



R&D at CEERI, Pilani

Long-Period Waveguide Gratings in Silica-on-Silicon

The Central Electronics Engineering Research Institute (CEERI), Pilani, has realized the corrugated Long-Period Waveguide Gratings (LPWGs) in silica-on-silicon material. Although a few research groups have recently reported the development of LPWGs using various polymers, the device based on silica-on-silicon technology offers better stability, long-term reliability and better compatibility to measurement system. The device has significant potential for various integrated-optic communication and sensing applications.

The LPWG structure consists of a thick SiO_2 thermal oxide under-cladding layer on a silicon substrate, a Ge-doped higher-indexed oxide guiding layer and a borophosphosilicate glass (BPSG) based over-cladding. Initially, LPWGs were designed after optimisation of various waveguide and grating parameters. Silica-on-silicon based LPWGs have been fabricated through various process steps like plasma enhanced chemical vapour deposition (PECVD), photolithography, plasma ashing, metallization, lift-off, deep/shallow reactive ion etching (RIE), etc. Following fabrication of LPWG devices in a relatively high contrast (0.8%) silica-on-silicon material, these were diced according to the device-dimension and their input/output edges were polished (at IRDE, Dehra Dun) and subsequently they were pig-tailed and packaged (at SAMEER, Mumbai). Waveguide and grating parameters were so chosen that the resonance wavelength of gratings could be achieved at the optical communication (C/L) band region. Packaged LPWG devices were tested thoroughly by using a polarisation splitter, and an optical spectral analyzer. LPWG characteristics were observed at ~1581 nm at room temperature. To realize the actual optimised value of a uniform and sub-micron level of tooth-height grating, corrugation has been found to be the most difficult, which plays a vital role for achieving a strong isolation dip of the LPWG device.

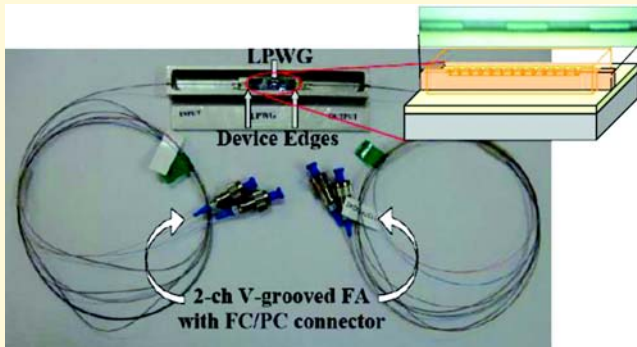


Fig 1: A Photograph of a Packaged LPWG Device. Insets Show the Schematic and a Portion of the Device

Placing the packaged LPWG in a controlled temperature chamber, researchers at CEERI have tested the temperature-tunability of the LPWG. The resonance wavelength of the LPWG was found to vary in the wavelength region of 1577 - 1584 nm with the variation of temperature from -30°C to 70°C . Temperature sensitivity of the LPWG has been estimated to be $\sim 82 \text{ pm}/^{\circ}\text{C}$, $64 \text{ pm}/^{\circ}\text{C}$ and $59 \text{ pm}/^{\circ}\text{C}$ for un-polarised, quasi-TE-polarised and quasi-TM-polarised light, respectively. Very small birefringence was noticed for the device at room temperature owing to symmetric waveguide structure with low refractive

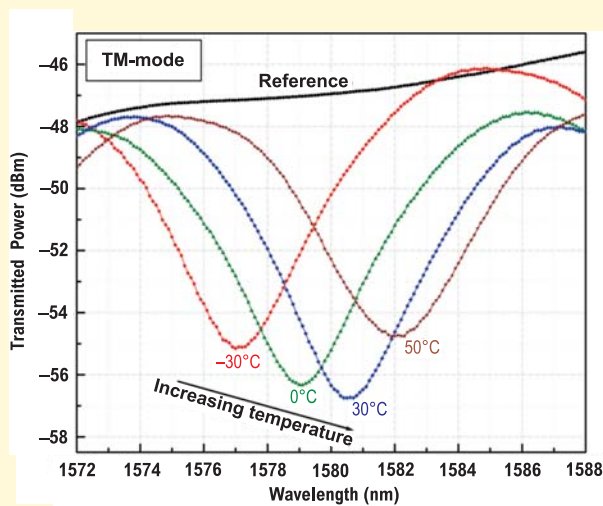


Fig. 2(a): Transmission spectra of LPWG device with a variation of temperature for quasi-TE mode

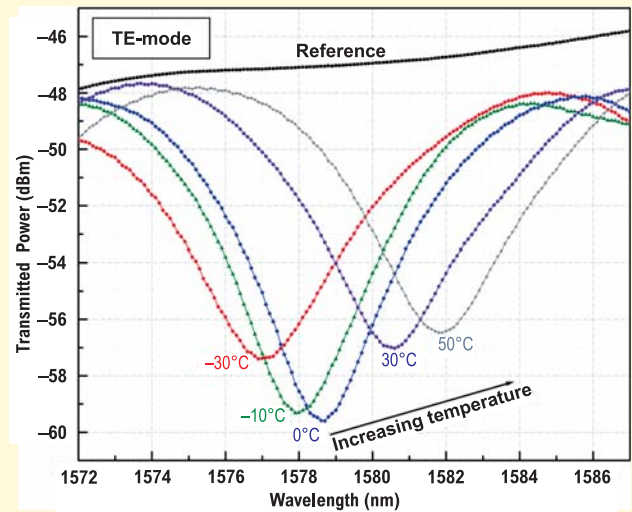


Fig. 2(b): Transmission spectra of LPWG device with a variation of temperature for quasi-TM mode

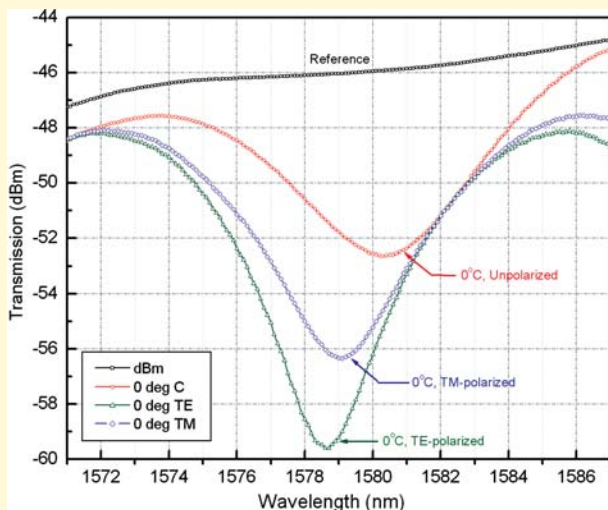


Fig. 3(a): Transmission spectra of LPWG device at 0°C for quasi-TE, quasi-TM and unpolarised light

