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Novel Process Technology developed for SMAS and ATBS

A team of scientists and technologists headed by Dr P.P. Barveat at the National Chemical Laboratory (NCL), Pune, has developed a novel process for 2-Acrylamido-2-methyl-1-propane sulfonic acid (ATBS), which is both efficient and cost effective. NCL has also developed a novel and highly improved method of recovery of excess acrylonitrile in the ATBS process.

2-Methlyallyl sulfonic acid sodium salt (SMAS) and ATBS are specialty monomers used in the acrylic fibre industry for imparting dye-affinity to the fibre. Polymers prepared by using ATBS as co-monomer are also extensively used in the enhanced oil recovery (EOR), water treatment chemicals and preparation of specialty polymers. Both these monomers were being imported in India by the acrylic fibre industry and ONGC. The domestic demand for ATBS is about 300 tonnes and SMAS, about 400 tonnes per annum. The global market size is about 25,000 tonnes for ATBS and 10,000 tonnes for SMAS.

M/s Vinati Organics Limited (VOL), Lote, Maharashtra, approached NCL to explore the possibility of setting up a manufacturing facility for ATBS and SMAS. NCL had earlier developed a process for SMAS and ATBS on the bench scale and, therefore, had requisite experience. NCL performed the techno-economic feasibility study based on which VOL signed a sponsorship agreement with NCL in May 2000 to develop a comprehensive technology for producing these two specialty monomers. Under this agreement, NCL had the responsibility to develop and demonstrate the process on bench scale, to validate and demonstrate the process on pilot scale with recovery and recycles, to deliver a basic engineering package (BEP) and to provide assistance for start-up and commissioning of the plant.

Samples were collected at each technology stage, i.e., bench stage, pilot stage and commercial plant stage and sent to the secondary customers for certification. The product produced in the commercial plant was submitted globally to various customers for their testing and approval. After getting feedback from the customers about the quality of the product, the technology issues related to market needs were resolved by NCL through additional process development work. In general, novel purification methods were developed and demonstrated on commercial scale for various grades of ATBS and SMAS.

The SMAS and ATBS plants are two separate dedicated process plants constructed at the customer's site with common utilities separated by a common walkway. Although the raw materials are almost same they employ an entirely different process technology. The combined manufacturing facility is situated at A-20, MIDC, Lote-Parasuram, Chiplun. There are over 125 major pieces of equipment in the process plant. The SMAS plant is based on a batch process, whereas in the ATBS plant the reaction and solvent recovery is in continuous mode, and ATBS purification is in batch mode. The Technology Development Board (TDB), New Delhi, provided a financial assistance to VOL for implementing this project.

The installed capacity of the ATBS is 2000 tonnes/annum and for SMAS is 1000 tonnes/annum. VOL has invested till date approximately Rs 25 crore in creating this manufacturing facility. VOL is producing both the monomers as per demand and is supplying and exporting most of its production to various countries.

The process developed by NCL is protected by two US patents (6,504,050 and 6,660,882). A third PCT application has been filed. This technology was selected for the CSIR Technology Awards-2005 for the Chemical Technology along with IICT, Hyderabad and also awarded the 'Technology of the Year Award' sponsored by ICICI Ltd on the NCL Foundation Day.

Plant commissioned to produce ATBS and SMAS at Lote MIDC, Chiplun (Maharashtra)

Laser Diode Reliability Measurements

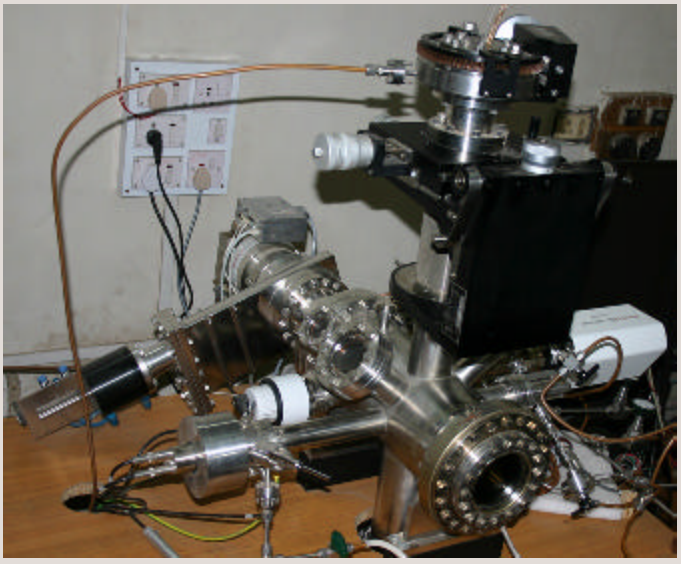
THE Central Electronics Engineering Research Institute (CEERI), Pilani, has performed the long-term aging test on laser diodes in a specially designed test jig. Initially, the L-1 characteristics of all the eight laser diodes were measured and recorded, then, the photodiode response as a function of laser diode current for all the diodes was recorded, thus giving the photodiode response vs emitted power for all the laser diodes.

