

# CSIR NEWS

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Team CSIR



## New R&D products/techniques from CEERI

The Central Electronics Engineering Research Institute (CEERI), Pilani, has developed a number of new products/techniques in the area of its expertise. A brief description of these is as follows:

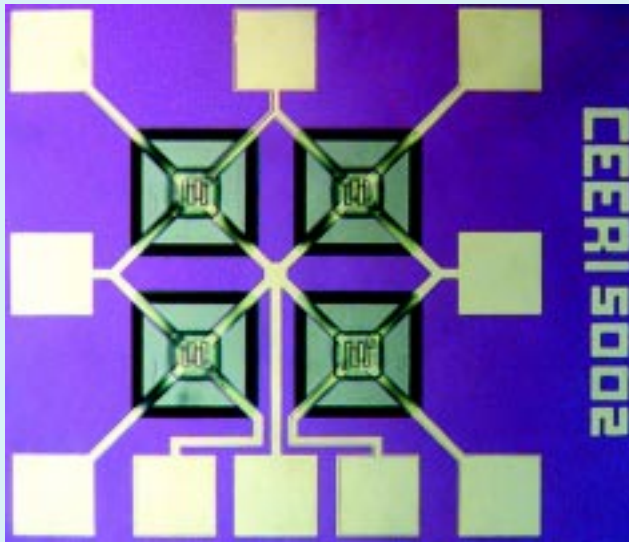
### **MEMS Hotplate for Metal Oxide Gas Sensors**

This is a generic structure for fabrication of gas sensors providing an elevated temperature platform for deposition of metal oxide films. Tin oxide, titanium dioxide and tungsten oxide are some of the commonly used materials for the fabrication of these sensors. Temperature in the range of 200-500°C is required to optimise the performance of the above materials.

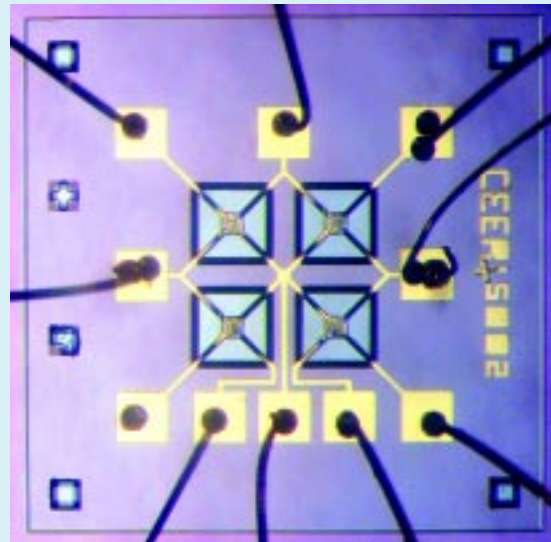
As compared to conventional technology-based hotplates, MEMS hotplate offers the advantages of very low-power consumption, around a few milliwatts, to reach these temperatures (the hot area being a thin membrane of low thermal conductivity), fast thermal response (in the range of milliseconds), small size, robustness, batch fabrication capability and low-cost.

The microhotplate developed at CEERI comprises a serpentine polysilicon heater fabricated on a 100 micron × 100 micron membrane of thermal silicon dioxide. For electrical insulation, the polysilicon heater is covered with a PECVD oxide layer. An interdigitated pair of chromium-gold electrodes has been patterned on this oxide layer for measuring the resistance of a gas sensing film to be deposited over it. Cr/Au contacts for the heater have also been defined in this metallisation layer. The polysilicon heater serves the additional role of temperature sensor.

The composite microhotplate structure of thermal oxide-polysilicon-PECVD oxide-Cr/Au layer has been suspended by four diagonal microbridges over a cavity in silicon etched by bulk micro machining process. The chip contains an array of four unit cells having the structural configuration described above. It has been mounted on a multi-pin header for wire bonding.



Microhotplate Chip



Top View of the Wire-Bonded Chip



Packaged Microhotplate Devices

Based on the temperature coefficient of resistance of polysilicon and observed resistance changes, on applying a bias to the heater, a temperature up to 367°C has been estimated for a heater resistance  $\approx 2 \text{ k}\Omega$  at a low-power supply voltage of 5V, corresponding to a power dissipation  $\approx 18 \text{ mW}$ . These are preliminary results and further studies are in progress.

Microheater-embedded gas sensors find wide applications in automobile exhaust emission control and for monitoring industrial environmental pollution by detecting gases like carbon monoxide, nitrogen

dioxide, sulphur dioxide, ethanol, acetone vapours, ammonia, etc.

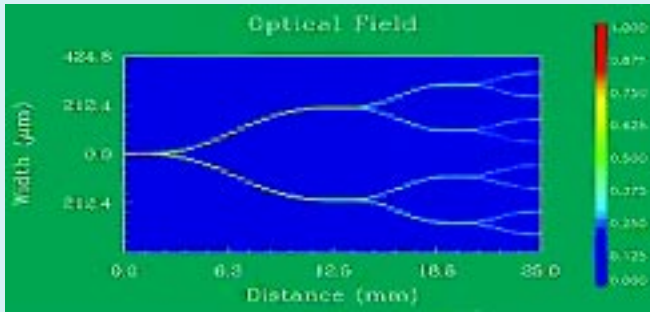
## Microhotplate Specifications

Poly Si heater finger width	: 10 $\mu\text{m}$
Interdigitated electrode width	: 10 $\mu\text{m}$
Width of the micro bridge	: 30 $\mu\text{m}$
Heater size	: 70 $\times$ 70 $\mu\text{m}^2$
Hotplate size	: 100 $\times$ 100 $\mu\text{m}^2$
Cavity size	: 300 $\times$ 300 $\mu\text{m}^2$
Die size	: 2.1 $\times$ 2.1 $\text{mm}^2$

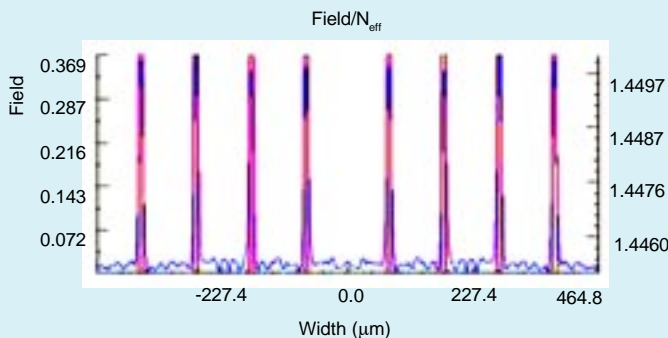
The development will lead to indigenisation of gas sensor technology.

## Optical Power Splitter

Silica-based planar lightwave circuits (PLCs) have lately attracted considerable attention due to their inherent superiority like low-insertion loss, possibility of hybrid integration, reproducibility and long-term reliability for the development of wavelength division multiplexing (WDM) and Fibre-To-The-Home (FTTH) applications. In view of its technological relevance, CEERI initiated an R&D activity in this important area of research under the CSIR network programme



Optical Field of the Device



Simulated E-field

of 15 μm thickness is applied as a top cladding layer. Figure shows the simulated E-field and optical field of the device.