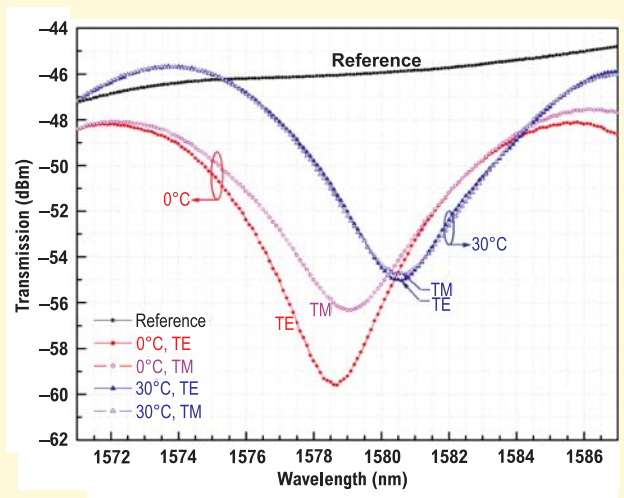


Fig. 3(b): Transmission spectra of LPWG device for quasi-TE and quasi-TM mode at 30°C

Parameters and specifications achieved for silica-on-silicon based LPWG

LPWG parameters	Material Parameters	Specifications achieved
Waveguide width = 6 micron Waveguide height = 6 micron Waveguide length = 30 mm Grating length = 15 mm Grating period = 228 micron Tooth-height = 85 (\pm 5) nm	Substrate: Silicon Under-cladding: Undoped SiO ₂ (thermally deposited): RI (1.445), Thickness (15 micron) Core: Ge-SiO₂ (PECVD): RI (1.457), Thickness (6 micron) Over-cladding: BPSG SiO₂ (PECVD): RI (1.445), Thickness (6 micron)	Grating resonance wavelength: Tunable across L-band 1577 – 1584 nm for Temp: -30 to +70°C Grating strength: 9-11 dB (quasi-TE), 7-9 dB (quasi-TM) Bandwidth (FWHM): ~ 7 nm Tuning: Temperature-tunable Operating temperature: -10°C to +50°C (tested up to +70°C) Loss: Low-loss design; total loss: ~4.4 dB for device length of 30 mm (including input and output coupling losses) Polarisation: Polarisation-independent (at room temp.)

index contrast, which would lead to a polarisation-insensitive measurement for the device at that temperature. The detailed parameters of LPWG and material along with the specifications achieved, are listed in the table.

A packaged LPWG device is shown in Fig. 1. Figs. 2(a) and 2(b) show the change in transmission spectra of the LPWG device with the variation of temperature for quasi-TE and quasi-TM modes. Fig. 3(a) shows the transmitted

spectra of the device at 0°C for un-polarised, quasi-TE and quasi-TM polarised light, where as Fig. 3(b) demonstrates the polarisation-insensitive measurement at 30°C with respect to a slight polarisation-sensitive measurement at 0°C.

New Projects

MEMS Microcantilever-based Biosensors for Medical Diagnosis

Sponsor : CSIR ; *Sanctioned Amount* : Rs 1.70 crore; *Participating Institutes*: Centre for Cellular & Molecular Biology (CCMB), Hyderabad, (Nodal Laboratory); Central Electronics Engineering Research Institute (CEERI), Pilani; and Central Scientific Instruments Organisation (CSIO), Chandigarh; *Duration*: Four years

The project is under “CSIR Network Programme on Nanomaterials and Nanodevices for Application in Health and Disease” with Centre for Cellular and Molecular Biology (CCMB), Hyderabad as nodal laboratory. In this programme, CSIR laboratories including CEERI, are participating

to develop nanomaterials and nanodevices for applications in human health. CEERI will work with CSIO and CCMB on the microcantilever activity.

CEERI will be concentrating its efforts and expertise on the development of MEMS-based biosensors for the detection of different diseases. Micro-cantilevers have been recognized as electromechanical sensing elements for different bio-molecules responsible for a disease. Microcantilevers can be sensitised with the help of bio-protocols based on antibody-antigen interactions for specific disease viruses. The advantage of using microcantilevers

is the speed of detection and portability, which make them potential tools for mass screening of epidemics. Another advantage, after development will be the ease of diagnosis without having specific technical knowledge.

Objectives:

- To develop technology for the fabrication of microcantilever structures
- Technology development for the detection of cantilever deformations
- Development of compatible micro-fluidics for sample handling and delivery to cantilevers
- Packaging techniques



Maintaining 6” Silicon Wafer Fabrication Facility for Supporting R&D Projects Under NPMASS

Sponsor : National Programme on Micro and Smart Systems (NPMASS); *Sanctioned Amount*: Rs 2.60 crore; *Duration*: Three years; *Expected Output*: Efficient MEMS foundry service

The Millimeter Wave Semiconductor Device Fabrication and Testing Laboratory, set up in late 80s, was modified and rearranged by accommodating state-of-the-art equipment required for fabrication of MEMS microsensors on 150 mm diameter silicon wafers. Equipment

suitable for MEMS device fabrication were inducted for making “Mini Foundry”, capable of process development for realisation of user-specified devices, and their fabrication and supply in quantities of a few thousands. The team at CEERI MEMS Laboratory is fully capable for accepting any challenging task from the users in the field of MEMS and microsensors fabrication.

Under this project, the 6” MEMS facility of CEERI will be

made available for NPMASS projects. CEERI will fabricate designs of MEMS sensors and structures submitted under NPMASS activity on 6” silicon wafers. Any design submitted under NPMASS funding will be taken up for its realisation after interaction with the designer to develop necessary unit processes. The estimate of the fabrication charges will be communicated to the designer along with any alteration of process steps.

Microsensors for Biomedical, Food and Environmental Applications

Sponsor: National Programme on Micro and Smart Systems (NPMASS); *Sanctioned Amount*: Rs 65 lakh; *Duration*: Three years; *Expected Output*: To develop a disposable chip for detection of biomedical and environmental parameters based on minute changes in pH

This project involves CEERI, Pilani; CECRI, Karaikudi; and Bigtec, Bangalore; with the objective to develop biosensors, specific ionsensors and gas sensors based on ISFET (ion-sensitive field effect transistor) and EGFET (extended-gate field effect transistor) pH sensors, in the form of products. Ion-sensitive field effect transistor (ISFET) is a generic structural platform for fabricating specific-ion chemical

and biosensors. EGFET is another structure in which the sensitive part (consisting of a pH-sensitive film on a conducting substrate) is made separately and connected as an extension to the gate of a commercial MOSFET. The combination behaves as an ISFET. For fabricating ISFET/EGFET-based gas sensors, a hydrophilic polymer layer containing electrolyte is provided which at least extends over both the FET gate region and a part of the reference electrode. A gas permeable membrane is laid over the polymer layer. pH of the electrolyte changes with gas concentration.