The long-term aging test was performed with constant power of 70 mW at 60° C. The diodes were selected randomly without any burn-in-test having a power output >150 mW as the selection criteria. The test was performed for first thousand hours at 60°C. The enhancement of driving current for constant output represents the degradation rate. Three failures occurred during the first 200 hours due to quasi-burn-in phase. However, no further damage of facets in the remaining five laser diodes was observed up to 1000 hours of the testing.

NCL develops Indigenous Molecular Beam Instrument

THE National Chemical Laboratory (NCL), Pune. has developed, a simple, compact and economically viable Molecular Beam Instrument (MBI), first of its kind in India. MBI enables study of complex heterogeneous catalytic reactions on active metal surface in a clean environment under vacuum and provides fundamental information about the catalytic reactions, such as transient kinetics and kinetic parameters. Such vital information helps to derive the mechanistic pathway of complex reactions. With high local coverage on the substrate under clean environment, MBI bridges the pressure gap between the real-world catalysts working at atmospheric or higher pressure and other conventional experiments carried out under high vacuum.

Developed by Dr C.S. Gopinath and his team at NCL, the MBI, consists of a mass spectrometer, molecular beam generation assembly, a shutter mechanism to control the beam from reaching the metal substrate, a sample cleaning mechanism called sputter ion gun, and a host of several other components in a 12-liter capacity stainless steel chamber. Substrate is attached to the sample manipulator for limited manipulation along the three axes with complete 360^0 on - axis rotation. MBI is evacuated to a low pressure of 10^{-13} atm range. Fabrication of MBI was funded by Volkswagen Foundation and Alexander von Humboldt Foundation, both from Germany, and an in-house research grant by NCL. Interfacing with an infrared spectrometer to study the catalytic reactions spectro-scopically and the real-world powder cata-lysts deposited on inert surfaces to make the MBI more practical for *in-situ* studies is under consideration. MBI is a rare facility, avail-able only in a few select labo-ratories around the world.



Molecular beam instrument

Integrated Automation of Tea Processing

BLACK tea manufacture calls for the application of knowledge from different domains namely, chemical, bio-chemical, instrumentation, computing, etc. A multi-institutional collaborative project 'Integrated Automation of Tea Processing and Model Tea Factory at Tea Research Association (TRA)', was taken up for the development and demonstration of a technology package for four Critical Unit Operations, namely, withering, CTC (crushing, tearing and curling), fermentation and drying. The implementing organizations were Central Electronics Engineering Research Institute (CEERI), Pilani; Centre for Development of Advanced Computing (CDAC), Kolkata; and Tocklai Experimental Station (TES) of TRA, Jorhat. CEERI's role pertained to the withering and fermentation processes; CDAC's role concerned with the CTC and drying processes, whereas TES's role concerned with the infrastructure and machinery for the tea factory.

A Model Tea Factory (MTF) along with machinery for a 50 kg/h tea production was established and PC-based

automation systems for four critical unit operations of tea manufacturing were successfully developed and commissioned at Tocklai Experimental Station, Jorhat, Assam.

TES, Jorhat, already has an environmentally controlled manufacture facility to carry out experimentation for the manufacture of tea under different operating conditions, at a laboratory scale, i.e. 4kg/h.

For the Tea withering process there are provisions to carry out withering in the open troughts and/or in the enclosed troughs. An Industrial PC-based Local Control Unit (LCU) caters to the open trough withering process and another such LCU caters to the enclosed trough withering process. A similar LCU caters to the Continuous Fermenting Machine (CFM) process and the another such LCU caters to the Floor and Gumla fermentation processes. In addition to these four LCUs, one LCU caters to the CTC process and another LCU caters to the drying process. All these six LCUs and Central Control Unit (CCU), with a hot standby were networked. One can view the details of any process stage from any of the six LCUs and two CCUs.

Process parameters such a leaf moisture, temperature, RH, CO_2 and O_2 at different locations for withering and fermentation processes were monitored and displayed at respective locations on the corresponding mimic diagrams of respective computers, i.e. Local Control Units (LCUs) of withering and fermentation processes. The monitored data were logged in the computers. The data were displayed as on-line trend graphs and as historical trend graphs selectively by means of pop-up menus. Audio-visual alarms were provided for the processes.

Auto control was implemented under LabVIEW for open and enclosed trough withering processes. Under 'Auto Control' actual moisture removal from tea leaves followed the desired moisture profile set by the user. Actual and desired moisture profiles were displayed graphically on the same screen. The mode of operation of fan, namely, blow/air-up, suck/air-down or OFF was displayed as a three level histogram on the same screen. The hot air requirement for the withering process was also displayed as histogram. Suitable colours were used for the histograms and the graphs that gave good contrast for viewing.

ON/OFF control of the nine fans of CFM through the LCU was implemented. Colour comparison of reference image and on-line image acquired through web camera was done and an indication to move the CFM conveyor belt in Fast/No Change/Slow mode was also provided.

Shri Tarun Gogoi, Honourable Chief Minister of Assam, recently inaugurated the Model Tea Factory (MTF) at Tocklai Experimental Station, Jorhat.

