparation of perfluoroisobutyric acid by Electro Chemical Fluorination (5Kg) was carried out.

Globally Competitive Chemicals, Processes and Products

The project 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. Upscaling of Taxol side chain and Diltiazem using supported catalysts achieved 50g and 100g batch of isonicotinamide and INH were standardized up to 95% yield of high purity INH.

Development of Novel Polymeric Materials

Copolymers of n-alkyl methacrylates and n-alkyl fumarates with controlled architecture were synthesized by Atom Transfer Radical Polymerization (ATRP). Tailor made (meth) acrylate based additives were evaluated on waxy Indian crude oils as pour point depressants. Synthesized polymers were evaluated on Safrai and Borholla crude oils of M/s Oil & Natural Gas Commission Ltd. as pour point depressants.

NON-NETWORK PROJECTS

Fouling Resistant Membranes in Desalination and Water Recovery

CSMCRI has prepared low molecular weight cut off (MWCO<1000 Da) polyethersulfone nanofiltration membranes and polyamide brackish water thin film composite membranes containing negatively charged and/or neutral hydrophilic functional group on the surface by surface modification of the membranes by *in situ* redox polymerization of acrylate monomers. The NF membranes exhibited separations of 68–85% for Na_2SO_4, 19–31% for $MgSO_4$, 10–26% for NaCl and 2–12% for $CaCl_2$ with water permeation rates of 10–50 l/m^2 h at the operating pressure of 4 kg/cm^2 for 2000 ppm feed solution. The NF membranes were tested for water recovery from reactive dye effluents containing solutes sizes in the range of 600–1000 Da along with salt solution and were found to reject the dyes >99%.

Enhancement of Anti-tubercular Activity of Extract of Salicornia Brachiata

CSMCRI has reported enhancement of anti-tubercular activity of active fraction isolated from *Salicornia brachiata*. The invention also discloses the non-toxic nature of the fraction and positively identifies sucrose as its main constituent. Pure sucrose is shown to have no anti-tubercular activity indicating thereby that activity of the fraction resides in one or more of the minor constituents.

Catalytic Oxidation of Styrene with Molecular Oxygen using Metal Ion Exchanged Zeolites

CSMCRI has carried out catalytic epoxidation of styrene to styrene oxide with molecular oxygen using cobalt containing zeolite. Catalytic epoxidation of styrene-to-styrene epoxide was achieved using molecular oxygen in presence of Co^{2+} exchanged zeolites. Molecular oxygen from air is also useful for the epoxidation reaction at atmospheric pressure. The presence of adsorbed water molecules in the catalyst also increases the styrene conversion without

affecting the styrene oxide selectivity. Various alkali and alkaline earth cationic promoters were introduced into the zeolite catalyst to increases the styrene oxide selectivity.

Defluoridation of Ground Water in Nalgonda District

IICT designed and installed a Reverse Osmosis (RO) pilot plant for generation of drinking water from a ground water source containing 5 ppm of fluoride in Myalaram Village, Nalgonda, Andhra Pradesh. The pilot plant produces 600 litres/hr of fluoride-free drinking water at an operating pressure of 8 kg/cm^2. The water containing <0.5 ppm of fluoride and about 20 ppm of total dissolved solids (TDS) which constitute essential nutrients required by humans, is produced from the raw water containing 1200 ppm of TDS. The rejection of total dissolved solids is ~98% and fluoride 92%.

Oxidation of Alcohols and Vic-diols with H_2O_2 Using Catalytic Amounts of n-methyl-pyrolidin-2-one Hydrotribromide

IIP has developed a methodology, which is highly efficient for the oxidation of various secondary, primary alcohols and 1,2-diols to corresponding ketones, aldehydes and 1,2-diketones respectively using catalytic amount of MPHT and hydrogen peroxide as oxidant. A variety of secondary alcohols, 1,2-diols and primary alcohols were selectively oxidized in excellent yields to their corresponding ketones, 1,2-diketones and aldehydes with aqueous 30 % hydrogen peroxide in refluxing acetonitrile in presence of catalytic amount of N-methylpyrrolidin-2-one hydrotribromide (MPHT).

Open-frame Networks in Coordinated Polymers Through Hydrogen Bonds

NCL used 3,5-dinitro-4-methylbenzoic acid to study the influence of both the types of bonds, carboxyl group (-COOH) and hydrogen bonds by the nitro ($-NO_2$) and methyl ($-CH_3$) groups, on the resultant assemblies. Single crystals in the form of golden yellow needles, obtained from the hydrothermal methods (synthesis at elevated temperature and pressure), revealed the formation of a porous assembly stabilized by C–H···O hydrogen bonds, as characterized by single crystal X-ray diffraction. The channels thus formed were occupied by six water molecules, which were held to the host network through O–H···O hydrogen bonds. The thermal studies and powder X-ray diffraction analysis revealed that this assembly is stable up to 300^o C even after loosing the guest water molecules. Further, the reactions with some aza-donor ligands like, 4,4'-bipyridyl, 1,2-bis (4-pyridyl)ethane and 1,2-bis(4-pyridyl)ethene, also yielded host guest assemblies, with the aza-donor compounds acting as the guest species.

Enantioselective Total Synthesis of Microcarpalide and Sapinofuranone B

NCL developed a practical and efficient total synthesis of two very important molecules, microcarpalide and sapinofuranone using a common intermediate and asymmetric catalysis. The salient structural features associated with microcarpalide are the presence of a *trans*- double bond at C7-C8 and four stereogenic centres. The synthetic strategy devised at NCL for microcarpalide is based on a convergent approach, which utilises 1,4-butanediol as one of the common achiral starting materials to synthesize both the target compounds. The asymmetric dihydroxylation has been executed to generate all the stereogenic centres in high enantioselectivity. The regioselective opening of an epoxide with various nucleophiles to establish exclusively the trans-olefin geometry and Yamaguchi protocol to achieve the lactone moiety were employed as the key steps.

Detergent Alcohols

NCL has developed a new iron based catalyst, which could oxygenate linear higher alkanes using tert-butyl hydroperoxide to ketones and alcohols primarily. With dodecane, the catalyst gave about 20% conversion of the alkanes with ketone and alcohol selectivity in the range of 60–70%. The catalyst was also efficient for the oxidation of other linear alkanes in the range C_{10} to C_{16} and even commercially available alkane mixtures were oxygenated to corresponding secondary alcohols and ketones. This catalyst was also prepared on granular supports so that a continuous operation could be feasible. A supported Pd catalyst has also been developed which is also active and selective in the oxidation of higher alkanes to alcohols and ketones. The synthesis of tert amyl hydroperoxide was also standardized and catalysts were developed for the oxidation of isopentane to TAHP in good yield.

Self-Assembled Nanotapes of Oligo (p-phenylenevinylene)s: Sol–Gel-Controlled Optical Properties in Fluorescent p-Electronic Gels

RRL-TVM. Has reported a rationale approach to the design of supramolecular organogels of all-*trans* oligo (*p*-phenylenevinylene) (OPV) derivatives, a class of well known organic semiconductor precursors. Self-assembly of these molecules induced gelation of hydrocarbon solvents at low concentrations (<1 mM), resulting in high aspect ratio nanostructures. Electron microscopic and AFM studies revealed twisted and entangled supramolecular tapes of an average of 50-200 nm in width, 12-20 nm in thickness and several micrometers in length. The hierarchical growth of the entangled tapes and the consequent gelation is attributed to the lamellar type packing of the molecules, facilitated by cooperative H-bonding, π-stacking and van der Waals interactions of the OPV units. Gelation of OPVs induced remarkable changes in the absorption and emission properties, which indicated strong electronic interaction in the aggregated chromophores.