The objectives of this project are: (i) Perfection of ISFET technology involving improvement of

ISFET packaging technology, and ISFET measurement circuit to 0.01 pH accuracy. (ii) Development of the fabrication technology of EGFET structure by sputtering method and provision of EGFET platforms for microsensor fabrication. (iii) Development of prototype of EGFET readout circuit. (iv) Perfection of ISFET gate coating technology for specific analytes. (v) Development of ISFET/EGFET-based sensors for dissolved gases like CO₂, NO, and NH₃ for environmental applications. (vi) Development of ISFET/EGFET-based sensors for Ca(II), creatinine and urea for clinical diagnosis. (vii) Development of ISFET/EGFET-based microsensors for H₂O₂ for analysis of breath gas in clinical diagnosis.

R & D on Design, Development and Supply of Piezoresistive MEMS Absolute Pressure Sensor

Sponsor: Department of Space, Government of India; *Sanctioned Amount:* Rs 96.60 lakh; *Duration:* 18 Months; *Expected Output:* Piezoresistive MEMS pressure sensor dies, 1000 numbers each, in five pressure ranges, viz. 30, 50, 70, 100 and 300 bar, and further, 100 numbers, in each range, in packaged form on headers to ATDD, LPSC

The conventional pressure sensors are bulky and consume large power for their operation, which in turn, increases the launch and

operational costs of the space missions. With the evolution of MEM technology, these pressure sensors are being replaced by MEMS microsensors having the advantages of small size, weight and low power consumption. The additional advantage is that they can be scaled down further according to their application. CEERI has already established its expertise in design and development of MEMS-based sensors. It has a well-equipped MEMS laboratory with proven

technology for silicon-based MEMS devices. Based on this experience, the above project has been taken up with a challenge to develop pressure sensors with stringent reliability and superior quality, mandatory for space qualification. CEERI will also batch produce these devices to cater to the preliminary testing needs of LPSC (ISRO), Bangalore. The ultimate aim of the development of device is socio-economic upliftment of rural India through communication networks.

Fabrication of MEMS Acoustic Sensor Chips

Sponsor: Department of Space, Government of India; *Sanctioned Amount:* Rs 28 lakh; *Duration:* One year; *Expected Output:* 100 Nos. of chips of MEMS Acoustic Sensor and 10 Nos of acceptance-tested samples (mounted on header and wire bonded)

The MEMS acoustic sensor consists of a micromachined silicon diaphragm over a cavity and pyrex glass bonded on the back side. Above the diaphragm, there is a

layer of thermal oxide and then zinc oxide piezoelectric layer sandwiched between PECVD SiO₂ layers with bottom and top Al-electrodes. A micro-tunnel is made inside each device for the compensation of changes in a acoustic pressure during vibration of the diaphragm. The electrical specifications of the acousticsensor are given below:

- Range of sound pressure level

(SPL) 100-180 dB

- Resonance Frequency 39.67 kHz
- Signal on region around edges
In terms of Voltage 165 μV/Pa
In terms of Charge 0.028 pC/Pa
Capacitance 171 pF
- Signal on region around center of diaphragm
In terms of Voltage 308 μV/Pa
In terms of Charge 0.025 pC/Pa
Capacitance 81 pF

Development of Acid Texturisation System and Process of Multicrystalline Silicon Wafers for Solar Cell Applications (R&D collaborative project)

Sponsor: ASSCP, Bharat Heavy Electricals Limited, Gurgaon; *Sanctioned Amount:* Rs 19 lakh; *Duration :* Two years; *Expected Output:* (i) Design of acid texturisation system and freezing the specifications of the system. (ii) Optimisation of acid texturisation process at laboratory level. Surface texturisation of silicon wafers reduces the optical losses

and improves the efficiency of solar cells. CEERI has expertise in silicon mesa etching and single crystal thinning using hydrofluoric and nitric acids. Since the texturisation process involves similar acidic processes, CEERI has taken up the challenging task of optimisation of texturisation process of multicrystalline (mc)-Si wafers. The

knowledge of automation, acidic processes and handling thin silicon wafers will be utilized in designing the Acid Texturisation System. The objectives of this project include standardisation of the texturisation process, design of the texturisation system and transfer of know-how to BHEL for industrial production of mc-Si solar cell.



Central Food Technological Research Institute (CFTRI), Mysore

R&D Highlights: 2008-09

The Central Food Technological Research Institute (CFTRI), Mysore, continues to make notable contributions in the field of nutrition, nutraceuticals, functional food, processes, products, automation, biotechnology, biomolecules, ameliorative studies, analytical strategic research and societal programmes. Presented here is a brief account of achievements under the various R&D projects during the past year. Also covered is the work carried out under the supra-institutional project and network project in which CFTRI is the nodal laboratory.

Nutrition

Enhancement of bioaccessibility, nutraceutical oil blends, role of enzymes on *chapati* making quality, fresh water fishes as the source of lipids and the use of fish eggs for the preparation of health-beneficial bakery products are among the major aspects studied.

Influence of therapeutic levels of exogenous iron and calcium on the bioaccessibility of zinc from selected staple grains were examined. The studies revealed that soy protein had negative effect on iron bioaccessibility, where as the raw and cooked grains enhanced the zinc bioaccessibility by 50% and 90%, respectively. Beta-carotene rich sources such as carrot and

amaranth and curcumin were found to have positive effects on zinc and iron bioaccessibility from food grains. Antioxidant rich oil blend was prepared using rice bran oil,

the nutritional status of coconut oil and also to make it pourable at low temperature, coconut oil was blended with linseed, safflower and sunflower oils. The blend of 70%

coconut oil to 30% sunflower seed oil improved the pourability and nutritional status. Trans-fatty acid free plastic fats as an alternative to hydrogenated *fat* and cocoa butter substitutes were prepared. *Sal*, mango, palm, palm oil fractions and coconut oil fractions were used for interesterifications. Coconut oil blends with sunflower oil, rice bran oil and palmolein ensured high stability and sensory acceptability. Blends of coconut oil were prepared with sunflower oil, rice bran oil, safflower oil, groundnut oil, sesame oil and palm oil. The incorporation of coconut oil to sunflower and rice bran oils provided oxidative stability, where as the addition of sunflower oil and rice bran oil to coconut oil contributed to

Achievements at a glance 2008-09

Patents filed in India	18
Patents filed Abroad	10
Research Papers published	140
Reviews	12
Book Chapters	3
Papers in Proceedings	4
Grant-in-aid Projects	76

Industrial Achievements

Consultancy Projects	44
Sponsored Research Projects	9
New Processes developed	14
Technologies transferred to Industries	49
Product Samples analyzed	2454
Technical Counselling	477
Technical Enquiries	5233

Human Resource Development

M.Sc. Students passed out	25
ISMT Students passed out	16
Short Term Courses	41
Ph.Ds awarded	25

sesame oil, lignan and tocopherol concentrates. The sensory attributes were found to be comparable to that of any commercial samples. Garden cress (*Lepidium sativum*), an edible underutilized herb was assessed for fatty acid composition, Sn-2 composition of fatty acid in triglycerides, quality, storage and stability. It was found that the oil was stable up to four months when stored at 4°C. In order to enhance

radical scavenging effects of the blends. Two structured lipids containing 29% behenic acid were prepared by enzymatic interesterification. These lipids have the physical characteristics similar to that of bakery products, making them suitable for the preparation of low calorie biscuits and cakes. Palm oil was fractionated and its suitability was assessed for its use as a vanaspati substitute. Trans-fatty

acid-free bakery shortening was prepared from palm oil fractions blended with rice bran oil.