All the systems and their features of the MTF were explained and demonstrated to the dignitaries and delegates on various occasions such as MTF inauguration, workshop and working group meetings.

Project documentation, covering the different functional details of the systems, was organized in four parts and was jointly made by CDAC, Kolkata and CEERI, Pilani and handed over to TES/TRA, Jorhat.

Two-phase training of five days each, was recently given to five personnel of TES, Jorhat, by CEERI, Pilani and CDAC, Kolkata on various functional details covering both theoretical and practical aspects.

The project has been successfully completed and the commissioned systems are being used by TES/TRA, Jorhat, on regular basis.

The facilities established at MTF, Jorhat, are first of its kind in India and stand at second place in Asia. The systems not only provide various important features but also a platform to carry out different experiments, data collection and analysis of results concerning different aspects of black tea manufacture by tea scientists and manufacturers and thus help in enhancing and understanding the science involved in tea manufacture.

Further activities that might be taken up include development of Smart Environmentally Controlled Machine (ECM), development of advanced control strategies for optimization of each process stage, and generation of recipes for processing different clones of tea leaves grown under different agro-climatic conditions.

CEERI signs MoUs with Kurukshetra University, and IIIT, Pune

THE Central Electronics Engineering Research Institute (CEERI), Pilani, has signed, in the recent past memoranda of understanding with Kurukshetra University (KU) and International Institute of Information Technology (IIIT), Pune.

MoU with Kurukshetra University

The MoU aims to promote academic and research interaction and cooperation between the two institutes. The salient points covered by the MoU are: Undertaking joint sponsored and consultancy projects within the specified areas of cooperation; Exchange/deputation of staff for limited period; Organisation of joint conferences/workshops/ courses; Sharing of facilities; Ph.D. registration of research fellows/ research associates of CEERI working on approved joint projects.

The major areas of cooperation include: devices and circuits, MEMS, VLSI design, electron tubes and intelligent electronic systems.

MoU with IIIT-Pune

Under this memorandum of understanding, CEERI and IIIT shall jointly identify and collaborate on important projects relating to Information and Communication Technology (ICT) with a view to establishing excellence in technological expertise and solving nationally and internationally important basic and applied problems.

The areas of collaborative education, research and training initially identified are: VLSI design technologies, embedded system design (specially for communication systems), computer integrated electronic instrumentation and control systems, etc. The MoU shall facilitate interaction between the CEERI scientists and IIIT faculty members and students; admission of CEERI scientists to PG programmes at IIIT as sponsored candidates; sharing of facilities by both the institutes and access to library and inter-library-loan facilities.

RRL-Bhopal signs MoU with IRA, Medenine, Tunisia

THE Regional Research Laboratory (RRL-Bhopal), has signed an MoU with the Institute of Regions Arides (IRA), Medenine, Tunisia, to contribute to a continuous development of scientific and didectic cooperation of the two institutes with an aim to increase their scientific and cultural contacts. The MoU emphasizes on working in the area of Natural Resources Development and Management.

Furanoflavonoids: An Overview

ALTHOUGH the distribution of furanoflavonoids among plants is relatively sparse, nevertheless, they form a large and very distinctive subclass of the flavonoid family with a wide variety of structural variations.

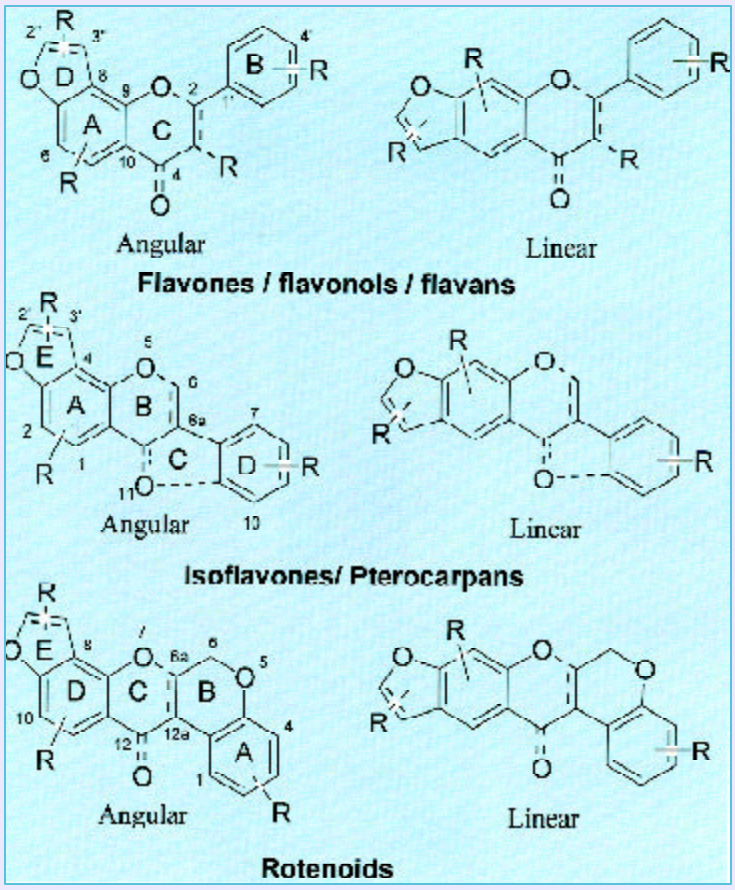
Rakesh Maurya and Prem P. Yadav of the Medicinal and Process Chemistry Division, Central Drug Research Institute (CDRI), Lucknow, have published an overview of the phytochemistry and pharmacology of furanoflavonoids describing 291 compounds and covering 228 references in *Natural Product Report*, **22** (2005) 400-424. The publication presents an overview of the angular and linear furanoflavonoid, dihydro-furanoflavonoids, bisfuranoflavonoids, flavonoid ketohexofuranosides and furano-biflavonoids.