Transcription and amplification of molecular chirality to oppositely biased supramolecular π-helices

RRL-Tvm has illustrated the "sergeants and soldiers" approach with the help of gel forming chiral and achiral oligo(*p*-phenylenevinylene)s to induce helicity to co-assembled π-gels. The induction of chirality occurs through inversion of helicity resulting in opposite handedness with mirror image CD spectra at very low composition of the sergeants. During the process an unprecedented formation of mutated diastereomers with fused *M*- and *P*- helices were observed. These phenomena were supported by the CD spectral studies and AFM morphological images. It is the first visual evidence for the formation of supramolecular diastereomers and stereomutated π-helices originated from common chiral centres through AFM techniques, which are complemented by circular dichroism spectroscopy.

2.4 Earth Resources & Natural Hazards Assessment

Two CSIR laboratories NGRI and NIO are exclusively devoted to R&D for earth resources.

NETWORK PROJECTS

Study of Mesozoic Sediments for Hydro-Carbon Exploration

Magnetotelluric data acquisition at 111 stations have been completed. Preliminary processing and modeling for 75 stations have also been completed and presented in a

national seminar in IGU annual meeting, Bhopal, 2005. Gravity Data acquisition of 4700 (2000+2700) stations in Central India is complete. The gravity base data is processed and loop errors are calculated. Thirty-one deep resistivity soundings measurements for delineation of Mesozoic basins in areas covered by Deccan Traps in the eastern part of Deccan Syneclise area carried out. Prefield reconnaissance survey of seismic refraction studies along 300km has been completed. Bathymetry and shallow seismic data acquired in Gulf of Kutch and data analyzed.

Development of Techniques and Methodologies for Exploration, Assessment and Management of Ground Water

Fracture delineation of 96 geo-electrical soundings in about 63 sq km area was carried out which has predicted the thickness of weathered / fractured zone from 1.6 to 48.5 m below ground surface. Likewise natural recharge rate was evaluated for tracer-injected sites of Wailapalli and Ghatiya watersheds of Andhra Pradesh. Geochemical maps showing the distribution of fluoride and uranium have been prepared which show very high concentrations of fluoride in rocks and soil samples. Resource-cum-recharge well with a dia of 8 m and depth of 15 m and a capture well developed. Interpretation of geophysical investigations has been carried out to delineate aquifer zones on the island.

Tectonic and Oceanic Processes Along Indian Ridge System and Back Arc Basins

Multi-disciplinary investigations have been conducted along the Carlsberg and Central Indian Ridge segments in the Indian Ocean by undertaking two cruises on board ORV Sagar Kanya. During these oceanographic expeditions of SK-201 and SK-207, about 11,176 km swath bathymetry, seabed sampling at 14 locations, and water column data at 55 locations has been acquired. Extraction of Helium from water samples and analysis for $^{3}He/^{4}He$ ratio were attempted for the first time on especially collected samples. New insights into the tectonic evolution of the Andaman basin have been provided based on the integrated analysis and interpretation of multibeam bathymetry, magnetics, and seismological data. These results provided, for the first time, information about the topographic fabric and the tectonic configuration of the backarc spreading center. Younger age of opening to the backarc basin than the previously proposed ages was suggested.

NON-NETWORK PROJECTS

Overpressure Detection from Seismic Amplitude Versus Offset (AVO) Response: An Application to Gas Hydrates

The high overpressure in the free-gas zone underlain by gas-hydrated sediments changes the seismic velocity and hence affects the AVO response appreciably. Therefore the effect on AVO due to overpressure is to be evaluated before making quantitative assessment of gas-hydrates. Besides, knowledge of overpressure helps in planning the drilling process to avoid potential geo-hazard due to abnormally high pressures. The AVO response of both P-P and P-S reflections from BSR for possible detection of overpressure in the free-gas-bearing zone is estimated. The theoretical computation shows that high and negative AVO anomalies for P-P reflected waves indicate a high overpressure condition.

Exploration of Puga Geothermal Field, Ladakh Using Magnetotellurics

NGRI has carried out wide band (1000 Hz - 0.001 Hz) magnetotelluric (MT) study to understand the crustal electric structure of the Puga geothermal field located in the Ladakh Himalayas. The time series measured at

35MT sites, distributed along three parallel profiles covering the geothermal field, is processed to obtain the best MT transfer functions at every site. The modeling studies show a surface low resistive (5-25 Ohm-m) region of ~ 400 m thick, correlating well with the thermal manifestation in the area, and an anomalous conductive zone (~ 10 Ohm-m) commencing at a depth of ~ 2 km. The possible presence of potential geothermal resources makes the area for significant exploitation of geothermal energy.

Constraints in Using Cerium-anomaly of Bulk Sediments as an Indicator of Paleo Bottom Water Redox Environment

NIO has revealed that the total rare earth elements abundance in a 5 m long sediment core from the Central Indian Ocean Basin shows nearly two fold increase (167-314 ppm) with the core depth and strongly co-varies with Mn, Ti, P and smectite content. The cerium (Ce)-anomaly in marine sediments is used as one of the promising tools to trace paleo bottom water redox conditions. The Ce-anomaly is positive in the top 4 m and negative between 4 and 5 m of core, suggesting oxic and suboxic environments respectively. The redox condition inferred by the Ce-anomaly is compared to a number of other redox sensative parameters to test its realibility. These include Mn content, total organic carbon, U/Th, authigenic U, Cu/Zn and V/Cr ratio that all are suggestive of deposition of sediment under oxygenated bottom water conditions. Thus, the negative Ce-anaomaly observed between 4 and 5 m core depth does not represent a suboxic environment, but more likely is due to the retention of a negative Ce-anomaly caused by the presence of authigenic phosphate and Fe-rich smectite. Therefore, it is suggested that the Ce-anomaly of bulk sediments as an indicator of paleo ocean bottom water redox conditions needs to be used with a caution.

Influence of Diatom Exopolymers and Biofilms on Metamorphosis in the Barnacle Balanus Amphitrite

NIO investigated the influence of diatom (Bacillariophyceae) films and EPS (>1000 molecular weight) on metamorphosis in the acorn barnacle *Balanus amphitrite* Darwin, a dominant fouling organism, using axenic and non-axenic films. It was observed that the EPS produced by diatoms are of similar nature, however, the proportion of monosaccharides varies with species, indicating a potential role for influencing larval metamorphosis.

2.5 ECOLOGY & ENVIRONMENT

CSIR has been a major contributor in providing S&T inputs to evolve national policies and to ameliorate environmental problems. Significant scientific achievements are outlined below.

NETWORK PROJECTS

Pollution Monitoring, Mitigation Systems and Devices with Applications to Environmental Assimilative Capacity in Select Regions

The project envisages developing innovative sensors, indicators and instruments for pollution monitoring and study of assimilative capacity of environmental media for pollution mitigation. Environmental assimilative capacity of following select regions was estimated. Central India - Part of Chhindwara, MP and Nagpur, Maharashtra, Northern Indian Hilly Terrain- Bilaspur-Sundarnagar-Mandi region in Himachal Pradesh, Coastal Region-Visakhapatnam District. AP.

Industrial waste minimization and clean up

It is proposed to dematerialize the resource intensive activities of industries into more

appropriate environmental technological solutions aimed at waste minimization, cleanup and remediation. NOx conversion at 60% at lab level by selective catalytic reduction achieved. Bioremediation of (heavy metals) contaminated soil curried out. Mandaman dump – metal contaminated site surveyed for screening of heaving metals (Cd, As). Standardization of analytical method for H_2S, DMS, Methyl and ethyl mercaptans achieved. A fast method of enzyme assays for laccase and other enzymes for bleaching wood pulp of Century Paper Mill was developed.

NON-NETWORK PROJECTS

Biomethanation of Municipal Solid Waste

NEERI has developed a cost effective two-phase biomethanation process for municipal waste. Studies reveal that in acid phase, solid concentration of 15-20% gives optimum COD and volatile fatty acid concentration. Optimum retention time for acid phase is 9-12 days. It has also been observed that if alkali treatment with 0.1% of NaOH solution is applied prior to initiation of the acid phase, maximum COD mobilization could be achieved. In methane phase studies, it was observed that a slurry of 10% solid concentration contributes in early initiation of methane generation. The methane generation starts after 30-40 days within pH range of 5.6-5.8. 75-85% COD reduction is achieved with biogas yield of 4-10 litres per kg of volatile solids. The biogas contains 45-50% methane. The optimum retention time for methane phase is 5-6 days.