### Input Parameters

Thickness of core	: 8 μm
Thickness of cladding	: 15 μm
Refractive index of core	: 1.4490
Refractive index of clad	: 1.4445
Relative index difference	: 0.3%
No. of input/output channels	: 1 × 8
Central wavelength	: 1550.12 nm

### Simulated results

E-field	: 0.359 (max) and 0.325 (min)
N <sub>eff</sub>	: 1.4497
Insertion Loss	: 9.989 dB
Non-uniformity	: 0.864 dB

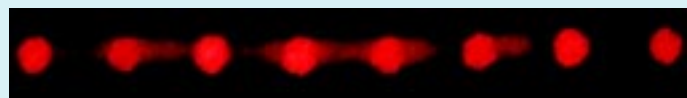
on 'Key technologies for photonics and optoelectronics'. Recently, a dual frequency PECVD system capable of depositing thick doped/un-doped silica film ( $\approx 30 \mu\text{m}$ ) with desired refractive index contrast has been installed along with design software and characterisation equipment like prism coupler and ellipsometer. Initially,  $1 \times 8$  optical splitter has been chosen as a test-vehicle to demonstrate the process and fabrication capabilities.

Optical power splitter is a crucial component for Passive Optical Network (PON) such as cable TV network and FTTH. Depending upon the structure and design, a splitter splits power in equal or unequal parts. Recently, CEERI has developed Silica-on-Silicon technology based  $1 \times 8$  Optical Power Splitter which divides the input power into eight equal parts. Light is guided through an  $8 \mu\text{m}$  core layer having higher refractive index. Core layer is deposited over an un-doped silica layer of  $15 \mu\text{m}$ , which acts as under clad layer. Boro-phospho-silicate-glass (BPSG) layer

Edge polishing and packaging of device were carried out at IRDE, Dehra Dun and at SAMEER, Mumbai, respectively. Insertion loss of  $\approx 12\text{-}16 \text{ dB}$  and non-uniformity of  $\approx 2\text{-}3 \text{ dB}$  were observed across the channel. Further optimisation of material and process parameters is in progress to achieve the state-of-the-art results.



Packaged 1 x 8 Optical Power Splitter



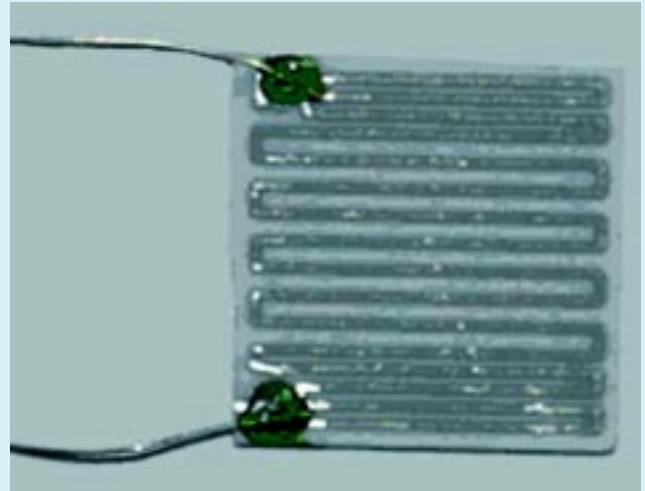
Output from 1 x 8 Splitter at 632.8 nm



## Larger Size Platinum Heater (Pt Heater)

A small size Pt heater (5.0 mm × 5.0 mm × 0.6 mm) on alumina substrate was developed and a large number of such heaters were delivered to user departments for developing gas sensors under a DST programme. In order to explore the other applications of Pt heater, a larger size heater (12.5 mm × 12.5 × 0.6 mm) on alumina substrate has been developed which can be used for solder reflow technique, annealing of metallised semiconductor devices (at about 450°C), e-nose and other applications.

Tin-plated copper wires of 100 µm diameter were soldered to the source and drain of the ISFET chip developed at CEERI by using the larger size Pt heater.



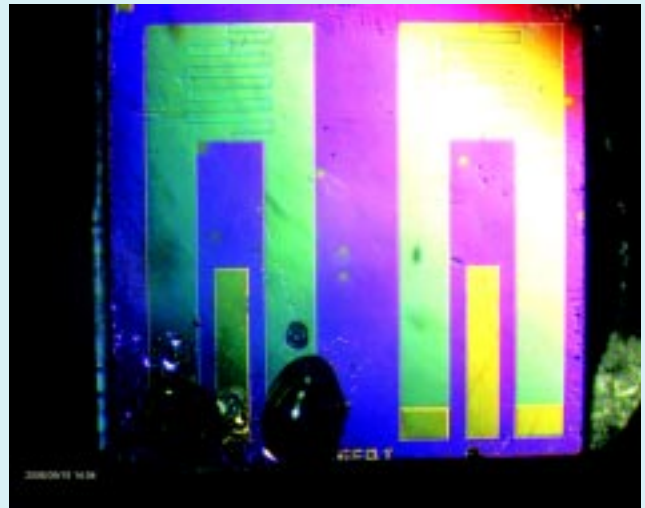
Pt Heater

## New Soldering Technique for ISFET Sensors

A new technique for direct soldering of tin-plated copper wire on to bonding pads of ISFET device has been developed. The technique avoids conventional wire bonding and improves bond strength. It is low-cost and more reliable, giving above 90% yield. This technique was used for packaging of single and multiple ISFET sensors.

In a single packaged ISFET sensor, one ISFET device was mounted on epoxy PCB of 3 mm width and 11 cm length. The bottom contact was made using a conductive epoxy. Tin-plated copper wires were soldered on the bonding pads of the device using the above technique. Other ends of these wires were soldered to the copper conducting lines of the PCB.

The connecting wires, the conducting strips and partially ISFET chip (except the gate portion) were protected by insulating epoxy. The packaged devices



Thin Wire Reflow Soldering on ISFET Pads

were tested and their performance was satisfactory. In multiple ISFET sensors, four ISFET devices were mounted on epoxy PCB of 20 mm width and 8 cm length. The remaining fabrication steps were similar to the single packaged ISFET.



Multiple ISFET Sensors

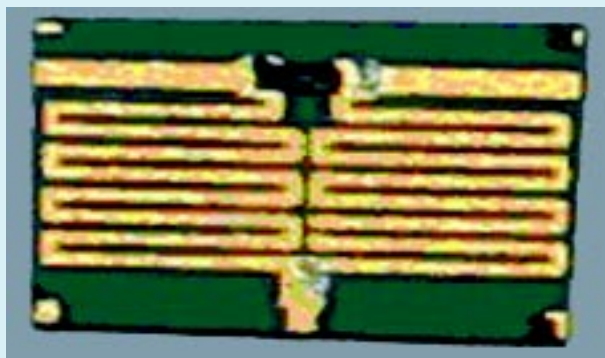


Single ISFET Sensor

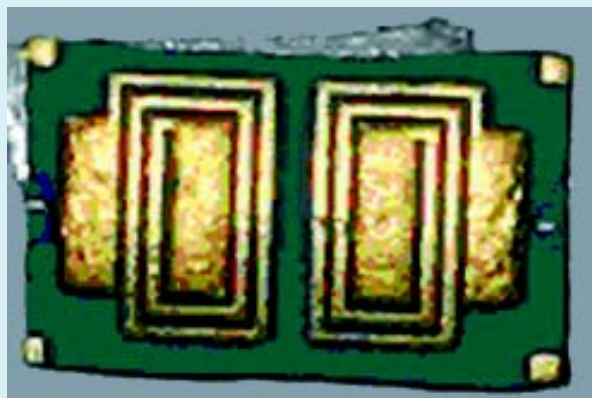
## Microwave Circuits using Low-temperature Co-fired Ceramic (LTCC) for SAC (ISRO)

Three different microwave circuits, namely LC-Power divider, LC-BPF and Laminated BPF were fabricated as per specifications of SAC. Processes involved are

9-screen preparation, cutting of LTCC tape (104 and 254  $\mu\text{m}$  thick), printing of conductor, 250  $\mu\text{m}$  via formation, via filling, alignment hole formation, cut formation, stacking of LTCC structures, iso-static lamination, cutting to circuit size and firing. Five samples each of LC-Power divider, Laminated BPF and LC-BPF have been delivered to SAC. These circuits met the desired specifications.