This review has arisen from the CDRI's researchers' work on medicinal plant *Pongamia pinnata*. The aim of the review is to survey the chemical and biological literature related to the furanoflavonoid class of compounds. To date no comprehensive review has been undertaken.

Furanoflavonoids are a major family of secondary metabolites that occur mainly in leguminous

plants with a few examples of other families. They are characterized with linear or angular anellated furan ring to A-ring of various flavonoids. This broad class of flavonoids can be represented schematically as shown in figure.

Flavonoids with an anellated furan ring have diverse biological activities including antifungal, antibacterial, antitubercular, anti-inflammatory, quinone reductase, cytotoxic, insecticide synergists and even as cosmetics and sun screen. Amongst other classes, dihydrofuranocompounds, furanorotenoids and bisfuranoflavonoids have shown promising therapeutic potential for development as anticancer agents. They have shown very good cytotoxicity results against human tumor cells and other cell lines. Some of these compounds mentioned in the literature have promise for further development and optimization of their activities to obtain candidates for drug discovery process.



Development of Nanophosphors – A Review

NANOPHOSPHORS have been extensively investigated during the last decade due to their application potential for various high-performance displays and devices. These act as a strategic component in almost all displays. Synthesis of nanophosphors can be accomplished in two ways, i.e. through chemical and physical methods.

In his review paper entitled 'Development of Nanophosphors', published in *Materials Science and Engineering*, 49 (2005) 113-155, Harish Chander of the Luminescent Materials and Devices Group, Electronic Materials Division, National Physical Laboratory, (NPL), New Delhi, lays emphasis on the chemical methods because of their better processability. In the domain of chemical methods, different routes such as colloidal, capping, cluster formation, sol-gel, electro-chemical, etc., are being followed. Chemical precipitation in presence of capping agents, reaction in microemulsions, sol-gel reaction and auto-combustion are the commonly used techniques for synthesis of nanophosphors. However, the particle size has to be restricted to 3-5 nm i.e. size must be less than twice the Bohr radii of exciton to get the real advantage of quantum confinement. Advantage to be gained for producing a material in nano size is the enhanced mechanical, electrical, magnetic, optical and opto-electrical

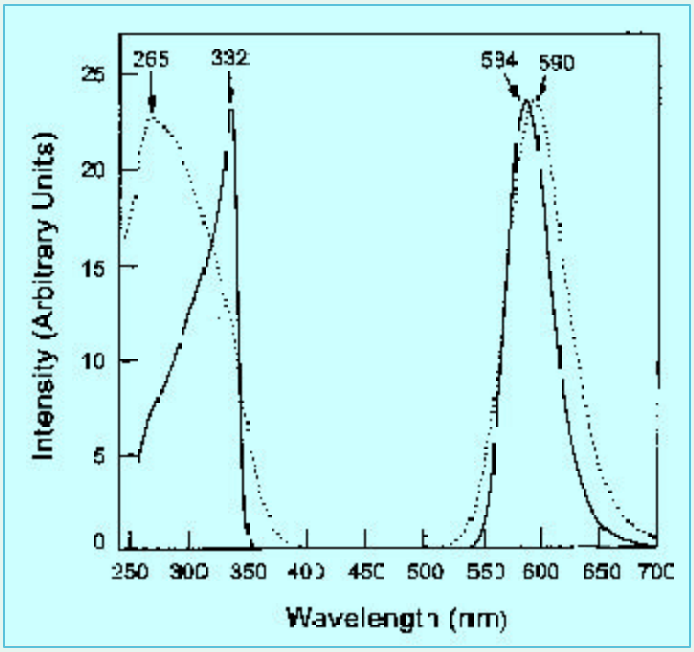


Fig. 1: Comparison of PLE and PL spectra of nanocrystalline (dotted lines) and bulk (solid lines) ZnS:Mn

properties. This feature of improvement in properties has been gainfully employed for many applications.

In 1994, Bhargava *et al* reported synthesis of manganese-doped nanocrystals of zinc sulfide. The nanomaterials had external photo-luminescence quantum efficiency of 18% and it ushered the era of nanophosphors. The synthesis involved reaction of diethyl zinc with hydrogen sulfide in toluene. The dopant manganese was added as ethylmanganese in tetrahydrfuran solvent to the parent solution of zinc salt before precipitation reaction. Surfactant methacrylic acid was used to maintain separation between the particles formed. Thus formed DNC were separated by centrifugation, washed and vacuum dried.