Appropriate Composting Process for Municipal Solid Waste

NEERI has carried out windrow composting by adopting different aeration mechanisms in the windrows (aeration from the bottom, aeration from the sides aided by perforated GI pipes etc.). Studies reveal that after a period of 8 weeks, substantial reduction of fermentable organic matter and total carbon occurs. In a windrow with bottom aeration, maximum reduction (39%) of C/N ratio was observed. Studies were conducted to assess the effect due to addition of inorganics like diammonium phosphate, sodium hexa-metaphosphate and alkali treatment. Experiment was also conducted on application of combined anaerobic and aerobic treatment of the MSW. It has been observed that if MSW is anaerobically treated for 5 days followed by aerobic treatment, compost of C/N ratio 18-19 is obtained.

Cold Setting Fly Ash Brick with High Ash Content

RRL Bhubaneswar developed an innovative process for conversion of oxides of aluminum-silicate mineral system to hydroxylated structures under atmospheric condition on making cementation materials to develop cost effective green technologies for utilization of various solid wastes in manufacture of building construction materials, ceramic, and heat and acid resistance products. The process has been worked out in the manufacture of cold setting building brick with the use of 80 to 97% by weight of fly ash. The bricks are resistant to water, sulfate and alkali.

2.6 Electronics & Instrumentation

NETWORK PROJECTS

Special Electron Tube Technologies for Large-scale Applications

The project 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. An RF window was designed and fabricated using 99.5% alumina. The windows were subjected to cold RF test and the results are quite satisfactory. One complete 4-stage collector assembly with POCO graphite electrodes and feed through was assembled. One pulse power system (40KV/10A) has been developed for characterization of Thyratron.

Development of Key Technologies for Photonics and Opto Electronics

Erbium doped Fibre Amplifier (EDFA) was developed and commercially launched on 28th August, 2005 through an agreement with M/s Network Systems Technology (NeST). The EDFA modules are now being used by some of the major CATV service providers. Facility for testing EDFA for WDM (wavelength division multiplexing) has been created at CGCRI to cater to the needs of the industry. A 980nm 14 PIN packaged pump laser module has also been developed which is a vital component of EDFA. Typical Output power of the device is 90-100mW. A seven segmented OLED device has also been fabricated and successfully demonstrated.

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. Modified set of masks (4 levels) has been made for the micropump to be used in the TAS system. For composite polymer gas sensor, MEMS micro cavities in the sizes of 250x250, 300x300, 500x500 and 500x600 micron and with a depth of 40 micron have been fabricated using UV LlGA technique with AI electrodes at the bottom of the cavity. A potassium-selective ISFET device developed under the project, which has been applied to the determination of K^+ ion concentrations in human, blood serum. A process for enzyme immobilization by cross-linking in photocurable polymer has also been developed.

Electronics for Societal Purposes

Experiments have been conducted on spectral characteristics for different external defects like bruises and cuts in apples. Hydraulically operated artificial knee joint with rotary vane system, damping system and hydraulic chamber has been developed. The prototype of programmable functional electrical stimulation system has been developed for which preliminary clinical trials have been conducted on a paraplegic patient at Government Medical College & Hospital (GMCH), Chandigarh. Algorithm and software for estimation of magnitude of earthquake has been developed. Lab testing of engineering model of Weak Motion Recorder has been completed. Data Acquisition System has been developed for acquiring/logging data of various geotechnical sensors required for monitoring the landslide. For data analysis & interpretation (at local control station), necessary software modules for the sensors have been developed. Spoon feeding robot system & myoelectric arm have been developed and tested in-house.

NON-NETWORK PROJECTS

Plastic Waste Sorting for Recycling

CEERI has developed the technology, for the first time in India, for sorting of plastic waste for recycling. The technology can directly be used by several plastic waste reprocessors to segregate five different kinds of polymers and

recover valuable raw materials for reuse. It is based on non-contact near-infrared spectroscopy of the plastic waste objects moving on a conveyor belt. A few novel chemometric algorithms have been developed for automatic detection and sorting of five popular kinds of plastics namely PE, PP, PVC, PET and PS.

Smart Card Based Intelligent Fuel Dispensing Machine

CMERI has developed Smart Card based intelligent fuel dispensing machine which provides an ideal low-cost automated solution for drawing a programmable quantity of fuel from the storage tank.

Microcontroller-based Clinical Chemistry Analyser for Measurement of Various Blood Biochemistry Parameters

CSIO has developed an inexpensive clinical chemistry analyzer. This is an open system in which any reagent kit available in the market can be used. The system is based on the principle of absorbance transmittance photometry. The developed system incorporates light source, an optical module, interference filters of various wave lengths, peltier device for maintaining required temperature of the mixture inflow cell, peristaltic pump for sample aspiration, graphic LCD display for displaying blood parameters, patients test results and kinetic test graph, 40 columns mini thermal printer, and also 32-key keyboard for executing various functions.

Interferometric Moiré Pattern Encoded Security Holograms

CSIO has developed a simple method for making interferometric moiré pattern encoded security holograms. These security holograms contain multi-fold concealed and encoded anti-counterfeit security features, which can only be decoded by using an encoded key hologram.

Fire Safety Sensor for LCA Phase IA and Phase II

CSIO has designed and developed the continuous fire safety sensor of various lengths 10 ft and 10-50ft` by interconnecting 10ft sensors along with end connectors for Light Combat Aircraft and for other strategic devices, meeting the required qualification test MIL grade specifications.

Night Driving Filter, Phase II

CSIO has designed & developed Night Driving Filter for use in the automobiles during night driving. The device used during night driving protects eyes from the blinding glare produced by the headlight of the approaching vehicles. The device comprises a gradient density absorbing film deposited upon glass/plastic substrate by vacuum coating and also anti-reflection coating on both surfaces of the substrate.

Multiple Laser Diode Based System for Shadowgraphy

To study the impact of the projectiles particularly just before and after they hit the target, flash shadowgraphy is being widely used. CSIO has designed and developed multiple laser diode sources having 100% Depth of Modulation (DoM), operated at few volts, which can be controlled more precisely using ultra short TTL pulses to provide exposure of few hundred nanoseconds. In international scenario, there is no report available about the use of multiple low power compact laser diodes to record flash shadowgraphs.

2.7 Energy

NETWORK PROJECTS

Developing New Generation Fuel and Lubricants

It is targeted to develop liquid fuels and ethanol production from biomass, biodegradable lubricants from vegetable oils & sugars and to set up emissions norms.

Gas to Liquid Technologies for Dimethyl ether (DME) and Fisher Tropsch (FT) Fuels

As a part of this project 41 FT and 13 DME synthesis catalysts were prepared and evaluated. 19 FT and 3 DME catalysts for screening and comparison on high pressure fixed bed reactor system were developed. 40% selectivity to middle distillates from syn gas achieved

Liquid Fuels and Ethanol from Biomass

Ethanol production from rice and wheat flour using commercial thermostable enzyme and yeast and also from starch by simultaneous liquefaction, saccaharification fermentation by using thermophiles has been reported. A 14-fold increase was marked in cellulose production by SSF process using *T. reesei.*

Catalysts for Atmospheric Residue Processing

Four catalysts, namely CoMo on 1% phosphoric acid treated alumina, CoMo on 2% silylated alumina, CoMo on Florinated alumina and CoMoP alumina (Phosphorous addition *in-situ*), sulfided by 10% hydrogen sulfide in hydrogen were prepared, characterized and evaluated. Five HDM, catalysts were also prepared, characterized and evaluated with feed as mixture of short residue.