LC Power Divider



LC-BPF



Laminated BPF

## Central Institute of Medicinal & Aromatic Plants, Lucknow

### R & D Highlights: 2006-07

Striving for excellence, the Central Institute of Medicinal & Aromatic Plants (CIMAP), Lucknow, has been making significant R&D achievements in its area of expertise. During 2006-07, 11 CIMAP technologies/consultancies were provided to industry: Crop consultancy on patchouli and lemongrass to Mr Roger Binny, Bangalore; Project report for cultivation and processing of MAPs to M/s Margadarsi Chit Funds Ltd, Hyderabad; Consultancy for menthol mint cultivation to Emami Biotech Pvt Ltd, Kolkata; Consultancy for cultivation of *Artemisia annua* (var. CIM-Arogya) to M/s Disinfecto Chemical Industries Pvt Ltd; Consultancy for vetiver distillation unit to M/s Satish Organic India Pvt Ltd, Belgaum, Karnataka; Cultivation and distillation of patchouli to M/s Balagundar Estates, Somvarpet; Material transfer agreement with M/s NESSO Pvt Ltd, Mysore; Designing, fabrication and installation of field distillation unit to PSCST, Chandigarh; Design drawing of directly fired type field distillation unit to M/s Avadh Nasesh, Etah, U.P. and Mr M. Runigta, Bihar; and Technology for mosquito repellent spray, mosquito repellent cream and hand disinfectant to M/s Vitomed Healthcare, Jaipur. In addition five plant varieties and five products were released.

During the year, six sponsored projects were completed, 30 sponsored projects were progressing according to plan and 19 R&D projects, 12 consultancy projects and one collaborative project were taken up. CIMAP has been working as nodal laboratory for two and is participating laboratory in 14 of the CSIR's network projects for mission mode research. Twenty-two patents (19 foreign) were granted to the institute. One hundred and sixteen original research articles, eight book chapters and 42 popular articles were published, and 49 seminar presentations and 79 invited talks were given by the scientists of CIMAP. The various institute's



publications, i.e. the MAP journal, farm bulletins, popular magazines (Hindi & English), technology bulletins, information folders, souvenirs, proceeding of institute seminars (Gyanankur), Annual Report and two issues of the newsletter were also brought out. During 2006-07, the institute earned an EBR of Rs 394.902 lakh, vis-à-vis CSIR grant of Rs 1762.33 lakh and network programme budget of Rs 312.074 lakh.

### Highlights of Significant R&D Achievements During 2006-07

#### Bio-village Mission

The *Artemisia* Bio-village Mission Programme was successfully implemented in Udham Singh Nagar, Nainital, Pauri, Champawat and Haridwar districts of Uttarakhand, and Pilibhit, Bareilly, Rampur, Moradabad and Bijnore districts of Uttar Pradesh. The pharmaceutical companies directly purchased the produce from the farmers.

Three varieties of vetiver *Vetiveria zizanioides*, namely CIMAP/KS-1, Dharini and Gulabi, were Supplied to 45 farmers to promote their cultivation.

The rose-scented geranium crop was raised by the farmers and linked to taker industry with the guidance of Team CIMAP at Champawat and adjoining areas in Uttarakhand.

#### Development of Improved Varieties

The improved cultivar 'CIM - Sujal' of fennel has average seed and

oil yield of about 9.73 q and 22.87 kg/ha, respectively with high t-anethole content (75-80%) and low fenchone content (8.08%).

'CIM - Jeeva,' an improved cultivar of

*Java citronella*, is characterized by remarkably high plant survival rate (90.95%) not observed in the check varieties-Mandakini and Bio-13. It consistently shows higher herb and oil yield in all field evaluation trials in different locations. The improved variety 'CIM-Jagriti' of *brahmi* (*Bacopa monnieri*) has a yield potential of producing on an average 85 kg/h of bacoside-A from an average dry herb yield of 40q/h.

'CIM-Balya', a high rhizome and oil yielding variety of *vachh* (*Acorus calamus*), developed and released by CIMAP gave highest dry rhizome (10.85 t/h), and oil content of 0.61% and 0.66% at Pantnagar and Lucknow, respectively.

The variety 'CIM-Ajar' of *Kewanch* (*Mucuna puriens*) is an early maturing variety with high L-dopa content (6.18%). The variety is trichome free.

#### Genetic Improvement and Breeding Efforts

In opium poppy (*Papaver*



Effect of soil sodicity (S<sub>1</sub>:ESP 35.0 and S<sub>2</sub>:18.0) on the growth of rose scented geranium

*somniferum*) the maximum values for heterosis of 17.1% for capsules/plant, 15.3% for straw yield/plant, 13.9% for seed yield/plant and 11.6% for morphine content were shown by the crosses, SG35II×VG20, VN23×VN351, VN23, VN351 and VN23×SG35II, respectively. Based on these results, four promising varieties/strains (SG35II, VG20, VN23 and VN351) involved as the parents in the four topical crosses were selected in crop improvement programme through hybrid breeding in opium poppy.

MMS-49, a strain of menthol mint, was found to perform better both in terms of herbage, oil content and oil yields. The yield of essential oil in MMS-49 was 7-11% higher than variety Kosi and 15-20% higher than Kushal.

#### New Products, Formulations and Technology Packages

An effective all purpose cream 'HALoe Skin' has been developed from *Aloe vera*. The cream possesses wound healing and anti

fungal properties and can also be used to cure cracks in heels, chapped hands and dry skin. An Ayurvedic based nutritive tonic 'CIM-Paushak' has been developed in the form of awaleh. The formulation comprises twelve powerful Ayurvedic ingredients known for their nutritive values with *Emblica officinalis* and sugar as the base. A nutraceutical, 'CIM-Phalse', has been developed using only two ingredients and an excipient from the Indian traditional system of medicine. Both the fruits used are known for their medicinal properties besides their nutritional values. A shampoo, 'Herby Soft', was prepared based on Indian traditional knowledge of hair care, and was released.

Phyllocladane diterpenoids were isolated from *Callicarpa macrophylla* (Family Verbenaceae) which has been found to promote the plant growth while simultaneously having property to alleviate the effects of growth retardant allelochemicals. Also, the process technology and formulation of 'CIM-Upaj', a plant growth promoter, has been developed. A value added herbal shampoo for dandruff control with natural conditioning was released on World Environment Day. The shampoo, 'Geranium active', has the active ingredient from a standard chemotype of *Pelargonium graveolens*.

### Processing Technologies, Value Addition and Upscaling

The lead anticancer taxoid brevifoliol, for which a processing technology has been developed for

its isolation in large quantities from the leaves of *Taxus brevifolia*, was converted into its different semi-synthetic analogues. The analogues have been prepared for the first time from brevifoliol. Some of the synthesized analogues have selective and significant activity against certain cancers.

The earlier process for the isolation of the liver protective coumarinolignoids Cliv-92 from the seeds of *Cleome viscosa* has now been successfully upscaled with a batch size of 50 kg. In the upscaled process, the yield of the coumarinolignoids Cliv-92 has increased by two folds, i.e. from 0.32% to 0.64%.

The process technology developed for the isolation of calliterpenone ex *Callicarpa macrophylla* has now been upscaled to a level of 30 kg/batch. Optimisation of the process parameters has resulted in many fold increase in the yield of the product.