The enhancement of efficiency has been explained on the basis of surface passivation of the nanocrystals due to photopolymerization of the surfactant. The photoluminescent (PL) and photoluminescence excitation (PLE) spectra of the nanophosphor have been compared with bulk ZnS:Mn. The PL is slightly shifted and there is a larger linewidth in the nanophosphor as compared to bulk. It is due to combination of inhomogeneous broadening and phonon assisted transitions. The large shift in PLE spectrum is attributed to an increase in value of s-p electron band gap in the ZnS nanocrystals as a result of quantum confinement. Further, luminescent decay has been reported to be faster by five orders of magnitude. The presence of an impurity within a nanocrystal and localization of electron and hole wave function due to quantum confinement leads to faster energy transfer to impurity in smaller particles as compared to transfer rate for band to band transition or surface recombination. Hence, luminescence efficiency increases with decrease of particle size. This increase of luminescence efficiency has been studied by many workers for zinc sulfide host. Many processes such as chemical precipitation with and without capping agents, sol-gel, sol-gel with heating, microemulsion, solid state heating, chemical vapour synthesis, hydrothermal synthesis, chemical synthesis

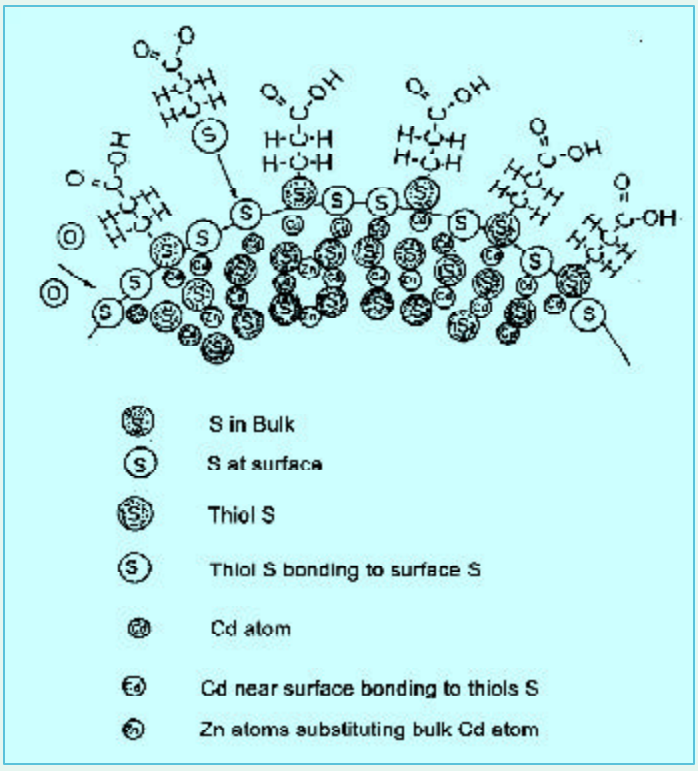


Fig. 2: A model for ZnCdS nanoparticles

within matrix, molecular beam epitaxy, electrochemical route, autocombustion, chemical precipitation from homogeneous solution have been developed for synthesis of nanophosphors. Apart from ZnS, nanophosphors based on other hosts such as CdS, Al_2O_3, Y_2O_3, $Y_3Al_5O_{12}$ (YAG), $SrAl_2O_4$, YVO_4, $LaPO_4$, ZnO have been synthesised and studied.

However, reports on nanophosphors for a particular application and attempts for fabrication of devices based on these are quite limited. Only a few works can be sighted on nanophosphors for application in field emission displays.

Dijken *et al* in 2001 prepared colloidal solutions of nanocrystalline ZnO particles and studied quantum efficiency with particle size. NaOH solution is added slowly to zinc acetate solution. Both the solutions are in 2-propanol and pre-cooled to 0°C. Colloidal suspension of ZnO particles of 0.7 nm radii is generated. Particle size grows with time due to aging. Growth up to 3 nm has been recorded and analysed. Heo *et al* in 2003 reported the preparation of nanorods of ZnMgO employing catalysis-driven molecular beam epitaxy, and measurement of their optical properties. In this, Mg doped ZnO nanorods were deposited on Ag coated silicon substrate. An ozone/ oxygen mixture was used as the oxidizing source. Nanorods of 15-40 nm in diameter and about 1 μm in length were formed. This has been confirmed by TEM and SEM. PL spectra of samples grown with substrate temperatures of 400°C and 500°C has been recorded. The emission has been attributed to the radiative recombination of photo-generated holes with electrons occupying the oxygen vacancy.