Studies were made on the role of enzymes such as superoxide dismutase and phenol oxidases in the cross-linking of wheat protein on quality of different wheat varieties. Proteins and pentosans were isolated from different wheat varieties to study their effect on the *chapati* making quality. High pentosan content was observed to wheat cultivars with good *chapati* making properties, along with high arabinose - xylose ratio. Effect of peroxidase on textural and physico-chemical parameters of wheat dough was carried out. Significant increase in dough hardness and decrease in adhesiveness was observed, by incorporating peroxidase. The extent of cross-linking of gluten subunits by peroxidase was found to be dependent on enzyme concentrations.

Fresh water fishes such as *Catla*, *Rohu*, *Mrigal*, Common carp and *Tilapia* were analyzed using their meat, head and viscera parts for total fat content, lipid classes and quality. The study indicated the potential of fresh water fish wastes as a source of lipids. Fish egg lipids of most of the fishes contained significant amount of phospholipids. The use of fish egg protein concentrates into bakery and extruded products resulted in improved protein content.

Detoxification of oilseeds, *Jatropha*, *Karanja* and *Simrouba* were carried out using different methodologies. Rats were fed with casein, 50% detoxified meal and 100% detoxified meal and the

efficacy and the level of detoxification of the meal was assessed. Removal of the toxic and anti-nutrients in all the three oilseeds were found to be partial.

Sugar was fully replaced with alternative sweeteners and the effect of these sweeteners on viscosity, texture and sensory quality of chocolate was studied. It was evidenced that polyols like maltitol, xylitol and isomalt could be used to prepare sugar-free chocolates without affecting the rheology and sensory quality significantly. Butter spread enriched with polyunsaturated fatty acids (PUFA), blend consisting of *Sal* and RBO along with hardened oil showed a melting profile comparable to that of commercial butter. A process for cereal bar preparation with dry fruits and nuts was standardized.

Nutraceuticals

Antioxidant activity of hydrolysates prepared from Japan seaweed, *Akamoku*; antiinflammatory, antioxidant and antiulcer properties of the nutraceutical molecules derived from sesame, marigold and *karanja*; influence of xylooligosaccharides (XOS), a non-nutritive sweetener; and the radical scavenging and antioxidant properties of the *Mangosteen* (*Garcinia mangostana* L.) pericarp extracts were assessed.

Njavara rice, cooked along with herbs is used for ayurvedic treatments. The rice is easily digestible with good high fiber content and vitamins, it could be a good source for infant and geriatric foods. Brown rice obtained by bioprocessing (controlled

germination, hydrothermal treatment, drying, devegetation and dehusking) had oryzanol retention up to 100%, tocotrienols (80-96%), vitamin E (70-76%) and antioxidant activity (45- 77%). *Njavara* and *Jyothi* were found superior compared to IR 64 owing to the presence of higher content of lipid soluble antioxidants. Thermal stability of antioxidants Chilli and pepper extracts incorporated into soyabean oil, sunflower oil and groundnut oil were evaluated.

Functional Foods

Studies were carried out on lactic acid bacteria cultures isolated from selected food materials for inhibition zone of *V. cholerae*. *Pediococcus pentosaceus* MTCC 5151 culture showed maximum inhibition to *Shigella* from feces. *Lactobacillus plantarum* has high antimicrobial activity against toxic food pathogens such as *Klebsiella*, *Acetobacter*, *S. typhi*, *L. monocytogenes*, *Shigella*, *E. coli* and *Pseudomonas*. An oat based beverage supplemented by this culture was prepared. Bacteriocinogenic cultures were isolated from vegetables, cereals, intestinal sources and fermented foods. Screening of the pediocin, PA-1 processing lactic acid bacteria from vegetables, dairy and fermented food was done.

Studies were made on biological activities of enzyme hydrolysis of proteins and synthesis of peptides generated from food protein hydrolysates for their use as ingredients in functional foods. ACE inhibitory activity of proteins such as whey, casein from bovine milk,



watermelon seeds and ground nut proteins were evaluated. The whey protein hydrolysates showed ACE inhibition and antioxidant activity with IC₅₀ values of 0.23 mg/ml and 6.9 mg/ml, respectively.

Onion agglutinin (*Allium agglutinin*, ACA), a 50 kD mannose-specific lectin having subunit was obtained from onion. ACA agglutinates rabbit erythrocytes. Onion agglutinin has moderate immunomodulatory activity with respect to lymphocytes proliferation.

Oligosaccharides are popular as a probiotic and there is a large demand for these as functional foods. Water soluble polysaccharides (WSP) and water insoluble residues (WIR) from bengal gram husks subjected to xylanase treatment yielded 8.8 and 5.2% of xylooligosaccharides (XOS), respectively. XOS from WSP consisted of xylose and arabinose in the ratio 1 : 3.5 whereas that from WIR consisted xylose, arabinose and galactose were present in the ratio 1 : 1:2.

Processes

Studies were made on the recovery of value-added products from the wastes of poultry industry and sea foods processing. Protein was extracted from poultry intestine. Conditions were optimized for the maximum proteases activity in the extractants. The effect of ensilaging on the proteases activity was assessed. Studies were also conducted for the stabilization of enzymes using various organic solvents.

To evolve an integrated

biocompatible method for downstream processing for natural colorants and enzymes, separations with membrane processing, aqueous two phase extraction (ATPE) and reverse micelle extraction (RME) were carried out. *Kokum* extract, was made using direct osmosis and osmotic membrane distillation at ambient temperature and atmospheric pressure. Integrated membrane processing (IMP) using suitable MF and UF membrane enhanced the specific activity of the submerged fermentation (SmF) PG to nearly fivefold. The IMP approach revealed its potential for purification as well as concentration for the SmF-PG. The experimental results showed UF has the potential to be a single step process for desalting and concentration of eluted PG. *Okara*, a byproduct obtained during processing of soymilk is an underutilized source of protein. To find out the effect of particle size on the recovery of protein, solubility of soybean and *Okara* protein was studied at different pH levels. The outcome in terms of protein recovery, quality and productivity indicated the use of MF 450 nm membrane for optimum results.