Extraction of the herb *Coleus forskohlii* was carried out at 2 kg level. An HPLC quality control



*Cleome viscosa* plant

method was developed and standardized for the analysis of forskolin.

A one pot conversion of artemisinin to ASA (artesunic acid) was developed earlier using column chromatography (CC) as purification step, yielding pure ASA (about 96%). Subsequently an improved process has been developed by removing the purification CC step with 10% enhancement in the yield (about 106% w/w).

Estradiol based steroidal chalcones have been synthesized. Chalcones are well known for anticancer activities. In most of cases of chalcones, the anticancer activities reported were found in  $\mu\text{M}$



concentration. One of the CIMAP synthesized compounds has been reported to be the most active synthesized chalcone so far, having IC<sub>50</sub> value at 0.21 nM concentration.

### New Analytical Methods

An HPTLC method was developed by CIMAP for the quality analysis of 'Ashwagandharishta' and 'Ashwagandha-crude drug'. In addition, an HPTLC method was developed for the profile analysis of CIMAP lead (IVT-15); HPTLC fingerprints have been generated for different *Phyllanthus* species. A reversed-phase high performance liquid chromatography (HPLC) with photodiode array detection method was developed to determine bioactive polyphenolic substances methyl-orcinolcarboxylate (MBO) and ethyl haematommate (EH) in thalli of various lichen species. An HPTLC method was developed for the quality analysis of 'CIM Paushak', an Ayurvedic based tonic of CIMAP. A characteristic peak profile for 'CIM-Paushak' was designated; and a robust method was developed to evaluate niaziridin and niazirin in samples from *Moringa oleifera* as well as for quality assurance of pharmacologically active standardized extract.

### Integrated Nutrient and Pest Management

The effect of AM fungi was evaluated on the root and shoot biomass yield of and control of root-rot and wilt disease in Ashwagandha



TLC Plate

CIM-Paushak

under glasshouse conditions. The study showed that inoculation at 30 days prior to planting with *Glomus aggregatum* was most effective resulting in 90% survivability of the plant with increase in root and shoot biomass. Antagonistic activity of different rhizospheric bacterial isolates from healthy Ashwagandha plant growing in the field was evaluated *in vitro* against *F. solani* by dual culture method. The findings indicate that two bacterial isolates, viz. WS-1 and WS-9 antagonize the growth of *F. solani*.

Studies on influence of different mycorrhizal fungi on the reserpine content of Sarpagandha have shown that sole treatment of *G. mosseae*, *G. fasciculatum*, *G. margarita* and *G. aggregatum* increase the fresh root biomass yield by 203, 157, 135 and 103%, respectively, over untreated control.

Two species of bacteria have been isolated from the root and stem of infected *Coleus forskohlii*.

The flower and fruit rot during July-September in north Indian plains in sarpagandha fields was found to be caused by a fungus *Rhizopus stolonifera*.

In continuation of molecular studies of ssDNA containing virus on *M. viridis*, AVI gene coding for virus coat protein (CP) was cloned and sequenced. The CP gene of Begomovirus producing leaf curl disease on *M. viridis* showed the highest level of sequence identity (93%) to whitefly-transmitted Indian Begomovirus from *Tabernaemontana divaricata*.

Influence of four selected bioinoculants namely, *Bacillus subtilis*, *Glomus aggregatum*, *G. intraradices* and *Trichoderma harzianum* was studied using them alone and in different combinations to evaluate their response over plant height, number of plantlet production and herb yield of and incidence of black spot disease in *Aloe vera*. Maximum plant height attained was 56 cm in *Glomus intraradices* treated plants followed by 53 cm in *Bacillus subtilis* and *B. subtilis* + *Glomus aggregatum* treatments.

Use of four different AM fungi, viz. *Glomus aggregatum*, *G. fasciculatum*, *G. intraradices* and *G. mosseae*, alone and in combinations with *Bacillus subtilis* showed that the mycorrhizal treatment significantly increases the growth and total biomass invariably over non mycorrhizal control plants under glasshouse conditions.

### Bioactivity Prospection

Thymol from the essential oil of *Trachyspermum ammi* seeds was identified as repellent and insecticidal against *Anopheles stephensi*. Extract of *Ailanthus excelsa* and *Ageratum conyzoides*



were found to be highly effective as both larvicidal and growth disruptor at 80.0 g/ml concentration. The ovicidal and adulticidal assay revealed promising potential in extracts of *Catharanthus roseus* and *Adhatoda vasica*. A crystalline taxoid  $C_{28}H_{40}O_{10}$  (M+ 536), isolated and identified from the needles of the Himalayan yew *Taxus wallichiana*, was found to possess dose dependent cytotoxic activity against five cancer cell lines as determined by MTT and clorogenic assays. Some of the cinnamic acid derivatives, i.e. caffeic acid and 3,4,5-trimethoxy cinnamic acid modified into their diamides, have shown potent cytotoxicity (IC<sub>50</sub>= 1.4 nM to 144 nM) against several human cancer cell lines, i.e., KB 403 (Oral and mouth), CaCO<sub>2</sub> (Colon), WRL (Liver) and HEPG<sub>2</sub> (Liver); The bioactivity guided fractionation of hexane extract of vetiver led to the identification of two pure molecules, khusimol and khusenic acid, which exhibited the activity against fluoroquinolone (FQ) drug resistant strains of *Mycobacterium smegmatis*.

The MTT assay of some lichens from Indian Himalaya species revealed significant cytotoxicity (IC<sub>90</sub>= 10 µg/ml) on one of the tested human cancer cell lines for at least one extract of each lichen species; A formulation comprising *Ocimum* and *Glycyrrhiza* in *Phyllanthus* base was prepared as per the standard Ayurvedic methodology. Upon quantification body weight showed immunopotential greater than the vehicle control. CLIV-92, a hepatoprotective molecule, was

tested for its effect on the pro and anti-inflammatory cytokines under *in-vivo* conditions. The results suggest that CLIV-92 can augment the protection of liver stressed by the intake of chemotherapeutic agents by inhibiting the expression of pro-inflammatory cytokines. Leaves of *Bidens pilosa* (Family Asteraceae), commonly known as hairy beggarticks, were extracted. The ethyl acetate fraction showed good antibacterial activity. Caffeic acid phenethyl esters (CAPE) and the structurally related 'Tyrphostins' have been found to be anti-HIV-I integrase and anticancer agents. Trimethoxy cinnamic acid derivatives were found to have higher anticancer activity.

#### Phytochemical Prospection

A new aliphatic glucoside, isolated from the hexane extract of aerial parts of *Clerodendrum inerme*, has been characterized as pentadecanoic acid - β-D-glucoside. The leaves of the plant *Mitragyna parvifolia* have afforded two new alkaloids, viz. 16, 17-dihydro-17 β—hydroxy isomitraphylline and 16,17 - dihydro - 17 β- hydroxy mitraphylline. The essential oil composition of *Murraya exotica* leaves and flowers from CIMAP Research Farm, Lucknow, were analyzed by GC and GC-MS, which resulted in the identification of 56 and 72 constituents, representing 99.8% and 99.2% of the oils, respectively. The rhizome essential oils of *Curcuma angustifolia* from Central and Southern India were subjected to GC-MS analysis, which resulted in

the identification of 81 and 78 constituents, accounting for more than 95 and 99% of the oil content, respectively. The leaves of Indian yew *Taxus wallichiana*, growing in Gulmarg, J&K, on hydrodistillation, gave 0.025% essential oil on a fresh weight basis. GC and GC-MS analysis of the oil resulted in the identification of 62 constituents, representing 93.3% of the oil. The oil of the exotic plant Culantro (*Eryngium foetidum*) was found to be rich in trans-2-dodecenal (45.89%) followed by mesitaldehyde (10.81%) and dodecanal (9.27%). Interestingly, these constituents were also observed in the oil of common Coriander leaf (*Coriandrum sativum*).