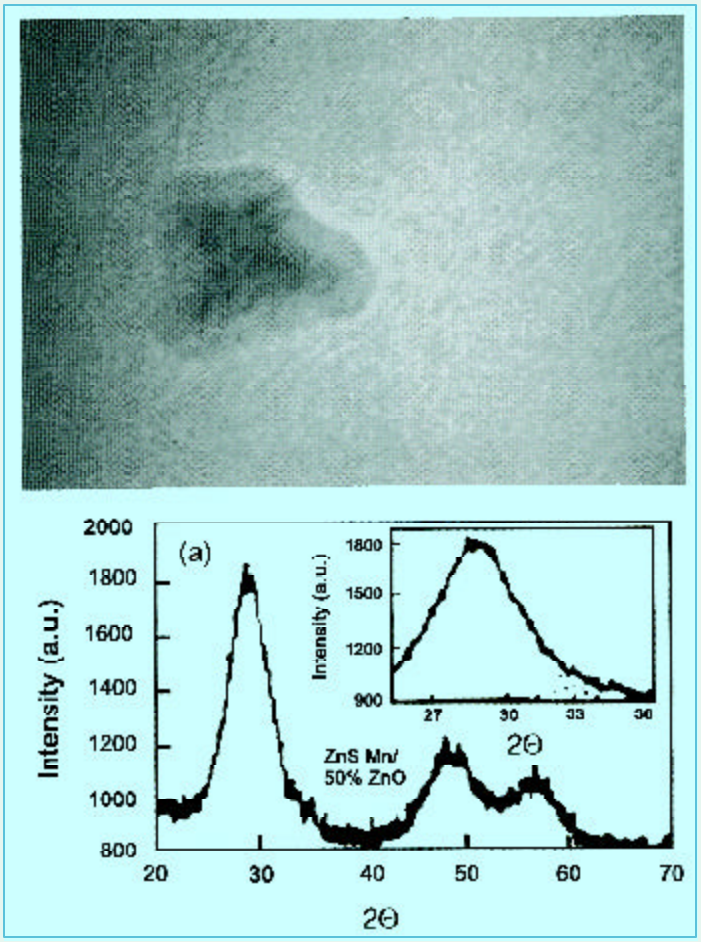


Fig. 3 : (a) XRD of nS:Mn/ZnO sample
(b) TEM- capped nanophosphor particles (89 kX)

Zhang and Li prepared ZnO nano-particles by precipitation transformation method. Solution of zinc sulfate was reacted with sodium carbonate solution with vigorous stirring. To this, NaOH solution was added dropwise. The reaction was performed at temperatures from 25–70 °C. Washing, filtration and drying followed to obtain powder ZnO nanoparticles. $Zn_5(CO_3)_2(OH)_6$ was formed as intermediate and phase transformation in presence of NaOH solution led to formation of ZnO. Pan *et al* in 2003 reported synthesis of Pr^{3+}-doped $CaTiO_3$ nanophosphor and red luminescence from polymer precursor.

Regarding devices and applications based on nanophosphors some reports have appeared for photoluminescent as well as electroluminescent (EL) displays with improved features of higher resolution, lower dose rates and low voltage EL operation (~ 10 V). Lower voltage operation for field emission display devices is a distinct possibility.

"What will it take for a Resident Indian to win a Nobel Prize?" Dr R.A. Mashelkar FRS, Director General, CSIR

Of the 520 Nobel Prizes that have been awarded in science till 2005, only three have gone to the scientists from developing countries for the work done in their respective countries. These three include the one to Sir C.V. Raman from India. This surely is not an encouraging statistics — this in spite of the fact that Alfred Nobel in his will dated 27 November 1895 has clearly stated that "in awarding the prizes, no consideration will be given to the nationality of the candidate". Therefore, more seriously, if the breakthroughs are truly Nobel Prize-worthy, then there is no reason as to why a scientist should not get it despite his nationality.

In his article published in the column '25 Challenges for India' of the 15 January issue of Business Today, Dr R. A. Mashelkar, FRS, Director General, CSIR, deliberates on: What will it take for a Resident Indian to win a Nobel Prize?

In June 1998, at the end of a brief conversation with Amartya Sen, at India International Centre in New Delhi, Dr Mashelkar said: "I hope this will be the year for the big one." He was referring to the Nobel Prize. Amartya Sen laughed and said: "Do you know Dr Mashelkar, you have to be 10 times as good to win the Nobel Prize if you are an Indian!" In the same year, Amartya Sen won the Nobel Prize for Economics. Dr Mashelkar sent him a one-line congratulatory message: "After all, you were 10 times as good!"

In science, they say only two people will be remembered, he who says the first word in science and he who says the last word in science. Of course, saying merely the first or the last word is not enough. What one says must have a lasting and indelible impact in the field!

To explain this, Dr Mashelkar cites the example of Roy J. Glauber. Glauber, who won half of the Nobel Prize in Physics, in the year 2005, "for his contribution to quantum theory of optical coherence". This raised a controversy, since it was felt by some that the contribution of E.C.G. Sudarshan, a scientist of Indian origin in the US, had been overlooked by the Nobel Committee. Sudarshan himself wrote to the Nobel Committee saying "it would distress him and many others if extra-scientific considerations were responsible for this decision". Some Indian scientists also protested to the Nobel Foundation.

But, did Sudarshan say the first word? The Nobel committee says: "Sudarshan drew the approach to the use of coherent state representations for the approach to classical physics. At this point, he refers to Glauber's work." Thus, the committee is subtly suggesting that Glauber had said the first word! "These subtleties are beyond me, since I am not an expert. But the implied emphasis on saying the first word is clear," points out Dr Mashelkar.