Coal Characterization & Resource Quality Assessment for Specific End-users

The project aims at petrographic characterization and coking behavior of coal, gainful utilization/value addition of North East (NE) coal directly or after suitably blending. The possibility of desulphurization of high sulphur coals of North Eastern region of India explored through fixed bed. Experiments conducted so far explored the feasibility of sulphur removal upto a desirable extent. Thermal treatment of NE coals at higher coal carbonization temperature also opened up some avenues for partial desulphurization as well as possibility of coke making incorporating some additives. A nano-particle based material developed & characterized.

NON-NETWORK PROJECTS

Physico-chemical Characterization and Catalysis on SBA-15 Supported Molybdenum Hydrotreating Catalysts

IIP has prepared SBA-15 supported Mo, CoMo, NiMo catalysts. The supports were characterized by surface area, pore size distribution, and X-ray diffraction. The finished catalysts in oxide state were characterized by surface area analysis and X-ray diffraction in the region where the molybdenum oxide lined are seen. The sulfided catalysts were examined by oxygen chemisorption at low temperatures and the catalytic functionalities of these catalysts, viz. hydrodesulfurization and hydrogenation were evaluated on sulfided catalysts, which are comparable with Al_2O_3- and SiO_2-supported catalysts.

Adsorption Technology for the Desulphurisation of FCC Naphtha

IIP has developed an adsorption process for the desulphurisation of FCC naphtha, which contains the maximum level of sulphur compounds and also forms the major component of a refinery gasoline

2.8 Food & Food Processing

NETWORK PROJECTS

Nature, Nature-identical or Similar Bio-molecules

A process has been developed for cost effective production of vanilla plantlet by screening and characterization of abundantly available targeted plants leading to a process for the preparation of γ- butyrolactones and their derivatives using microwave and ultrasound conditions. Food grade microbes rich in cellulase, peroxidase and β-galactosidase were used to enhance vanilla flavour during curing of vanilla beans. An eco-friendly process for extraction of vanillin from vanilla pods has been developed. Pilot scale extraction of green tea from pruned tea leaves was completed. Three different synthetic oryzanol samples were prepared using soybean, sunflower and rice bran oil phytosterols and are being evaluated for cholesterol lowering property.

Establishment of Genetically Modified Food Referral Facility

Quantified measurements using competitive PCR and TaqMan™ Real Time PCR technology for the insect resistance maize and herbicide tolerant soya have been studied. Number of primer pairs was designed to amplify different regions of the transgene both in maize and soya. A texturised vegetable protein prepared from GM-soya (RUR soya-pesticide resistant) was evaluated. The GMFRF, a state-of-the-art facility for the testing of GMOs has been setup. Both DNA and protein based methods have been optimized for the detection of herbicide tolerant soya and insect resistance maize seeds.

NON-NETWORK PROJECTS

ACE Inhibitors

CFTRI has synthesized two tripeptides by solid phase FMOC-chemistry using rink amide MBTH resin. The sequence of the peptide was verified by amino-terminal sequence analysis and amino acid composition. The ACE inhibitory activity was evaluated using porcine kidney and lung ACE. The peptide was found to be a competitive inhibitor of both lung and kidney ACE. The peptide was stable to in-vitro digestion with pepsin, pancreation and a combination of these two. This suggested that the peptide would be bioavailable if administered through the oral route to cure Hypertension.

Utilization of Fish Processing Wastes

CFTRI has assessed the quantitative and qualitative distribution of carotenoids in different body components of four species of shrimp (*Penaeus monodon, Penaeus indicus, Metapenaeus dobsoonii* and *Parapenaeopsis stylifera*) harvested from shallow waters off the Indian coast. The highest total carotenoid contents were observed in the head (1531.1μg g^{-1}) and carapace (104.7 μg g^{-1}) of P. stylifera, Astaxanthin and its mono and diesters were the major carotenoids (63.5-92.2% of total carotenoids) present in the carotenoid extracts from the shrimps, while the extracts contained low levels of β-carotene and zeaxanthin. The major fatty acids in the carotenoid extracts

were palmitic, heptadecanoic, palmitoleic, stearic and oleic acids.

Preparation of the Curcuminoids of High Purity

CFTRI has evaluated individual curcuminoids, such as curcumin, bisdemethoxycurcumin and demethoxy-curcumin, for their antioxidant activities by *in-vitro* model systems, such as the phosphomolybdenum and linoleic acid peroxidation methods. Antioxidant capacities of the extracts, as ascorbic acid equivalent (μmol/g) were in the order: curcumin>de-methoxycurcumin> bisdemethoxycurcumin. In comparison with butylated hydroxyl toluene (BHT), at 100 ppm, the anti-oxidant activity, by linoleic acid peroxidation, was found to be highest with curcumin, followed by demethoxycurcumin and bisdemethoxy-curcumin. The data obtained by the *in vitro* models clearly establish the antioxidant potencies of individual curcuminoids. This is the first report on antioxidant activity of individual curcuminoids using the phosphomolybdenum method and linoleic acid peroxidation method.

Garlic as Neuro and Immuno Modulator

CFTRI has demonstrated the presence of a glycoprotein of molecular weight 12-13KD in addition to two non-glycoprotein agglutinins or lectins of 2 subunits of approximately 12.5KD each by Glycoprotein staining of raw garlic extract. The new glycoprotein of subunit molecular weight 12-13KD has been detected in raw garlic extract, which appears to be immuno modulatory. Analysis of dried garlic powder indicates that it lacks the 50-55KD protein representing alliance and/or high molecular weight agglutinin of raw garlic. The propensity of `fresh garlic powder' to attenuate incidence of embryopathy and oxidative stress in pregnant rats rendered diabetic (streptozotocin induced) during the early gestation period as well as the beneficial consequences against oxidative damage in fetal tissues has been established.

Effect of Process Parameters on Transmembrane Flux During Direct Osmosis

CFTRI has come up with a new concept of mixed solutes as osmotic agent to overcome the problems of cross contamination of osmotic agent into the fruit juice. Direct osmosis is a non-thermal membrane process employed for the concentration of fruit juices at ambient temperature and atmospheric pressure, thereby maintaining the organoleptic and nutritional properties of fruit juices. Aqueous solution of sucrose (0 to 40% w/w) – sodium chloride (0 to 26% w/w) combi-nation has been investigated as an alternative osmotic agent. The sucrose-sodium chloride combination can overcome the drawback of sucrose (low flux) and sodium chloride (salt migration) as osmotic agents during direct osmosis process. The effect of the hydrodynamic conditions in the module and feed temperature ($25\text{-}45^{0}$C) on trans-membrane flux has been evaluated. The ascorbic acid content was well preserved in the pineapple juice concentrate by direct osmosis process.

Swing Technology

The Swing Technology (to process fresh/dry spices for essential oils, oleoresins and active principles) developed by the RRL-Trivandrum, was licensed to the two largest spice oleoresin companies in the country, namely M/s Synthite chemicals, Cochin, and M/s Plant Lipids, Cochin. The process was demonstrated for several spices including onions, garlic and chilli in the commercial facility of M/s Synthite chemicals as well as in the RRL, pilot plant. The licensing to

M/s Plant lipids was followed by successful process demonstration on fresh turmeric and fresh ginger in their premises.

2.9 Health Care, Drugs & Pharmaceuticals

NETWORK PROJECT

Asthmatic and Allergic Disorders Mitigation Mission

Twelve lead molecules that inhibit one or more specific targets of bronchial asthma (i.e.5-Lipoxygenase, cytosolic phospholipase A2, phosophodiesterase F4, cytokines) have been synthesized and purified. One of the molecules (5-Lipoxygenase inhibitor) has been tested *in-vivo* in mouse model for anti-asthmatic activity. Toxicity studies in animal model indicate high therapeutic window for the molecule (approximately thousand fold). Other lead molecules are being evaluated for *in-vivo* anti-asthmatic activity and toxicity. Predictive medicine and genetic poly-morphism studies associated IFN-gamma and IL-4 with asthma in North Indian population. Mustard seed and pollen have been identified as common allergens in Indian population.