Extension of storage life and quality parameters of pink flesh guavas (CV.L-49), brinjals and cauliflowers were evaluated for different packaging films and temperatures. Coffee industry substrates such as coffee pulp, coffee cherry husk, silver skin, spent coffee and a mixed combinations were evaluated for their efficacy as a sole carbon source for the synthesis of alpha-amylase in solid state

fermentation (SSF). Maximum alpha-amylase activity was observed in the case of coffee pulp and the mixed combination with steaming. Conserves and value added products were prepared using pepper and ginger oils extracted from pepper powder and dry ginger powder, dried with spent residues. Sensory analysis and consumer acceptance studies showed that the bengal gram flour based *Sohan papdi* was more acceptable than the one made using wheat flour.

Bacterial PHA production using starch as a carbon source was investigated. Around 200 cultures from different soil samples were isolated, purified and maintained on nutrient agar slants. Twenty of these isolates were found to produce a maximum of 63% PHA in the biomass with sucrose or glucose as carbon source.

Products

The *chapatis* prepared using whole wheat flour adding selected preservatives, stored for 21 days were compared against the fresh *chapatis*. Sensory studies showed acceptable quality. In order to make fabricated wheat based breakfast cereals, moisture and powdery mixture of the whole wheat flour, corn grit along with other ingredients were extrusion cooked and flaked. Flakes were dried and coated to prepare the breakfast cereals. Bengal gram dal and green gram dal flours were selected to prepare legume based pasta and their chemical characteristics were analyzed. Multigrain mix (MGM) was prepared using oat flakes, soyabean, fenugreek, flax seeds and

sesame seeds by milling them into grits of equal quantity. Replacement of whole wheat flour with 15% MGM was used as the control with the combination of different additives. MGM (15%) showed significant improvements in the volume and decrease in crumb firmness with enhanced sensory attributes. A formulation for the preparation of multi-grain bread was standardized. Selected raw materials, viz. wheat flour, *Aestivum* and durum semolina, white oats, coarse wheat bran, defatted soy flour (DSF) and whey protein concentrate (WPC) were analyzed for the protein content and dietary fibre for the preparation of instant vermicelli. Vermicelli with *Aestivum* semolina was found to be more suitable compared to durum semolina. Non-wheat protein supplementation with DSF and WPC blended at different levels was evaluated for rheological characteristics of the wheat flour dough. Wheat flour substituted by finger millet flour showed that 60% finger millet flour was optimum in muffins. Thermally processed *chapatis* kept in refrigerated storage for a period of six weeks were evaluated in comparison with the freshly prepared ones. Standardization of recipes for the preparation of *Wadian* with various blends of cereals, pulses and vegetables were carried out. Blends of ready-to-serve pulpy fruit juices (smoothies) were prepared from selected regional varieties of fruits; papaya, mango, pineapple, watermelon, banana and grapes.

Under the supra-institutional projects, nutrition intensive

products were formulated using quality proteins fortified with micronutrients. These include: Supplementary foods for children, Fruit and vegetable based snacks, Egg albumin *paneer*, Vegetable oil, Nutra-rich *chikki* and fortified beverages.

Shelf-life extension of *Capsicum* using chitosan and chitosan blended poly-psi-capralactone was tried. *Capsicum* samples packed in chitosan blended could delay the ripening and extended shelf life for two weeks.

Automation

Conceptual design of an automatic weighing machine for wheat products, extrusion and encrusting of traditional snack, kargikai and machineries for integrated coconut processing were at different stages of development. In the network project, design and development of machineries were carried out for *Roti* making units, Forming and frying units for *Murukku/Sev*, *boondi* and *poori*; Lemon cutting machine, *Jilebi* forming unit, Rotary drum roaster, Mini *chakki* mill, low- moisture foods, Garlic peeling machine, Pressure frying units for meats and Laboratory freeze dryer. Also the isolation of bioactive and nutraceutical compounds from curry leaves and fenugreek seeds were carried out.

Biotechnology

Based on the studies conducted, two fold increase in the production of nigerloxin was achieved supplementing wheat bran with appropriate content of sweet lemon

peel, methanol by controlling various process parameters such as moisture content, initial inoculum size and incubation period. The product was found stable between the pH 4-5. Efforts were made to detect and quantify the intracellular vitamin B₁₂ produced by lactic cultures. Competitive ELISA was used for the detection of cobalamin concentration in the culture extracts of lactic acid bacteria. A simple, quick and sensitive chemiluminescence (CL) based method was developed in which parameters such as luminol concentration, hydrogen peroxide concentration and pH were optimized for obtaining the maximum CL. *Spirulina* biomass extract was evaluated for B₁₂ using HPLC, microbiological assay, AAS and chemiluminescence methods.

Studies were made at the institute to find out the role of *Coffea canephora* and caffeine production in the embryos using coffee *in vitro* cultures. Transformation studies to develop plants with antisense and RNAi constructs of N-methyl transferase was in progress.

Characterization of one of the transgenic coffee plant for correct integration and functioning of the inserted fragment, i.e. RNAi or antisense construct of N-methyl transferase was completed. *Bixa orellana* roots obtained by *in vitro* normal root cultures was able to produce ~0.36% of the total annatto pigment. Different abiotic and biotic elicitors were used to find out effect on annatto pigment production in the normal roots. The total annatto pigment content during the ontogeny of *Bixa orellana* L. fruit was



analyzed. Extraction of RNA from the seeds and seedlings of *Bixa* and cDNA from extracted RNA were standardized. Primers were designed for three important enzymes involved in the bixin biosynthesis pathway. Genetic transformation of *Dunaliella bardawil* with astaxanthin biosynthetic gene from *H. pluvialis* was tried. Amplification of approximately 1.9 kb was obtained from the genomic DNA of *H. pluvialis* for beta-carotene ketolase gene. Cloning of beta-carotene ketolase gene into binary vector is under progress. Suitable shoot multiplication media using Thidiazuron (TDZ) was standardized for explants such as cotyledonary leaf segments, hypocotyls and leaf segments.

Monascus purpureus MTCC 410 fermented rice (red mould rice) is one of the food supplements used in order to lower the blood-lipid levels. Safety of the red mould rice (RMR) was studied in albino rats. Rats fed with the RMR showed significant reduction in the cholesterol and triglycerides levels in both serum and liver without causing any toxic effects in the rats. UV mutant of *Aspergillus carbonarius* grown in shake-flask cultures over produced polygalacturonase and accumulated carotenoids like partially saturated astaxanthin and canthaxanthin in their biomass. Differential display RT-PCR techniques are being standardized for the pigment synthesis.

The pattern of gene expression for several genes involved in carotenoid biosynthesis in tomatoes was studied. *Arka Ahuti* showed

highest carotenoid accumulation at BR7 stage, where typically a higher expression of upstream genes coincided with sudden drop in the expression of downstream genes. Also tissue culture protocols for the *in vitro* growth of tomato (Cv. *Arka Ahuti*) were also standardized. An mRNA-differential display technique coupled with silver staining was developed for the identification and isolation of cDNAs representing transcripts, differentially expressed during banana ripening process.