"As an Indian, I would have been truly proud if Sudarshan had won the Nobel Prize, as did so many other scientists in the past, who deserved it," adds Dr Mashelkar.

Jayant Narlikar, in his book *The Scientific Edge*, which has been published by Penguin in 2003, lists top 10 achievements of Indian science and technology in the 20th century. There are five before 1950 and five after 1950. Interestingly, the five before 1950 are all individual efforts, namely, the works by

Ramanujam (mathematics), Meghnad Saha (ionisation equation), S.N. Bose (particle statistics), C.V. Raman (Raman Effect) and G.N. Ramachandran (molecular biophysics). After 1950, he lists the other five achievements as nuclear power, Green Revolution, space programme, superconductivity and CSIR's transformation. All these five are government-funded big team initiatives. The moot question is: what has happened to individual excellence after 1950?

However, if one looks at what happened before 1950, C.V. Raman did get the Nobel Prize but the others did not. S.N. Bose's work leading to Bose-Einstein condensate is winning Nobel Prizes today. Many Indians feel that G.N. Ramachandran's work on triple helix should have won him the Nobel Prize, but it did not.

Let us look at the history of Nobel Prizes. There are three Nobel Prizes for Sciences, one each in chemistry, physics and medicine. In chemistry, of the total 152 prizes, 54 have gone to the US alone, followed by 27 to Germany and 25 to the UK. Similarly, in physics, of the total 182 prizes, 79 have gone to the US alone, followed by 23 to Germany and 21 to the UK. Similar is the story with Nobel Prizes in medicine. Of the total of 186, 89 have gone to the US, followed by 24 to the UK and 15 to Germany.

Why is the US the leader? Why is it that the other economic superpower, Japan, has not been as successful? Many people believe that this has to do with the culture of questioning that exists in the US, as against the culture of compliance that exists in Japan.

A potential Nobel Laureate, Dr Mashelkar emphasizes, needs to be, first and foremost, a true innovator. What is the definition of a true innovator? An innovator is one who does not know that it cannot be done. Bednorz and Muller won the Nobel Prize because they tested materials, which, through accepted wisdom, were not supposed to show superconductivity!

An innovator is also one who sees what everyone sees but thinks of what no one else thinks. To explain this, Dr Mashelkar cites this year's Nobel Prize winners for medicine, Robin Warren and Barry Marshall. Everyone had thought that the cause of gastritis inflammation and stomach ulceration is excessive acid secretion due to irregularities in diet and lifestyle. Warren and Marshall postulated that the causative agent was, in fact, a bacterium called *Heliobacter pylori*. They were ridiculed but they stuck to their guns. They could see and think beyond what others saw and thought.

Indians can always argue that they do not win Nobel Prizes because our investment levels are low. The US spends $250 billion on R&D as against India's $5 billion. "Size of the funding is, of course, important. You build large critical mass in a given field, setting up a competition. You empower the scientists hugely with modern tools so that they can run faster and arrive at the results first. But to me, it is not the size of funding but the size of ideas that ultimately matters. If tomorrow, any Indian thinks of an out-of-the-box idea to get a material which shows superconductivity at 20°C, he cannot be denied the Nobel Prize, even if he is an Indian, so profound will be the impact of his discovery on our lives!"

"The question is how do we make people think out of the box? I tried to promote this when I was the Director of National Chemical Laboratory. We created a 'kite flying fund', where an out of the box idea with a chance of success of one in one thousand will be supported. When I moved to CSIR, I created a 'New Idea Fund' with a similar objective. Eventually, I found that it was not lack of funds, but it was lack of ideas that was the bottleneck! One corollary of the statistics that I have cited is that the traditional and conservative societies, which include China and Japan along with India, appear to be at a disadvantage for a fundamental reason — namely the culture. But can this culture be changed? I believe it can. But we do require a change at all levels right from school science education to the way we fund and the way we do research."

"We have to remould the school science education to the mode of 'learning by discovery' and 'learning by doing' in contrast to the prevailing 'learning by rote'. Rather than memorizing the products of science, the child needs to learn the beautiful process of science. Questioning and dissent in the classroom and at home

must be respected and not punished. Indian scientists and institutions are risk averse. We must take risks. We must be more tolerant of failures. A certain amount of irreverence is essential for creative pursuit in science. True path-breakers in science will refuse to preserve the status quo because they enjoy the fun of creation of new ideas and destruction of old dogmas. We need to identify and support such scientists to the hilt. Eliticism in science needs to be promoted. A potential Einstein or a Ramanujam will have to be identified and nurtured from early on, just as the genius of Sachin Tendulkar was recognised at the age of 14! There is nothing like intellectual democracy."

"Our current research funding pattern, which is too conservative and democratic, needs to change. Out of the box thinking needs to be done not only by scientists but also by those who manage science! Can we speculate about the potential Nobel laureates from among the current resident Indians? In a recent survey, the two names that came up prominently were C.N.R. Rao and Ashoke Sen. It augurs rather well that C.N.R. Rao won the Dan David Prize recently, which is supposed to be among prizes that get counted as being next to the Nobel Prize."