#### Plant Genomics & Molecular Biology

The crucial gene in the artemisinin biosynthetic pathway amorpha-4,11-diene synthase (ads) from the artemisinin-rich genotype CIM Arogya was isolated, cloned and sequenced. The end sequence provides homology with the respective genes in the database. This will provide a starting step towards the bio-mimetic synthesis of artemisinin in heterologous expression system.

The gene involved in initial step of benzylo-quinoline alkaloid biosynthetic path-way, tyrosine decarboxylase (tydc), was cloned and end-sequenced. The end sequence provides homology with the gene sequence present in the database.

Analysis of chloroplast DNA polymorphism through AP-PCR



*Eryngium foetidum*

was carried out to predict the difference, if any, and correlate it with the disease resistance, in *Papaver somniferum*. Sequence analysis of cloned DNA fragment revealed similarity with plastid encoded RNA polymerase subunit rpoCI encoding RNA polymerase subunit of divergent higher plants like *Eucalyptus*, *Arabidopsis*, *Nicotiana* and also to bacteria like *E. coli*.

A novel terpene acetyltransferase (AAT) has been identified, isolated and characterized from palmarosa. The enzyme belonging to BAHD family of proteins forms the key basis of biosynthesis of geranyl acetate in the plant.

Genetic diversity was characterized by PCR based RAPD

marker technique in *Commiphora wightii*, commonly known as guggul, collected from different regions of Rajasthan and Gujarat and regarded as different accessions.

### Sequence Submissions to Public Databases

The following have been submitted to GenBank (NCBI): 106 ESTs of *Papaver somniferum* (accession numbers: EB388963-EB389068), 67 ESTs specific to menthol-induced human colon cancer cell-line Caco-2 (accession numbers: EE683989-EE684055), *Bacillus* sp. CIMAP B1-16S ribosomal RNA gene, (partial sequence) (accession number DQ675022); and Human mRNA for alpha-1 antitrypsin variant from India (accession number DQ682455).

### Plant Tissue Culture

To maintain true to the plant type collections of *Withania somnifera*, an efficient method of *in vitro* shoot propagation using six elite accessions of collected germplasm from all over the country was developed. Multiple shoot cultures of the experimental lines of *W. somnifera* plants established using nodal segment as *ex-plant* under specific hormonal combinations of benzyl adenine and kinetin resulted in significantly higher level of biogeneration of withanolide A in the *in vitro* shoots. Production of withaferin A was also found in the *in vitro* shoot cultures. In withanolide A biosynthetic studies in the *in vitro* cultured normal roots as well as native/orphan roots study it has been unequivocally illustrated that *W. somnifera* roots inherently and locally biosynthesize withanolide *de novo* from precursor primary metabolites.

A method for hairy root induction was developed in *Solanum nigrum*. *In vitro* raised plant's leaf and stem were used as explant source for the *Agrobacterium* mediated genetic transformation of *S. nigrum*. An *Agrobacterium rhizogenes*-mediated hairy root line (CR-N2) of *Catharanthus roseus* (var. Nirmal) has been developed that exhibits unique capability to regenerate transgenic plants via adventive



Capsule of var. Sujata



Capsule of var. Sampada

shoot bud organogenesis on a modified medium. The transgenic shoots were found to be high serpentine yielders *in vitro* when compared with high ajmalicine and serpentine accumulation in the parent transgenic root clone.

An ingenious protocol for eradicating the prevalence of phytoplasma infection in the available *A. roxburghiana* plants was developed through apical meristem culture. *A. roxburghiana* has been effectively used as an anti-pyretic tonic and also for treatment of skin allergies.

A high throughput micro-propagation protocol using stem disc explant was developed and is being utilized for mass multiplication of the improved variety 'CIM-Oj', of *Chlorophytum borivilium* (safed musli), for its early commercial cultivation

An efficient protocol for direct shoot regeneration from leaf explants has been developed for the first time in *Artemisia annua* (variety CIM-Arogya). The method is being used to standardize the transformation

system using *Agrobacterium tumefaciens* strains LBA-4404 and EHA-105

Synthetic seed technology offers an important option for *ex situ* biodiversity conservation and maintenance in tissue banks. Methods for synseed production have been standardized in *Vinca minor*, *Bacopa monnieri*, *Rauvolfia serpentina*, *Hypericum perforatum*, *Pelargonium graveolens* and *Centella asiatica*. Test results indicate that these synthetic seeds can be stored at 4-10°C for one month.

Using young offset as explants, a rapid *in vitro* micro-cloning method has been developed to produce disease-free stocks of *Aloe vera* (var. CIM-Sheetal). The developed protocol is also being exploited to screen disease resistant lines against *Alternaria* toxin induced screen.

### Basic Sciences

Artificial polyploids have been developed in a seed forming clone

of vetiver, *Vetiveria zizanioides*. The polyploids thus developed evince not only high gametic and seed sterility but are also accompanied by enhanced biological potential for the characters associated with increased cell size and physico-physiological efficiency. This has far reaching implications in utilizing a given ideotype for efficient application of vetiver ecotechnology for its multifarious environmental and industrial applications.

It has been observed in *Brahmi* (*Bacopa monnieri*) that Cr concentration in plant increases with increased supply of Cr, indicating the hyper-accumulative capacity of *Brahmi*. The experiment suggests that because of its hyper-accumulation ability hyper-accumulation *Brahmi* could be used as a scavenger to clean Cr contaminated soils.

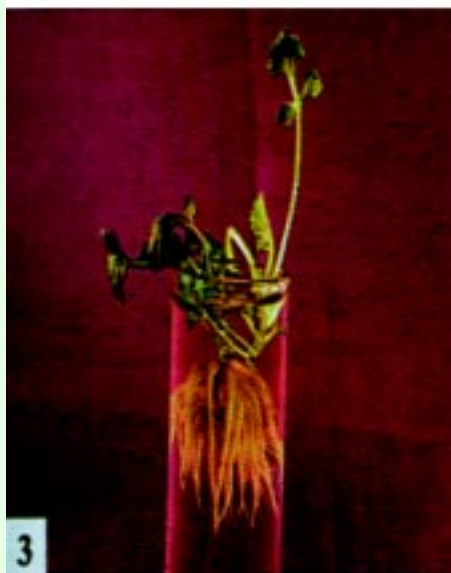
To characterize the withanolide metabolome of the plant, Ashwagandha (*Withania somnifera*) a high resolution DAD-ELSD-HPLC method of analysis of complex mixture of withanolides from leaves and roots of *Withania somnifera* plant has been developed and validated.

*Artemisia verlotiorum* (Asteraceae) plant which is native of Western China has been introduced and acclimatized at CIMAP. The essential oil was extracted and oil composition studied. The results indicate that even in the subtropical climate  $\alpha$ -thymone was found as the major constituent of the oil.

Effect of calliterpenones, a compound isolated from *Callicarpa*, on rooting of stem cuttings of rosemary and geranium showed



Field view of *Artemisia annua* experiment



Regenerates of *Artemisia roxburghiana* under different conditions

chloride and paclobutrazol significantly enhanced the total pyrethrin in flowers. The sum of pyrethrins multiplied by average dry weight of flowers (mg of flower) was higher due to application of growth retardants.