Newer Scientific Herbal Preparations for Global Positioning

Twenty-eight medicinal plants have been evaluated for adaptogenic, immuno-modulatory, anti-oxidant & antilipidemic activities. Three Positive Health Promoter formulations (PHP-Anti aging/PHP-Cancer/ PHP-Diabetes) have been designed from five identified promising plants in consultation with Ayurvedic experts.

Predictive Medicine using Single and Repeat Polymorphism

It is proposed to build an Indian SNP (Single Nucleotide Polymorphism) database of common diseases and drug response related genes, which is in the larger interest of human health in general and predictive medicine & drug response in particular in the country. About 1700 samples belonging to 44 distinct endogamous populations for SNPs have been validated. 467 SNPs have been discovered representing all the major linguistic lineages and zones in the country. 950 non-overlapping genes have been identified and located based on their relevance to various complex and monogenic disorders. 63 populations have been identified from different large and isolated subpopulations of 4 major linguistic lineages that are Indo-European, Austro-Asiatic, Dravidian and Tibeto-Burman from different geographical zones viz. North, South, East, West and Central. Two genomic regions representing 140 SNPs i.e. 6 Mb region which could be potentially involved in schizophrenia and BPAD and 0.4 Mb gene involved in SCA12 has been analysed in 1695 samples.

Drug Target Development using In-silico Biology

A comparative genomics method has been developed to identify non active site (structural determinants) of proteins as drug targets. Human micro RNA (miRNA) was identified as a potential therapeutic for HIV infection. Five new nontoxic targets have been predicted for *Mycobacterium tuberculosis*. A novel method for human GPCR protein prediction in human genomes has been developed. Potential candidate genes for Schizophrenia and Bipolar disorder using genetic information, pathway modeling and text mining software have been identified.

Animal Models and Animal Substitute Technologies

The project aims to influence the process of new drug development and toxicity/ safety

evaluation of drugs/chemicals. Following facilities for screening & testing of new drug entities have been established: Yeast and Drosophila models for screening of anticancer drugs; two hepatotoxicants established in mouse model for detecting hepatotoxicity of the NCEs at levels lower than the doses which cause pathological changes; model based on *Mycobacterium aurum* developed for screening of the antitubercular NCEs and Regulatory genotoxicity assays established.

NON-NETWORK PROJECTS

Specific DNA Probes and Oligonucleotide Primers for PCR–based 'Tuberculosis Diagnostic Kit'

CDRI has developed a sequence specific DNA probe for detection of *Mycobacterium tuberculosis* which is isolated from a λgt11 library of *M. tuberculosis* by DNA:DNA hybridization using genomic DNA as probe followed by subtractive hybridization with cocktail of other mycobacterial DNA. This led to identification of CD192, a 1291 bp fragment of *M. tuberculosis* containing repetitive sequences, which produced positive hybridization signals with *M. tuberculosis* DNA within 30 min. The oligonucleotide primers designed from this sequence for development of PCR based assay were evaluated directly in clinically diagnosed cases of pulmonary tuberculosis and tubercular meningitis along with controls in collaboration with KG Medical University, SGPGIMS and Command Hospital, Lucknow, GSVM Medical College, Kanpur, PGIMER, Chandigarh and JALMA, Agra. The sensitivity and specificity of 90 and 100 % in sputum samples; 70 and 100% in cerebrospinal fluids and 78 and 100% in pleural effusion samples has been observed. The detection of amplification product has been developed on two formats for commercialization.

Structural and Functional Features of the Streptococcus Pyogenes Bacteriophage Hyaluronate Lyases

CDRI has reported for the first time hyaluronate lyase having an oligomeric structure. Limited proteolysis and GdmCl denaturation studies demonstrated that the terminal region of the hylP2 protein is flexible whereas, the C-terminal portion has a compact conformation. A functionally active C-terminal fragment (S128-K337) of *hylP2* protein has been isolated, and was stabilized in trimeric configuration. Structural and functional studies on isolated domain demonstrated that the active site of the *hylP2* protein is present in the C-terminal portion of the enzyme and this domain is also responsible for the stabilization of the trimeric conformation of the *hylP2* protein. Detailed comparative functional studies with full-length protein and C-terminal domain demonstrated that the N-terminal portion of the enzyme modulates the enzymatic activity of C-terminal domain and is also responsible for specificity of enzyme for polysaccharide substrate.

Slow Solvation Dynamics at the Active Site of an Enzyme: Implications for Catalysis

IICB studied using a fluorescence probe, acrylodan, site-specifically attached at cysteine residue C229, near the active site. The picosecond time-dependent fluorescence stokes shift indicates slow solvation dynamics at the active site of the enzyme, in the absence of any substrate. The solvation dynamics becomes still slower when the substrate [glutamine or tRNA (Gln)] binds to the enzyme. A mutant Y211H-GlnRS was constructed in which the glutamine binding site is disrupted. The mutant Y211H-GlnRS labeled at C229 with acrylodan exhibited significantly different solvent relaxation, thus demonstrating that the slow dynamics is indeed associated with the active site.

Recombinant Staphylokinase, a Fibrin-specific Clot-buster Drug

IMTECH has developed a process for high-level production of recombinant Staphylokinase. Staphylokinase is produced intracellularly using genetically engineered strain of *Escherichia coli*. Recombinant Staphylokinase is produced at high level using fed batch fermentation and purified protein is recovered after cell lysis and column chromatography. Patents for this technology have been filed in several countries to protect the IPR. The technology is currently being scaled-up with a commercial partner.

Applied and Basic Insights Into Bioremediation Pathways for Nitro-aromatic Pollutants

IMTECH has studied the biochemistry and molecular biology of biodegradation of nitroaromatics (NACs). Degradation pathways of some of the lab-isolates (*Ralstonia* sp. SJ98, *Burkholderia cepecia* RKJ200, *Arthrobacter protophormiae* RKJ100) have been elucidated and included in the University of Minnesota Biocatalysis/Biodegradation Database. To assess the efficiency of PNP degradation and stability of the selected strain RKJ100 in the PNP-contaminated site, field studies were successfully conducted under conditions optimized earlier in microcosm and pot studies.

Aspartic Proteases Inhibitors: Implications in Drug Development

NCL has isolated a bacterium (*Bacillus* sp.) that lives under extreme environmental condition and produces an aspartic protease inhibitor (ATBI). ATBI has been characterized for its inhibition against HIV-1 protease, pepsin, and the protease from the fungus *Aspergillus saitoi*. The inhibitor is found to be a hydrophilic peptide with a molecular mass of 1147 Da. Sequence homology exhibited no similarity with the known peptidic inhibitors of HIV-1 protease. Investigation of the kinetics of the enzyme-inhibitor interactions revealed that ATBI is a non-competitive and tight binding inhibitor of HIV-1 protease.

Assessment of Declining Effect of the Antioxidant Capacity and Phenolic Contents in Indian Herbal Teas Due to Long Storage

ITRC has carried out studies to assess the declining effect due to long storage of the anti oxidant capacity and phenolic contents, thereby affecting adversely the beneficial effects of Indian herbal teas. The changes in the stability of antioxidant capacity with time and its relation to the phenolic content were evaluated in 8 Indian herbal teas. These herbal teas are claimed to have multiple bioactivities from anti stress to anti hypertensive and memory enhancer. Anti oxidant capacity was determined over a period of 15 months from the date of their procurement using assays for SOD mimetic activity, LPO inhibitory capacity and total thiol content. These activities were found to decrease positively with time. The study assume significance as most of the herbal teas available in the local market in India do not carry any information regarding time limit in use so as to maintain the beneficial effects of Indian teas.