Biomolecules

The allergens from egg plant pulp, (43, 45, 64 and 71 kD) were characterized as glycoproteins by periodic acid-Schiff staining. Zymograms exhibited beta-fructofuranosidase activity in 52 and 54 kD proteins. Coffee diterpenes, cafestol and kahweol are known to be cholesterol elevating factors present in the saponifiable fraction of coffee brew. Documentation of the levels of cafestol and kahweol in coffee and the effect of various brewing and roasting methods on diterpene profile are in progress.

N-terminal peptide (residues 1-13) mimicked obestatin, a 23 amino acid C-terminus amidated peptides produced in stomach. Middle fragment (residues 6-18) reduced epididymal fat without altering the feed intake or gain in body weight. Phe5 and Gly8 were substituted and synthesised to obtain Nt5cha and Nt8U peptides and by replacing both Gly3 and Gly8 in the middle fragment, Mf38dU was obtained. The substitution of glycine with alpha-aminoisobutyric acid at

position 8 in the N-terminal fragment rendered the peptide as effective as obestatin. Also the double substitution of glycine at position 3 and 8 by alpha aminoisobutyric acid in the middle fragment has led the peptide, Mf38Du to be effective in reducing the gain in body weight, total cholesterol without affecting its ability to reduce the epididymal and perirenal fat.

Ameliorative Studies

Bacopa monnieri ethanolic extract (BME) and brahmi capsules were supplemented in diets to adult males of *Drosophila melanogaster* for a period of 7 days. Preliminary studies have indicated that BME has a potential to alleviate rotenone induced neurotoxicity in *Drosophila* model. *Bacopa monnieri* standard extract offered significant protection against paraquat induced mortality.

Banana, a rich source of bioactive compounds and dietary fibre is considered effective as an antidiabetic agent. Methanol and water extracts of flower showed 3.9% and 3.4% antioxidant effects respectively. DPPH assay of methanol and water extracts for flower and stem were found to be 17 and 19%, respectively.

Alpha-Synuclein is found in the form of aggregates in Parkinson disease affected brains and it was found glycosylated in the aggregation. Effect of glycation on DNA binding was studied using conformation specific oligonucleotides, 5' CGCATATATGCG 3'. Circular dichroism spectroscopy showed that *alpha-Synuclein* bound to 5' CGCATATATGCG 3', but not

induced any conformational change in the oligonucleotide. *H. pylori* was isolated from endoscopic samples of gastric ulcer patients. The Swallow Root Pectic Polysaccharide (SRPP) showed effective healing of acetic acid induced gastric ulcer (~88%) at 200 mg/kg body weight. It was inferred that healing was due to the ability of SRPP to enhance the mucin synthesis, inhibition of H+K+-ATPase enzyme which controls acidity and also inhibition of *H. pylori*. SRPP treatment showed clear evidence of restoration of epithelium and reduced inflammatory exudates after 5 days of treatment. The treatment also increased mucine synthesizing cells and regenerated completely similar to that of controls after 10 days by upregulating the production of PGE2 and by down-regulation of matrix metallo proteinases.

Amelioration of hyperglycemia and other associated complications were studied with finger millet, pearl millet and foxtail millet. Lipid soluble antioxidants such as tocopherols and carotenoids are rich in finger millet and pearl millet, and the polyphenols were lower in foxtail millet. In terms of total antioxidants and free radical scavenging activity, finger millet was more potent. Galectin-3 is a galactoside-binding protein, which plays a key role in cell-cell matrix interactions leading to invasions and metastasis. Stages of the diseases with galectine-3 level and Swallow Root Polysaccharide (SRPP) inhibition of metastasis were correlated. Diabetic induced *prepubertal* (PP) rats of 4 and 6 weeks old were investigated for

oxidative dysfunctions in *mitochondria/microsomes*. Evidence suggested that during acute phase, testis mitochondria/microsomes were less susceptible to oxidative stress compared to stress during progressive phase. Amyloid betapeptide is a key etiological factor involved in the pathogenesis of *Alzheimer's* disease. Investigations were carried out to understand the mechanism of amyloid beta-enantiomers binding to DNA and to characterize nicking property of amyloid.

Analytical Strategic Research

A simple analytical device was developed for noninstrumental immunoassay. The device was used to estimate low concentrations of DDT in food samples by using an improved catalysed reporter deposition. Spiked and contaminated samples of milk, soft drinks and vegetable samples were analyzed. The dipstick chemiluminescence method was able to detect the DDT at 50 ppt level where as the gold nanoparticles based dipstick assay could show the sensitivity in the range 1000-30 ppb.

Bioactive molecules having insecticidal activity against *Rhizopertha dominica*, *Sitophilus oryzae*, *Tribolium castaneum* and *Callosobruchus chinensis* were characterized. The compounds were also found effective against wheat and green gram infestation in grain treated at 0.1 g/kg. Usefulness of *C. elegans* as a model for toxicity of anticholinesterase compounds was demonstrated. *C. elegans* could be suitably exploited for studying the oxidative stress due to toxicity by

pesticides. Suitable detection methods of GMOs in insect resistant Bt-brinjal and Bt-cauliflower, DNA based methods targeting 126 bp fragment of the junction region between CaMV 35S promoter (not duplicated) and cryIAC gene of the transgenic construct inserted in Bt-brinjal were developed and validated.

Bacterial cultures belonging to DDT degrading microbial consortium were screened for the DDTdehydrohalogenase activity. The cell free extract of *Pseudomonas putida* T5 showed higher DDTdehydrohalogenase activity and enzyme was purified to apparent homogeneity with 73% overall recovery. The primary sequence of HPLC purified enzyme protein was deduced by LC-ESI-MS.

Societal Programmes

Food Processing Training Centres (FPTC) were established at Nizamabad and Anantapur districts (Andhra Pradesh) in coordination with the District Rural Development Agency (DRDA), Government of Andhra Pradesh. Various equipment and machineries were installed for the dehydration of fruits and vegetables. Awareness and hands-on training programmes were arranged for the entrepreneurs and DRDA personnel in which the ready to serve beverages (pineapple), Squash (orange), Mixed fruit jam, Tomato ketchup, Chilly sauce, Ginger and onion brine, Ginger and garlic pastes as well as dehydrated onion and potatoes were demonstrated.



Shri Prithviraj Chavan, Minister for S&T and Earth Sciences visits NAL

Shri Prithviraj Chavan, Minister for Science and Technology & Earth sciences, and Vice President CSIR accompanied by Prof. S.K.Brahmachari Director General, CSIR, visited National Aerospace Laboratories (NAL), Bangalore, on 18 June 2009. Dr A. R. Upadhyya, Director, NAL, while welcoming the distinguished guest and the Director General to the Laboratories, said that NAL was very proud that the Hon'ble Minister has chosen the Laboratories for his first visit amongst the CSIR Laboratories after assuming charge as the Minister for Science and Technology. He informed the Hon'ble Minister that the Laboratories was celebrating its Golden Jubilee and he was happy to have the Minister's visit during this landmark year.