Post harvest changes in yield and quality of oil in leaves of patchouli were determined by monitoring the changes in distribution of  $^{14}\text{CO}_2$  assimilated metabolites. The  $^{14}\text{C}$  feeding studies support that its content in oil and patchouli was maximum at five days of storage.

Studies relating to effect of gibberellin and ethrel in Fe cultured *Catharanthus roseus* showed that iron application @ 11.2 mg/l with ethrel significantly enhanced Fe uptake. The ethylene here presumably acts as an elicitor in Fe uptake.

### Gene Bank Status/ Updates

During 2006-07, 476 accessions have been added to seed gene bank raising the present tally to accession of 2286 species. *In vitro* bank has been enriched by 16 accessions and now comprises 248 accessions. The DNA bank now comprises 1322 accessions with the addition of 67 accessions.

improvements in root and shoot weights when co-inoculated with a superior strain of *Azotobacter*-AZ 26.

Cytokinins were found to be effective in positively influencing growth, flowering, and enzymic activity in *Rosa damascena*.

Peroxidase, polyphenol oxidase, succinate dehydrogenase, amylase, catalase, proline content, protein

content and IAA content were studied at different stages. Peroxidase activity decreased with the age of flower. The highest peroxidase activity was recorded during green bud stage and coloured bud stage coinciding with early flower development.

Application of growth retardants, viz ethrel chormequat



## From Vaccines to Virogenomics

### Prof. P. N. Rangarajan's Shanti Swarup Bhatnagar Prize-winning Work

**P**rof. P. N. Rangarajan, Department of Biochemistry, Indian Institute of Science, Bangalore, has been awarded the Shanti Swarup Bhatnagar Prize in Medical Sciences for the year 2007 for his research contributions in the area of recombinant vaccines and virogenomics. He was the first to initiate research on DNA vaccines in India and his research has spanned the development of DNA vaccines against Japanese encephalitis virus (JEV) and rabies virus as well as characterization of host genes activated in mouse brain by these neurotropic viruses. He developed a novel vaccination strategy which has led to the development of a novel combination rabies vaccine. Preclinical toxicity studies of this vaccine have been completed and the veterinary vaccine is likely to be introduced in the market under the trade name DINARAB by Indian Immunologicals Limited, Hyderabad, after obtaining approvals from regulatory agencies. He also contributed to indigenous recombinant Hepatitis B vaccine production in India by developing recombinant yeast strains expressing high levels of Hepatitis B surface antigen. These strains were transferred to two companies in Hyderabad, one of which (Biological E Limited) launched the recombinant hepatitis B vaccine as BEVAC on 22 December 2004 while the other (Indian Immunologicals



Limited) launched it as ELOVAC on 26 September 2006.

To understand host gene expression changes during virus infection, Prof. Rangarajan isolated a number of host genes that are differentially expressed in mouse brain during JEV infection and characterized many of them. One of these genes was shown to encode a novel noncoding RNA called VINC which localizes to distinct nuclear structures called paraspeckles. Another virus-inducible gene encoding the interferon-inducible tetratricopeptide repeat protein 2 (IFIT2) was shown to be localized in microtubules of mitotically active cells. One of the genes down regulated during JEV infection was shown to encode  $Ca^{2+}$ /calmodulin kinase II inhibitor  $\alpha$ , which for the first time, was shown to be localized in the post synaptic density (PSD) of mouse brain.

In addition to leading his own research group focussed on eukaryotic gene expression and infectious diseases, Prof. Rangarajan has also contributed to a number of collaborative research programmes. For example, his ongoing collaboration with Prof. G. Padmanaban at IISc on Malaria led to the identification and biochemical characterization of heme biosynthetic enzymes of the malarial parasite as well as demonstration of antimalarial activity of curcumin, a component of turmeric.

Prof. Rangarajan (born on 15 April 1963) obtained his B.Sc degree in 1981 and M.Sc degree in 1983 from Bangalore University. He obtained his Ph.D from the Department of Biochemistry, IISc, in 1989 and then pursued post doctoral research at the Salk Institute, San Diego, till 1993. He joined the Department of Biochemistry, IISc, in 1993 as Assistant Professor and is currently a Professor.

Prof. Rangarajan is a recipient of the National Bioscience Award and Biotech Process, Product Commercialization award of the Department of Biotechnology. He has also received B.M. Birla Science Prize from the B.M. Birla Science Centre, Swarnajayanthi fellowship from the Department of Science & Technology, OPPI scientist award from the Organization of Pharmaceutical Producers of India and BRSI Industrial medal from the



Biotech Research Society of India. Recently, he received the NASI-Reliance Industries Platinum Jubilee award from the National Academy of Sciences, Allahabad. Prof. Rangarajan is a fellow of Indian

Academy of Sciences, Bangalore and National Academy of Sciences, Allahabad. He has published 44 research papers and 12 review articles. He developed a novel method of enhancing the potency of

a DNA vaccine which has been granted patents in Europe (EP1365799), China (ZL01820695.6), South Africa (2003/4631), Canada (CA2431938) and India (20734).

### NAL hosts the 108th Semi-annual meeting of STAI

The 108th semi-annual meeting of the Supersonic Tunnel Association International (STAI) was hosted by the National Aerospace Laboratories (NAL), Bangalore, at Eagleton Golf Resorts during 7-9 October 2007. This was for the first time since NAL became a member in 1978, that an STAI meeting was organized by NAL. Fifteen delegates from USA, Japan, France, Germany, England, Belgium, Russia and South Africa participated in the deliberations. About 50 participants from NAL, DRDO, ADA and VSSC also took part. After inauguration by Director, NAL, 17 technical papers were presented in five technical sessions. NAL had the largest number of presentations. The meeting focused on topics related to test facility operations, maintenance issues, instrumentation, data acquisition and control systems, development of flow diagnostic tools, etc.

The meeting ended with a visit of the foreign delegates to the 1.2 m wind tunnel, the *Hansa* and *Saras* hangars and the Acoustic Test Facility. One of the delegates, who owns and flies an Ultralight airplane in Europe, was quite impressed with the *Hansa*.

Several delegates expressed interest in collaborative projects with NTAF.

### Training-cum-Awareness Programme on Aromatic Plants and Edible Mushrooms

The North East Institute of Science & Technology (NEIST), Jorhat, organised a training, demonstration cum awareness programme on aromatic plants and edible mushroom in three villages namely Ddantola, Baragara and Kumurikata of BTAD, Assam, during 13-17 August 2007 in pursuance of the intended objective of a DBT sponsored project. Organized under the aegis of Manav Shakti Jagaran, an NGO of Kairara, BTAD, the programme was attended by around 60 participants comprising 20 growers from each of the three villages. Training was imparted on cultivation and processing of aromatic plants like citronella, lemongrass and patchouli. Dr T. C. Sarma, Principal Investigator of the DBT project coordinated the programme.

A similar one-day programme was also organized at NEIST Sub-station at Lamphelpat, Imphal, Manipur, on 6 September 2007 in which more than 30 trainees comprising mostly educated youths from in and around Imphal took part. Dr H. B. K. Singh, Scientist-in-Charge, NEIST Sub-station, Imphal, coordinated the programme and Dr R. K. Adhikery, Co-PI of the project, imparted the training. Dr T. C. Sarma, the Principal Investigator, inaugurated the programme.