A New Plant Based Hepatoprotective: Liv –1

RRL, Jammu has licensed end-to-end package for single plant based herbal drugs as hepatoprotective against alcoholic and viral cirrhosis. The product is standardized based on two identified chemical markers. The formulation has been licensed to M/s Madley Pharmaceuticals Ltd., Mumbai. The company

after conducting the proof of concept in humans has finally launched the product as Liv-1 in both tablet and syrup forms. The product exhibits at least 50% more hepatoprotective potential than any available commercial herbal formulation. The drug can be used both as preventive and curative against hepatic disorders.

2.10 Housing & Construction

NETWORK PROJECTS

Design Analysis and Health Assessment of Special Structures Including Bridges

Early detection of structural health degradation can help in prevention of catastrophic failure. Studies relating to advanced analysis and design methods for steel frames, and experimental investigation of frame connections have been completed. Wind tunnel experiments were performed on three sectional models of cable stayed bridge decks viz., Model A - open channel section, Model B – open channel section with fins and Model C – box girder section with fins. Wind tunnel investigation on across-wind response of prismoidal structures having different cross sectional shapes under atmospheric wind has been completed. A database for fatigue and fracture behaviour of pipes and elbows has been developed for in-house use. Experimental studies were carried out for evolving suitable procedures for embedding fiber optic sensors in concrete structures. A few studies were conducted on health assessment of actual structures including a flyover bridge at Visakhapatnam and railway bridge at Tiruttani.

New and Improved Road Technologies

Screening and characterisation of feedstock for modification of bitumen by molecular alteration in short residue by polymerisation and condensation have been completed. HPC sections laid at CRRI campus and at Dhaula Kuan are under periodic evaluation.

NON-NETWORK PROJECTS

Flooring & Paving Tiles

- ***Acid-resistant Tiles***

CBRI has developed a process to bind the sanitary waste into acid-resistant tiles and bricks with an acid resistant ceramic binder. The binder provides the liquid phase, required for sintering the waste to strongly bind it into acid-resistant tiles and bricks. The quality of tiles and bricks so produced conform to BIS requirements and are economically viable.

Vibration Control of Buildings and Structures Subjected to Multi-axial Excitation

SERC has tested two pairs of laminated bearings made of natural rubber with two different shore hardness values using a specially fabricated fixture. In the test program, excitation frequency, applied axial load and the shear deformations were varied. From the measured response parameters, the force-displacement hysteretic loops were obtained. Using these hysteretic loops, dynamic characteristics of the isolator specimens like dynamic stiffness and damping were calculated, and further, the values of storage modulus, loss modulus and the loss factor of these specimens were evaluated. The study showed that the stiffness of the isolator specimens decreased with increase in axial load and shear deformation.

Health Assessment of Bridges and Other Structures

SERC has designed fiber optic sensor based structural health monitoring towards predicting the time-dependent losses in prestressing steel and evaluating the stress condition of concrete in the beam.

2.11 Information Dissemination & Products

NETWORK PROJECTS

Comprehensive Traditional Knowledge Digital Library (TKDL)

Database has been created on Traditional Medicinal formulations comprising 13 million A4-size pages of data on transcribed 62,000 formulations in Ayurveda; 60,000 formulations in Unani; and 1,300 formulations in Siddha. Other achievements include i) value addition to the database on medicinal plants for 500 species, ii) digitization of more than 50,000 herbarium specimens, iii) preparation of datasheets for 750 primary information and over 8,000 secondary information on Tribal Knowledge, iv) creation of five video films on Tribal Knowledge, v) preparation of TKRC on Traditional Foods and collection and entry of data on 70 traditional cuisines, and vi) preparation of TKRC on Traditional Architecture and construction Technologies and entry of 105 items in the data entry software.

NON-NETWORK PROJECTS

Dissemination of Information to S&T Community

NISCAIR publishes nineteen scholarly journals of international repute, covering all the major disciplines of science and technology. Two of the its journals, namely *Indian Journal of Traditional Knowledge (IJTK)* and *Medicinal and Aromatic Plants Abstracts (MAPA)* have been included in the coveted list of 'Prior Art Journals' used for prior art search before grant of patent(s) by the International Search Authorities. India is one of the 13 nations whose journals have been included in this list.

Subscriber Base and Impact Factor

Continuous efforts towards improving the quality and subscriber base of the journals are yielding very good results. There has been a steady increase in the subscriber base (~ 20 % per annum) and many of the NISCAIR journals are covered by the Science Citation Index and have an impact factor varying from 0.087 to 0.509, quite respectable among Indian journals.

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 and an encyclopedic science dictionary, with a view to generating awareness about scientific developments and creating a scientific temper among the students and common men. The institute also focuses on the R&D activities of CSIR labs through the newsletters - *CSIR News* and *CSIR Samachar*.

Raw Materials Herbarium & Museum (RHMD)

RHMD houses authentic samples of economically important raw materials of plant, animal and mineral origin of India to cater the needs of scientists, researchers, industry, entrepreneurs, students and the public. At present, it holds 6478 plant specimens, 190 zoological specimens, 207 mineral samples, and 2000 carpological samples (crude drugs, roots, seeds, bark, wood, etc.).

IT Literacy Programme

NISCAIR has brought out a series of seven simple-to-use, practical books on various subject areas of IT in English. Some of these books have been also translated in nine Indian

languages, viz. Hindi, Punjabi, Tamil, Kannada, Gujarati, Marathi, Bangla, Malayalam and Urdu, with a view to enhancing IT literacy among a much wider cross-section of the society. Already 65 of the 70 translated versions have been brought out and the rest are in various stages of processing. Over 55,000 copies of these books have already been sold.

Attitude-behaviour Consistency: An Empirical Study of Indian Scientists

NISTADS explored the attitude-behaviour consistency among scientists (n = 490). The results showed five dimensions of scientist's research-related attitudes: a) attitude towards utilitarian aspects of research; b) attitude towards scientific research per se; c) attitude towards institution; d) attitude towards professional-self and e) attitude towards individual self. The study reaffirms the attitude-behaviour consistency hypothesis in the field of science. Attitudes pertaining to the professional characteristics are explained more by the nature of the scientific role rather than by the biographical features of respondents.

2.12 LEATHER

NETWORK PROJECTS

Standardization of technologies for bioresources for and from leather

The project envisages consolidating lead processes and products and developing technologies with commercial applications. Bench scale processes for a total of seven bio-products (lipase and protease) for use in leather processing have been standardized. Three collagen products commercialized for human health care applications. A 'Knowledge network' on the area has been formed.

Environment Friendly Leather Processing

The project aims to design, develop and disseminate through appropriate measures viable technologies environment friendly leather processing in India at near-zero environmental risk. A number of small yet useful achievements have been reported, such as: (i) basket of technologies for reduction of TDS to <5000 ppm developed and demonstrated, (ii) reduction of waste waters from 17 liters for processing raw skins and hides into wet blue developed and standardized. The process has been engineered and a pilot plant is being commissioned under private-public partnership mode at CLRI, (iii) technology packages for zero liquid discharge from leather processing activity developed. Prototypes and pilot plant including membrane bioreactor, forced evaporation system, winning water from wastes for leather, Zero Emission Research Initiative for Leather commissioned, (iv) a bench scale (10 L capacity) reactor for nitrification and denitrification process for treatment of tannery wastewater designed and fabricated, and (v) a prototype for electro flocculation system for sectional waste waters designed and fabricated. RO plant with 50 m^3 water production capacity in 20 hrs operations designed and fabricated.

NON-NETWORK PROJECTS

Engineering Shoe Design

Some of the initiatives in footwear science and engineering include toe caps for protective footwear, development of therapeutic footwear. CLRI has developed custom made shoes based on specific foot measurement. By using rocker bottomed sole, the pressure from the forefoot of patients can be off-loaded Rocker bottomed sole reduces the angle of flex so that the foot

remains relatively flat and the energy spent is less. The ulcer is at rest and devoid of friction. Muscle strains are reduced and chance of healing is enhanced.