Dr Upadhyya in his address presented an overview of the current activities of the NAL and the future programmes, stressing the three-fold mission of the Institution— Establishing national strengths in aerospace S&T through R&D and infrastructure development, advanced technology support to national programmes, particularly in defence and space sectors and small civil aircraft design and development. The laboratory has established itself as a leader in critical technology areas in the last five decades. It has provided valuable strategic technologies and testing services to the prestigious Light Combat Aircraft programme and missile

programmes of DRDO, launch vehicle and satellite programmes of ISRO, Life extension/upgradation programmes of IAF and Indian Navy etc. Some societal contributions of NAL include, solar selective coatings, wind turbines, solar energy harvesting, and the under-development micro gas turbines, multi terrain vehicle etc. The civil aircraft programme included the pioneering all composite trainer *HANSA*, the under certification multi role light transport aircraft *SARAS*, the first public-private partnership in aircraft design — the five seat NM-5 with Mahindra Aerospace Pvt Ltd, and the ambitious network project – the 70 seat regional transport aircraft which is expected to launch India as a major civil aircraft designer and manufacturer.

Shri Chavan in his address said that NAL has covered many areas of aerospace research including civil aeronautics, but we were lagging behind in the civil aircraft sector when compared to countries like Brazil. He stressed that in spite of the unfortunate accident to *SARAS* aircraft, he was positive about the success of the programme and would support it to reach full airworthiness certification. He expressed his confidence that aircrafts like *SARAS* and *RTA-70* would not only promote indigenous technology and industrial development but also would be good for regions like north eastern states, and high altitude routes such as from Leh to Kargil, Srinagar etc. Sharing Hon'ble Prime Minister,

Shri Manmohan Singh's message and expectations, he stated that this time the expectations were very high and that a visible change should be effected in every sector by making a technological or societal impact. It was his strong belief that science and technology alone could make the difference. Shri Chavan complimented the scientists for their excellent work and urged them to do more original, innovative contributions. He compared the situation in the early 70's when import licenses were mandatory, to the situation today when we can source anything from anywhere. He was of the opinion that research should be done at low cost and reasonable time frames. He stressed on the need for our research to be product oriented (and not just end up as spiral bound reports!) and on the need for the products to reach the market for the public good. The proof of our success was when people were ready to pay for our products. He assured the scientific community that they had his unstinted support. It was necessary for the country to ensure quality education with stress on science as there was no doubt that only science could make the nation prosperous.

During his interaction with the scientists, the Minister stressed on the need to adopt new management principles and e-governance for speedier, more efficient networking, communication and information dissemination. Citing an example, he said that sitting in Delhi one should be able to know the status of a project in Bangalore at the click



of a button. Prof. S.K.Brahmachari added that the present project management system was very archaic and that we should have a horizontal and vertical matrix type of project management.

Shri Chavan also sought information/clarifications on the status of the SARAS accident enquiry, revenue generated from the wind tunnels, proposed RTA objectives, program schedules, participating agencies, and manufacturing partners for HANSA. Responding to a query from the Minister, Dr Upadhyaya stated that unfortunately the country was not yet successful in indigenously developing large sized aircraft power plants, and thus large engines had to be imported as of now. NAL has developed small aircraft engines such as the Wankel engine which had been recently flight-tested on DRDO (ADE)'s

NISHANT UAV successfully. Dr Upadhyaya also spoke about NAL's recent large project from DRDO on R&D of MAV's, measuring less than 300 mm in size, weighing 300 g, and with a flight time of 30 minutes.

Shri Chavan remarked that in India the projects were generally overstuffed, yet take more time than originally planned. Efficient project management was essential to cut costs and deliver reliable products on time. Prof Brahmachari opined that the private sector did not find our science/products attractive as they felt that the products were not well conceived and hence not commercially viable.

In the end, the Director thanked the Minister for his visit, his valuable advice and words of support and encouragement. He also thanked the Director General

for the visit.

A visit to the Advanced Composites and Flosolver Divisions was also made. Dr Upadhyaya and concerned scientists briefed the minister on the technologies and products developed/under advanced stage of development in the Laboratories.

In his message in the Visitor's Book, Shri Chavan stated that he was very happy to revisit NAL after a period of almost 15 years, and his first official visit to a CSIR Lab after taking over as a Minister for S&T. He complimented the dedicated team of scientists and engineers of NAL on doing path-breaking work in several fields. He also stated that he expected NAL to deliver the first commercial aircraft.

The programme was co-ordinated by KTMD.



Workshop-cum-Training Programme on Advances in Processing of Heavy and Non-conventional Crude Oils

The first event of the Golden Jubilee Celebrations of Indian Institute of Petroleum (IIP), Dehra Dun, a workshop-cum-training programme on “Advances in Processing of Heavy and Non-conventional Crude Oils”, was held during 20-22 May 2009. Twenty executives of different refineries and oil companies participated in the workshop. Shri V. P. Sharma, Incharge, Training, welcomed the faculty and the participants. Shri G. S. Dang, Programme Coordinator of the workshop, said that the availability of light crude oil (conventional crude oil) on Earth is limited and is concentrated in Middle East but heavy crude oil (non-conventional crude oil) is located in different parts of the world. These heavy oils are currently available with discount and refiners want to encash it to increase their profit/refining margins. However, the production, transportation and processing of these heavy crude oils is a big challenge. The workshop covered three topics namely:

- Heavy oil production trends, composition, handling and transportation
- Various options for processing heavier crude oils/ residues
- Effect on refining configurations and also on refining-petrochemicals integration.

Speaking on the occasion, Dr Y. K. Sharma said that the magnitude of these extra heavy and heavy oil resources is almost in the



Seated on dais during the workshop (from left) are: Shri V. P. Sharma, Dr Y. K. Sharma, Prof. I.M. Mishra, Dr A. Datta and Shri G. S. Dang

same order of magnitude as those of light and medium oil, but at present their contribution to world supply is less than 5%. This can be increased by innovative technologies in refining sector.

Dr A. Datta, Officiating Director, IIP, while welcoming the delegates said that the ratio of reserves of crude oil to consumption has not changed for the last 40 years. This signifies that today we have advanced refining technologies and

every drop of the crude oil is being used profitably.

The Chief Guest of the function Prof. I.M. Mishra from IIT, Roorkee, who is also Dean of Saharanpur Campus of IIT, said that the main challenge in processing the heavy crude is to reduce the emission of green house gas, i.e. carbon dioxide. World has to look for technologies which do not affect environment and planet earth, he cautioned.



A group photo of the participants of the workshop



Dr Raghava Rao awarded Indira Gandhi Paryavaran Puraskar 2008

Dr Jonnalagadda Raghava Rao, of the Central Leather Research Institute (CLRI), Chennai, who is also a Fellow CLIFFer (LDP 0701 batch), has been awarded the prestigious Indira Gandhi Paryavaran Puraskar 2008 for his work on bio-processed leather that ensures a near-zero-waste leather tanning process. The award was conferred during the Environment Day Celebrations on 5 June this year at the hands of Hon'ble President of India Smt. Pratibha Devisingh Patil.