## NBRI celebrates Annual Day

The National Botanical Research Institute (NBRI), Lucknow, celebrated its 54th Annual Day on 25 October 2007. Prof. J.S. Singh, former Member, National Forest Commission, New Delhi, was the Chief Guest on this occasion and delivered the Annual Day lecture on 'Environmental challenges in the Anthropocene'. Prof. V.L. Chopra, Member, Planning Commission, New Delhi, delivered the presidential address.

Delivering the Annual Day lecture, Prof. Singh said that today the Earth is experiencing environmental conditions which it had never experienced in the past. For example, the CO<sub>2</sub> concentration



Dr Rakesh Tuli, Director, NBRI, presenting the progress report of NBRI

had varied between 180 and 280 ppm during the past 4,20,000 years, but it has now increased to 379 ppm. Regarding the diminishing oil resources, Dr Singh said that 40% of known oil reserves has been exhausted by humans in the last 150 years that took hundreds of million

years to generate. Narrating the changing scenario of ecosystem, he informed that 50% land surface has been transformed affecting biodiversity, soil biology and climate. More nitrogen is fixed synthetically

for fertilizers than that fixed naturally. More than 50% of all accessible freshwater has been appropriate for human use. Ground water resources are getting rapidly depleted. Concentrations of gases that affect climate have substantially increased and coastal and marine habitats have been dramatically altered. Around 50% mangroves have been removed and wetlands reduced by one-

half, 22% of recognized marine fisheries have been depleted, while 44% are at their limit of exploitation, and their extinction rates have been increasing sharply, he elucidated. Between 1970 and 2003, the Living Planet Index (biocapacity of the Earth) fell by about 30 per cent and Ecological Footprint exceeded the Earth's biocapacity by 25% as of 2003. Cautioning about the other alarming harmful changes in the future, Prof. Singh said that owing to continuous global warming the average temperature of the Earth's surface could increase by 5.8 degree Celsius and the sea level could rise by an additional 88 cm by the year 2100. For India, predictions include: frequent dry days. There will be 38% drop in per capita water availability by 2050 and displacement of around 50 million people from coastal areas due to rise of sea level. Presenting the alarming situation with regard to India, Prof. Singh said that by



Prof. V.L. Chopra, Member, Planning Commission, New Delhi, delivering his presidential address. Seated on the dais (from left) are: Dr S.K.S. Rathore, Scientist, NBRI; Dr Rakesh Tuli, Director, NBRI, and Prof. J.S. Singh, former Member, National Forest Commission, New Delhi



## Annual Day Celebrations



Prof. J.S. Singh, former Member, National Forest Commission, New Delhi, delivering the Annual Day Lecture

2035, the Himalayan glaciers might disappear and food grain production might fall by 30%, vector borne diseases and those associated with floods and droughts would increase. By 2030, 25% flora and fauna might be at a high risk of disappearance, he warned. Worldwide, the figure of 2.2 billion people living under moderate or severe water stress would increase to 4 billion by 2025, he added.

Prof. Singh further said that tropical forests resources are still the source of livelihood for 1.6 billion people worldwide, while 1.2 billion people in developing countries use trees on farms to generate food and cash. More than 2 billion people rely on biomass fuels. Natural products from forests are the only source of medicine for 75-90% of people in developing countries. However, 350 million ha of secondary and primary forests have been degraded at the rate of 0.8% per year. As also 500 million

hectare of secondary and primary forests have been degraded, affecting the generation and flow of ecosystem services vital for human well being, mentioned Dr Singh. He also pointed out that the world has entered into a phase of mass extinction. "We seem to be losing two to five species per hour from

tropical forests alone. This amounts to a loss of 16 million populations per year or 1800 populations per hour." "Solutions have to be found for the above problems, and this needs concerted research efforts," he concluded.

Prof. V.L. Chopra in his presidential address said that annual day of an institute provides an opportunity to give a thought to the year that has gone by and an enquiry for future activities to be carried out and thrust to perform better in the coming years. He said that NBRI had made extensive contributions in terms of scientific

achievements and developed technologies of larger societal interest. He congratulated Dr Rakesh Tuli for his dynamic leadership in creating an enabling environment for achieving this growth.

Earlier, welcoming the august gathering comprising dignitaries from the research community, industry, academia and media, Dr Rakesh Tuli, Director, NBRI, articulated the present research vision and summarized the various activities undertaken and major achievements made by the institute during the past one year. Highlighting the R&D accomplishments, Dr Tuli informed that during the year 2006-07, the scientists of NBRI published 76 research papers in SCI journals. The average impact factor (IF) of NBRI publications during 2006-07 was 1.55 as against 1.152 during the preceding year. Besides these, 69 papers in non-SCI journals, eight books and bulletins, 33 chapters in books, three extension bulletins and 27 popular articles were published. Fifty-six patents were filed in India and six abroad. Ten foreign patents

were granted. He congratulated the hardworking teams for publishing papers in high IF journals and those having high citations and assured them his full support in their future endeavours. Dr Tuli said that CSIR invested much more at NBRI during the last year than ever before, which reflected the immense



NBRI's anti-cough technology transfer to M/s Toral Herbals, Lucknow



increase in the level of confidence that CSIR now places in NBRI. This confidence comes from the unique strength that NBRI has in plant sciences – spanning from the knowledge of plant diversity to molecular biology and from the recognitions that NBRI received in recent years - most importantly, the winning of the CSIR Technology Prize, the INSA Young Scientist Award and the Innovative Young Biotechnologist Award. He was pleased to enlighten the gathering that DST conferred the prestigious ‘JC Bose National Fellowship Award’ to him. ‘I must confess that I was only a means to bring this honour to NBRI. The recognition is a reflection of the excellent work that several of my students and young colleagues did with me through the last several years,’ he said. Later he narrated the R&D achievements of various research groups.

On this occasion, Annual Report 2006-07 of NBRI was also released by the Chief Guest. Know-how of anti-cough technology developed by NBRI was transferred to M/s Toral Herbals, Lucknow.

## NGRI celebrates Foundation Day



Seen on the dais during the NGRI Foundation Day function (from left)  
Dr V.P. Dimri, Dr P. Rama Rao and Shri V.K. Sibal

The National Geophysical Research Institute (NGRI), Hyderabad, celebrated its 46<sup>th</sup> Foundation Day on 11 October 2007. Dr P. Rama Rao, former Secretary, Department of Science and Technology (DST) and Chairman, Governing Council, International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI), Hyderabad, delivered the NGRI Foundation Day

Lecture on ‘Management of S&T in India: Is there some thing missing?’ Shri V.K. Sibal, Director General, Directorate General of Hydrocarbons, New Delhi, was the Chief Guest on this occasion.

Dr Rao in his lecture expressed that there was no design, until recently, to draw up a long term plan for scientific research to support planned economic development. He said that there are many programmes with huge budget for rural development but the application of scientific research to fulfil rural development goals is rather debatable. In this context he referred to the pilot project undertaken in Karimnagar in seventies.

Noting that we tend to operate in isolation, Dr Rao stressed the need to establish stronger linkages and prioritization of areas for



Dr P. Rama Rao delivering the Foundation Day Lecture



## Appointments/Honours & Awards

better results. He called for better coordination between various departments and advocated the need for a visible mechanism to connect DST with other ministries.

Dr Rao also emphasized the need for an integrated approach to link scientific research and economic development. In this context he complimented the pharma industries for supporting basic R&D. He said there should be immediate measures to popularize research programmes and underlined the need for greater involvement of younger generation in R&D activities.

Outlining the importance of coordination, Shri V.K. Sibal said that scientists should interact with industry and co research agencies frequently and try to understand their needs. He asked the scientific community to spare some time with industries, try to understand the problems and come out with result-oriented research to tackle the problems. He said R&D institutions should dictate the business but business should not dictate R&D. He offered to facilitate regular exchange of scientists between NGRI and DGH. He lauded the role of NGRI in hydrocarbon exploration.