Foot-care Product Design

CLRI has designed rehabilitation sandals for comfort and pain mitigation in children with flat foot deformity. These sandals have been designed as a medical-aid with anatomically shaped step-on sections, which have been mathematically derived. This is useful both for prevention as well as for medical treatment of fallen arches. Special footwear has been designed for leprosy patients by taking biomechanical principles into consideration to recognize high stress areas of the foot and deal with them before ulceration occurs.

Connective Tissue Biology

CLRI has standardized a novel rat model for acute myocardial infarction using the surgical technique of coronary artery ligation. This study conclusively shows that initiation of complement activation is observed to be significant at the 8^{th} h of acute myocardial infarction induced by coronary artery ligation in rats. A tetrapeptide derivative developed has been found to have antinociceptive activity as shown by tail-flick model and acetic acid induced writhing in rats. It also exhibits antipyretic effect as demonstrated by lipopoly saccharide - induced pyrexia model in rats.

Electro Catalytic Oxidation

CLRI has developed a technique based on generation of high concentration of hydroxy radicals for oxidizing organics at a faster rate. The reactor used for the generation of hydroxy radicals consists of non-expendable anodes and cathodes and nickel impregnated meso porous activated carbon, which forms the third phase. It constitutes several electrochemical cells and generates a high concentration of hydroxy radicals. Thus, the wastewater of any strength can be treated using low electrical energy input.

Biotechnology of Leather: Towards Cleaner Processing

NCL has screened several enzymes for application in leather manufacture. Two proteases, a lipase and an amylase were found to be suitable. Based on the evaluation trials conducted at CLRI, both the proteases viz. NCL Protease 1 and NCL Protease 3 were selected as lead products for enzymatic dehairing for commercialization.

2.13 Material, Minerals, Metals & Manufacturing

NETWORK PROJECTS

Custom Tailored Special Materials

It is envisaged to generate strong knowledge base and up-to-date expertise by developing new generation materials like novel non-linear optical materials, bio-molecular electronic materials and functional nano-materials. Gold (Au) nanocluster doped films in SiO_2 and mixed SiO_2-TiO_2 hosts have been prepared on glass substrates and characterized by different techniques. Also a process for solid state processing of $Ba(Mg_{1/3}Ta_{2/3})O_3$, $Ba(Zn_{1/3}Ta_{2/3})O_3$ and $(RE)TiNbO_6$ and $(RE)TiNbO_6$ ceramics has been developed. Porous nano alumina powder and tape cast multi layer composites (MLC) of 3, 5, 10 and 20 layer configurations prepared to about 63 to 70% theoretical density, showed much higher failure energy (10 -70 KJm^{-3}) than that (4.38 KJm^{-3}) of the porous nano alumina single tape.

Fullerene (C60) Doped Glasses for Non-Linear Optical (NLO) Application

Fullerene has large number of π -electrons on its surface and hence sensitive to light. High concentration C60-doped bismuth borate glasses are synthesized by using chemical bond formation ability of C60 with Bi and B. Color of the glass varies with the extent of the reactions.

Capacity Building for Coastal Placer Mineral Mining

Ground Penetrating Radar (GPR) has been attempted along many profiles (8 profiles during two field seasons) to find out the thickness of placer mineral layers. Validation of GPR data with ground truth has been established. About 10 km along Malvan Coast, South Maharastra and few beaches of Goa have been surveyed for placer mineral exploration. New deposit has been reported. Geo-statistical modelling of few selected deposits completed for some placer deposits.

Developing capabilities in Advanced Manufacturing

The dental implant (with threaded/smooth surface) made of Ti-6A1-4V alloy developed and coated with hydroxyapatite (HAp). Human trials with the implants were also carried out with this technique at Main Hospital, Durgapur before dental surgeons. The HAp coated dental implants are being evaluated *in-vitro* and *in-vivo* and the results are encouraging. Yet another component was optimization of process parameters for Metal Injection Moudling for use in the production of engineering components.

Biomineral Processing for Extraction of Metal Values from Ores and Concentrates and Wastes

Bioleaching of low-grade copper ore of Malanjkhand (0.3%) was carried out in shake flasks by varying parameters like pH, pulp density and particle size. Leaching kinetics was studied using mixed culture containing acidophilic microorganism. The copper recovery was around 40% in 50 days at a pulp density of 20%. Likewise, bioleaching of Uranium (UCIL 0.02% U) was carried out using acidophilic microorganism by varying parameters like pH, pulp density and particle size. Uranium recovery was more than 70% in 30 days of leaching.

Technology for Engineering Critical Analysis

Experiments on Inconel 718, En steel, medium carbon steels and Al alloys have been conducted using BIT and conventional mechanical test wherein microstructural evaluation and hardness measurements were carried out. Conceptual design was made for a PORTABLE-BI SET-UP. For enhancing component performance by grain boundary engineering, first phase of thermo-mechanical treatment was carried out. Analytical studies were conducted and phenomenological mathematical models developed to quantitatively predict the ash particle erosion behaviour on coal fired boiler components.

NON-NETWORK PROJECTS

Arsenic Removal from Ground Water by An Electrochemical Method

NML has designed, fabricated and retrofitted to the domestic water treatment system an electro-coagulation cell (2 litre capacity). Experiments were conducted with different concentrations of As (III). The results indicate that more than 95% of arsenic could be removed. The proto type system was field tested at many places in West Bengal near Kolkata (24 parganas Dist.) where the ground water is contaminated with arsenic. The system is effective in removing arsenic from ground water from 500-1000 ppb to below 10 ppb.

Modelling of Crack Tip Blunting Using Finite Element Method

NML has developed a menu-driven software named *Fracture Data Analyser* (FracDA) which can calculate various parameters like load, displacement, crack tip opening displacement and simultaneously plot various graphs and also compare the data obtained from experimental data and FE analysis.

Failure Mode Analysis/Metallurgical Examination of Viper Aeroegines Jet Pipe Below Assembly Ex Aircraft U-719

The viper aeroengine jet pipe bellow assembly ex aircraft U-719, failed owing to bellow burst. NML has carried out failure analysis for the same. Circumferential cracking was observed at a number of locations on the component. Sampling was done from two such cracked locations i.e. one from corrugated (austenitic stainless steel, type S30900) and other from non-corrugated region. The hardness value, optical and scanning electron microscopy examinations revealed that the crack initiation occurred by intergranular decohesion owing to overheating induced intergranular precipitation of brittle phases. This analysis has enabled the Indian Air Force to take necessary precautions to prevent such failures in future.

Process for Preparation of Nanomaterials

NPL developed a novel process to produce nanomaterials on commercial scale. The technique has many control parameters to adjust particle size, morphology etc. of nanomaterials produced. The process has diverse applications, as preparation of nanomaterials is very important nowadays as these materials are finding newer and crucial high-tech applications everyday. Some of the applications are high-resolution displays, smart windows, dye-sensitized solar cells, sensors for various applications, batteries, large value capacitors and others.

High ductility Mg-alloys employing hot extrusion process

NPL has conducted systematic experimentation using variety of Mg-alloys and employing different extrusion ratios and extrusion dies, such as, port-hole die, contoured and conical dies to produce tubes and circular rods using hot extrusion by optimising various process parameters. The extruded products were extensively characterized for metallurgical and mechanical properties. It was observed that after optimisation of process parameters, some extruded Mg-alloys exhibited remarkable ductility of more than 25% with moderate values of tensile strength.