Born in 1961 at Nellore, Andhra Pradesh, Dr Rao obtained Bachelor's and Master's degree in Leather Technology from the Anna University, Chennai. He was a Fellow of CSIR during 1987-93, where he carried out Doctoral and Postdoctoral Research in Leather Technology.

Dr Rao's contribution to leather science and technology through fundamental changes in the conventional leather processing has revolutionized the leather sector. He has demonstrated these fundamental changes through paradigm shift from chemical to bioprocessing, narrow pH leather processing, pickle-free chrome tanning, reverse leather processing and integration of processes, thereby avoiding the 'Do-Undo' process logics. This led to the development of cost-effective and environmentally sustainable bio-mediated tanning technology for which Dr



Dr Jonnalagadda Raghava Rao, receiving the Indira Gandhi Paryavaran Puraskar at the hands of Hon'ble President of India Smt. Pratibha Devisingh Patil

Rao has been awarded Indira Gandhi Paryavaran Puraskar (IGPP) 2006 (Individual category), country's highest honour for preservation and protection of environment.

Dr Rao's research has generally pertained to the study of zero waste tanning methods, particularly chrome management in tanneries through various approaches. He has made several important contributions to the identification of low affinity tetrameric chromium species in the spent chrome tanning liquors. The application of his fundamental knowledge in the chemistry of chromium has led to the development of an innovative high exhaust chrome tanning salt as well as formaldehyde-free chrome syntan for which he received NRDC Award 2007. These technologies are gaining commercial importance (Burhani Foundation-NEERI Award 2001).

Dr Rao's recent work on a new integrated method of tanning is a

landmark in cleaner and zero waste tanning technologies. The bioprocessing in leather making is gaining global importance in recent times. The work on biocatalytic leather processing is a path breaking work in leather science with a paradigm shift from chemical to bioprocess. Dr Rao received Biotech Award 2005 from DBT, GoI for this work. He has received Environmental Award 2003 for the Best Research Paper in Environmental Science & Technology from the

Department of Environment, Government of Tamil Nadu and the Innovation Potential of Students Project Award (Doctoral Level) for the Dissertation on 'Approaches towards Zero Discharge Tanning Methods' by Indian National Academy of Engineering (INAE).

Dr Rao is a recipient of several other awards and prizes. Gold medal from the Indian Leather Technologists Association and prizes from Anna University, Mrs Kannamal Krishnaswamy Prize, Jawaharlal Nehru Memorial prize and BM Das Gold Medal for securing First Rank in M. Tech, a special award of Sulabh International for best paper presentation during Annual Conference of Indian Association for Environment Management and Hari Om Ashram Prerit Shri S S Bhatnagar Research Award for the prevention of water pollution are some of the landmarks in his career. He has been awarded Burhani



Honours & Awards/Appointments

Foundation-NEERI Award- 2001 for his Innovations in Environmental Sound Technology, Biotech Award-2005 for Process and Product Development and Commercialization for his Innovations in Bioprocessing of Leather from DBT, GoI and NRDC award for the invention on “A high performance polymeric syntan for ecobenign chrome tanning” – 2007. He has also been conferred the prestigious National Environmental Award the Indira Gandhi Paryavaran Purashkar Award IGPP-2006 in the field of Environmental Protection from The President of India, by the Ministry of Environment & Forests, Government of India. In recognition of the outstanding research work in the area of Leather Science and Technology leading to clean and green leather processing, The Tamil Nadu State Council for Science and Technology conferred on him, the Tamil Nadu Scientist Award (TANSA) in the field of Engineering and Technology for the year 2007.

He has published 150 papers in peer reviewed national/international Journals and about 85 technical reports and general articles. He is the first author of a ‘Workers Manual’ on Chrome Management published in three languages for the benefit of the leather industry. He is a reviewer for several international journals of repute. He is a leader of several projects under the Leather Technology Mission of the Government of India and CSIRO-CLRI collaborative programme. He has filed 23 patents, of which nine patents have been granted. He has developed 35 technologies of which about 15 technologies have been transferred to the industry.

He is an ‘Honorary’ Professor at Department of Leather Technology, Anna University. He is a Fellow of the International LEAD-INDIA Programme. He is a life member of several societies like the Indian Leather Technologists Association (ILTA), Chemical Research Society of India (CRSI) and Indian Science Congress Association (ISCA). He was a Member of Environmental Research Committee (2003-2006), MoEF, GoI.

Dr P. Banerjee, appointed Acting Director of NPL

Dr P. Banerjee, senior-most Scientist Gr. IV (6) of the National Physical Laboratory (NPL), New Delhi, has been appointed as Acting Director, NPL, w.e.f. 1 August 2009 till the date of joining the new Director, following the retirement of Dr Vikram Kumar on 31 July 2009.



Dr (Mrs) Veena K. Parnaik, appointed Acting Director of CCMB

Dr (Mrs) Veena K. Parnaik, senior-most Scientist Gr. IV(6) of the Centre for Cellular and Molecular Biology (CCMB), Hyderabad, has been appointed Acting Director, CCMB, w.e.f. 1 August 2009 till the date of joining of the new Director, following the retirement of Dr Lalji Singh, on 31 July 2009.

Shri Nitesh Gupta and Dr Ramesh Sundaram of NAL get K. Suryanarain Rau Memorial Award

ISAMPE “K Suryanarain Rau Memorial Award for Smart Technology Development-2009” was presented to Shri Nitesh Gupta and Dr Ramesh Sundaram, Advanced Composite Division, National Aerospace Laboratories, Bangalore for “Development of Fiber Optic Flow Sensor Technology for Manufacture of Composite Structures using the Vacuum Enhanced Resin Infusion Technology (VERITY) Process.”

Printed and Published by Deeksha Bist on behalf of National Institute of Science Communication And Information Resources (NISCAIR), (CSIR), Dr K.S. Krishnan Marg, New Delhi -110 012 and printed at NISCAIR Press, Dr K.S. Krishnan Marg, New Delhi -110 012

Editor: Dr B.C.Kashyap; **Associate Editors:** Meenakshi; Vineeta Singhal; **Editorial Assistant:** Neelima Handoo

Design: Neeru Sharma; Sarla Dutta; **Production:** Kaushal Kishore; **Editorial help:** Dr Sukanya Datta

Phone: 25846301; Fax: 25847062; E-mail: bck@niscair.res.in; meenakshi@niscair.res.in; vineeta@niscair.res.in; Website: <http://www.niscair.res.in>

For subscription: The Sales & Distribution Officer, NISCAIR; E-mail: sales@niscair.res.in; Annual Subscription: Rs 300; Single Copy: Rs 15.00

Subscription Complaint No: 25843359