Dr V.P. Dimri, Director, NGRI, in his presidential address said that the institute was now in top one percent of research citation globally. He spoke about the future societal projects of the institute and also the human resource development programmes at NGRI.

Dr Y.J. Bhasakara Rao, and Er. S. Narayana, Scientists G, introduced the speaker and the Chief Guest respectively to the invitees and staff. Dr S.N. Prasad, Scientist G, proposed a vote of thanks.

Dr P. Rama Rao also inaugurated the seismological observatory for Tsunami Warning System, which has been established in NGRI campus. It is one of the components of the 17 stations of Tsunami Warning System in India.

### Dr Gangan Prathap is the New Vice-Chancellor of Cochin University of Science and Technology

Dr Gangan Prathap, Head of the CSIR Centre for Mathematical Modelling and Computer Simulation (CMMACS), Bangalore, has been appointed the 11th Vice Chancellor of Cochin University of Science and Technology (CUSAT). Dr Prathap was a Senior Scientist at the Structures Division, National Aerospace Laboratories (NAL), Bangalore, before joining CMMACS.

His contribution to the field of science and engineering brought him one of the most prestigious awards for scientific research in the country, the S.S. Bhatnagar Prize, in 1990.

He is a Fellow of the Indian Academy of Sciences, Fellow of the Indian National Science Academy and Distinguished Alumnus of IIT, Madras. Dr Prathap has published more than 300 research papers, and the book *Finite Element in Structural Mechanics*, published by Kluwer in 1993. He is also a member of the editorial boards of many scientific journals.

Dr Prathap did his schooling in Singapore. Later he joined IIT Madras after passing the entrance examination with first rank and graduated from the institute in Aero Engineering, again as a topper in 1974. He was awarded a Doctorate by the institute in 1978.

### International Award for Dr T.R.K. Chetty

Dr T.R.K. Chetty, Scientist F, National Geophysical Research Institute (NGRI), Hyderabad, has been selected to receive the prestigious 2008 Endeavour Executive Award from the Department of Education, Science, and Training, Australian Government under International Endeavour Programme. An internationally competitive and merit based scholarship, this forms the part of the Australian Government's \$ AUD 1.4 billion scholarship initiative.



Dr Chetty has made several outstanding contributions related to diamond exploration, large-scale earth's processes and geodynamic modeling. He played a key role in the discovery of diamond-rich kimberlites of Venkatampalle, Ananthapur district

of Andhra Pradesh. He has been working in NGRI since 1974. He is author of more than 100 International publications and has guided a number of Ph.D. students. He also initiated several international research collaborative programmes, and organized the first international

geological field workshop where several top scientists from USA, Germany and Australia were led by Dr Chetty. He is a recipient of INSA-Royal Society Fellowship, CSIR-DAAD Senior Fellowship, AP Academy of Sciences Fellowship, and has been Secretary of

International Association of Gondwana Research, Japan. He has been selected this year for the prestigious National Mineral Award, Department of Mines, Government of India, for 2006.

## Dr Amitabha Chattopadhyay selected for Ranbaxy Research Award 2006

**D**r Amitabha Chattopadhyay, Deputy Director, Centre for Cellular and Molecular Biology (CCMB), Hyderabad, has been selected for the prestigious Ranbaxy Research Award in Basic Research in Medical Sciences for his pioneering contribution on the role of membrane lipids in the organization and function of G-protein coupled receptors, and its implications in health and disease. His group was the first to demonstrate the vital requirement of membrane cholesterol on the organization and function of the serotonin<sub>1A</sub> (5-HT<sub>1A</sub>) receptor by making intelligent use of biochemical, biophysical and cell biological approaches. His recent

work has shown that the function of this important neurotransmitter receptor (the serotonin<sub>1A</sub> receptor) is

impaired in diseases such as the Smith-Lemli-Opitz Syndrome (SLOS) in which cholesterol biosynthesis is defective. Interestingly, Dr Chattopadhyay's group was the first to show that host membrane cholesterol plays an important role in the process of infection caused by the parasite



*Leishmania donovani*, which results in leishmaniasis.

Dr Amitabha Chattopadhyay joined CCMB in 1989 as a Group Leader and has published more than 120 research papers in peer-reviewed national and international journals, and edited and reviewed 5 books. He has received several awards for his outstanding research contributions in biological sciences, such as the Shanti Swarup Bhatnagar Prize, Raman Research Fellowship, and Dozor Visiting Fellow (Israel), to name a few. He is also a Fellow of all three Indian Academies of Science, besides being a Member of the Editorial Boards of several reputed international journals.

## Dr B.G. Unni conferred FIANSc

**D**r B.G. Unni, Scientist F and Area Coordinator, Biological Sciences, North-East Institute of Science & Technology, Jorhat, has been awarded the fellowship of Indian Academy of Neurosciences for his significant contribution to the

area of molecular endocrinology with special reference to the studies related to isolation and characterization of



insect neuropeptides by *in vitro* techniques, its molecular and functional properties with respect to juvenile hormone biosynthesis and silk protein biosynthesis in silkworms and *in vitro-in vivo* assay with the chemically synthesized



insect neuropeptides. Dr Unni's contribution to the area of silkworm biochemistry/molecular biology, both basic and applied, have made significant impact on the enhanced growth of the silkworms and silk fibre production in terms of quality and quantity.

The fellowship was conferred to Dr Unni by Prof. Colin Blakemore, Chief Executive, Medical Research Council, University of Oxford, UK, at Banaras Hindu University, Varanasi, on 22 November 2007 at the International Symposium on Advances in Neurosciences & Silver Jubilee Conference of Indian Academy of Neurosciences.

## Best paper award

**The technical paper titled "Effect of diffuser blade setting angle on centrifugal compressor stage" by R. Rajendran, S. Ramamurthy and P. Mohanan of the National Aerospace Laboratories (NAL), Bangalore, was given best paper award at the 34th National Conference on Fluid Mechanics and Fluid Power held at BIT, Mesra, Ranchi during 10-12 December 2007.**

## COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH (HUMAN RESOURCE DEVELOPMENT GROUP) CSIR COMPLEX, Library Avenue, Pusa, New Delhi 110 012

### NOMINATIONS INVITED

#### *CSIR Young Scientist Awards for 2008*

**T**he Council of Scientific & Industrial Research (CSIR) invites nominations for the CSIR Young Scientist (YS) Awards for the year 2008. The awards are to be given for research contributions made primarily in India. The nominee should be a regular employee of CSIR system holding a position of a Scientist in Group IV. The age of the nominee should not be more than 35 years as on *26 September 2007*.

The YS Awards are given annually in the following disciplines: (1) Biological Sciences, (2) Chemical Sciences, (3) Earth, Atmosphere, Ocean and Planetary Sciences, (4) Engineering Sciences, and (5) Physical Sciences (including instrumentation). The YS Award carries with it a citation, a cash award of Rs.50,000 (Rupees fifty thousand only), and a plaque for each scientist selected for the Award.

Nominations addressed to Dr Rajesh Luthra, Head, Human Resource Development (HRD) Group, CSIR Complex, Library Avenue, Pusa, New Delhi 110 012, should be sent as per the prescribed pro-forma (20 copies) along with one set of research papers published during the last 5-year period, by 29 February 2008. The details of the YS Award and the prescribed pro-forma for nomination can be obtained from above address or may be downloaded from our website: <http://csirhrdg.res.in>

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