Electrochromic Nanostructured Tungsten Oxide Films by Sol-gel

NPL has reported that as-deposited sol-gel derived amorphous tungsten oxide films transform into nanostructured films with an interconnected framework of grains and pores and a dominant triclinic crystalline phase upon annealing at 250^0C. Transmission electron microscopy and scanning electron microscopy images clearly reveal the annealing induced microstructural evolution for the film. Subsequent to lithium intercalation, the film annealed at 250^0C shows quasi-reversible structural changes, as ascertained by X-ray diffraction and Fourier transform infrared spectral data. Dynamic transmission modulation for film revealed a high optical modulation of 72 % (λ = 650 nm) and a coloration efficiency maximum of 132 cm^2C^{-1} at 800 nm under a lithium intercalation level of x = 0.20.

Nanostructured Mesoporous Tungsten Oxide Films with Fast Kinetics for Electrochromic Smart Windows

NPL has successfully fabricated a self-assembly of sodium dodecyl sulfate/ tungsten oxide aggregates at the electrolyte-electrode interface followed by template extraction and annealing by mesoporous thin films of electrochromic tungsten oxide (WO_3). Electron microscopy images revealed that the films are characterized by a hitherto unreported hybrid structure comprising nanoparticles and nanorods with a tetragonal crystalline phase of WO_3.

Estimation of Radiative Forcing Due to Aerosols:

NPL has reported that: surface fluxes of aerosols during pre-monsoon period, derived through measured spectral distribution of aerosol optical depth (AOD) and model calculated over Delhi indicate a typical urban and desert sources mixture, explaining also very low value of single scattering albedo. The average total radiative forcing efficiency experimentally observed at the surface in the broad wavelength band (280-2800 nm) was of the order of 13.6 ± 1.4 Wm^{-2} comparable to that estimated using the SBDART model.

Technology Enabling Center for Manufacturing Natural Fiber Composites (R WOOD)

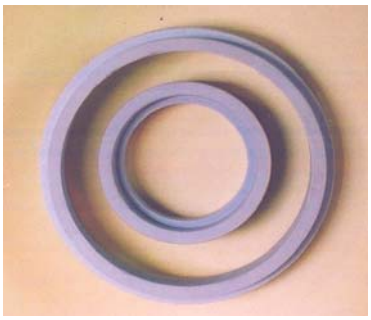
RRL, Bhopal has developed a technology for making composites (R-wood) using industrial wastes, natural fiber and polymer. The salient features of the composites are high strength to weight ratio, termite and corrosion resistant, self-extinguishing, durable and environmental friendly. These composites can be used for various applications such as doors, tiles, partitions, ceilings, boards, panels, furniture, instant houses, electrical application etc. The door shutter with innovative technology was thoroughly tested by CPWD, BHEL and CBRI, Roorkee for their performance. After successful field trial CPWD approved the door shutters. For up scaling and customization of these products, a Technology Enabling Centre (TEC) is setup.

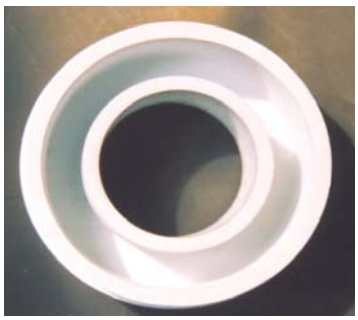
Production of Plasma Spray Grade Powder by Jet-wheel Impact Atomization

RRL Bhubaneswar developed a new kind of spray dryer, called 'Jet-wheel impact atomization based spray dryer' of 26 kW capacity producing spheroidal alumina powder of plasma spray quality. The spray dryer has been designed by overcoming the demerits of pressure nozzle as well as centrifugal atomization and operates at low slurry pressure (< 5 bar) and low wheel speed (<12000 rpm).

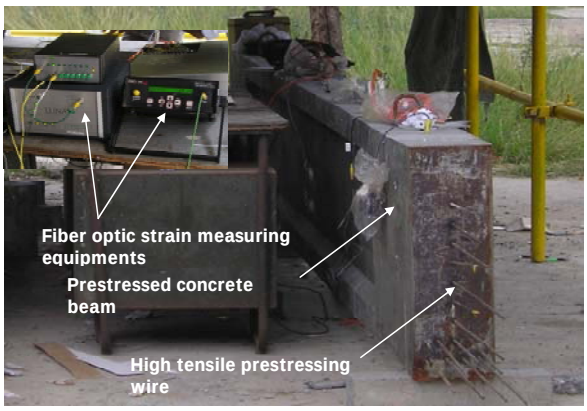
2.14 New Millennium Indian Technology Leadership Initiative (NMITLI)

The six projects under NMITLI, which were taken up earlier for necessary R&D have graduated to second phase for further development. These projects are: (i) Biotechnology for Leather: Towards Cleaner Processing Phase-II; (ii) Development of production system for tea polyphenols and their condensed products; (iii) A prospective study to correlate gene signatures with clinical outcome of astrocytomas and identification of potential therapeutic target(s); (iv) Development of DNA microchips for the detection of eye infections and Glaucoma; (v) Lactic acid and lactic acid based polymers- establishment of a 300 TPA Pilot plant for lactic acid production; and (vi) A cost effective Simple Office Computing (Sofcomp) platform to replace PC.





BN-SiO_2 Ceramic Discharge Chamber (Two Different Designs) of Hall Effect Thruster for ISAC, Bangalore

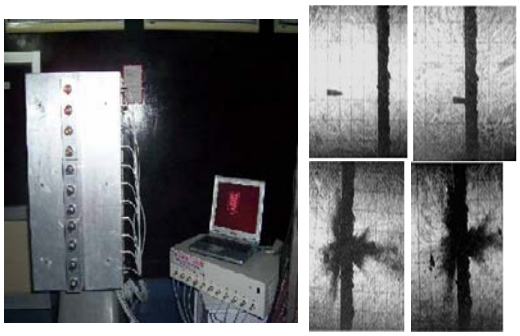


Health Monitoring of Pre-stressed Concrete Beam Using Fiber Optic Sensors

Cold Setting Building Bricks with 95% Fly Ash

Cement Free Concrete Blocks of Fly Ash

Twin Domes of Air Combat Simulator for Pilot Training



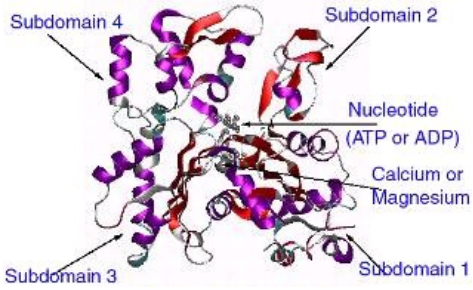
Multiple Laser Diode Based System for Shadowgraphy

Two-phase Biomethanation Process

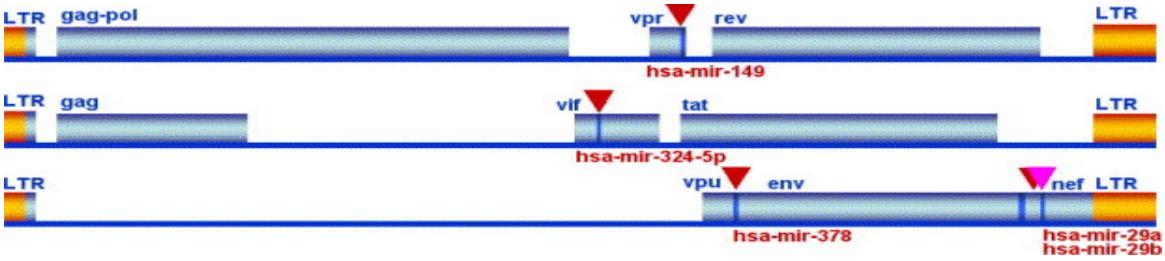
Himbala

Himkachari

Composite Cultivar of *Valeriana Jatamansi*



Actin Monomer of Microfilament



Positions of the Five MicroRNA Targets on the HIV-1 Genome. Triangular Marks: Relative Positions of the MicroRNA Targets in the Genome. Blue Bars: Genes. Bold Vertical Lines: Gene Boundaries.

RRL(J)CF HP

RRL(J)CF HSR

New Chemotypes of *Cymbopogon Flexuosus*