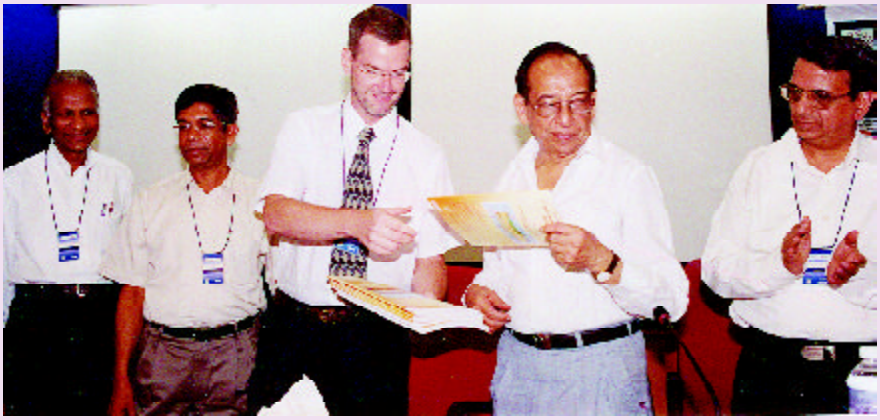
But is there a way to predict as to whether resident Indians will be in a zone of contention? Well, as mentioned earlier, in science, saying merely the first or the last word is not enough. What one says must have a lasting and indelible impact in the field. The Institute for Scientific Information (ISI) has been publishing citation analysis of each Nobel Prize winner's work. All Nobel Laureates tend to have exceptionally high level of productivity (articles per author), author impact (citations per author), and article impact (citations per paper). The citation data has frequently been used to forecast the future Nobel awardees. The results indicate that high rankings by citation frequency are strongly correlated with 'Nobel Class' authors. In the highest percentile, e.g., the top 0.1 per cent of authors, a significant percentage have won the Nobel Prize or go on to win the Prize in later years.

Unfortunately, the Indian presence in this highest percentile is rather rare. Our presence here as well as our strong presence internationally through partnerships is going to be critical.

Finally, what does it take to win a Nobel Prize? Dr Mashelkar quotes a Nobel Laureate, said: "First and foremost, you have to be very clever. Secondly, you have to work very, very hard. But thirdly, and most importantly, you have to be very, very, very lucky! He is absolutely right. "But," Dr Mashelkar concludes, "luck favours only the brave. In order for a resident Indian to win the Nobel Prize, Indian science must become brave. I hope the emerging brave new young India will also create some unusually brave scientists, who will go on to win Nobel Prizes."

INDO-US Workshop on Carbon Sequestration

THE National Geophysical Research Institute (NGRI), Hyderabad, recently organized a two-day Indo-US Workshop on Carbon Sequestration, in association with Battelle Pacific Northwest National Laboratory (PNNL), Richland, USA and with support from Indo-US-Science & Technology Forum and National Thermal Power Corporation (NTPC). The workshop was inaugurated by Dr Harsh K. Gupta, Secretary, Department of Ocean Development, New Delhi. Dr V. P. Dimri, Director, NGRI and Dr B. Kumar, Convenor and Organizing Secretary, welcomed the Chief Guest and the delegates. The souvenir and abstract volume were released by Dr Peter McGrail, Chief Scientist, PNNL, USA. The workhop was attended by eminent scientists from PNNL, Richland; University of Alaska, Fairbanks; University of Texas, Austin; University of Illinois; Carnegie Mellon University, Urbana-Champagane; USA, and more than 40 Indian delegates from CSIR laboratories (NEERI, Nagpur; NCL, Pune; CMRI, Dhanbad; IMTECH, Chandigarh; Indian Institute of Technology; Agharkar Research Institute; National Thermal Power Corporation Ltd; Oil & Natural Gas Corporation Ltd; Directorate General of Hydrocarbons and SICGIL Gases Ltd, Chennai.



Dr Peter McGrail presenting the abstract volume to Dr Harsh K. Gupta.
Seen with them are: Dr V.P. Dimri, Dr Balesh Kumar and Prof. K.V. Subba Rao

The concentration level of CO_2 a major greenhouse gas in the atmosphere is increasing as a result of emissions from combustion of oil, gas and coal and is of great concern due to its impact on global climate change. Carbon Sequestration technology involves the capture of millions of tonnes of CO_2 from point sources such as coal and gas fired power plants, its transport and long-term storage away from the atmosphere, in geological reservoirs, oceans and forests. Twenty-two research papers and four invited talks were presented on five key themes of the workshop viz Emerging Trends in Science & Technology of Carbon Sequestration; Geological Sequestration of CO_2 and Monitoring & Modeling; CO_2 Capture and Transport; Biological and Chemical Sequestration of CO_2; and Overview of International Initiatives and Programmes. The invited talks were delivered by Dr R.R. Sonde, Executive Director (Energy Technologies), NTPC; Dr Peter McGrail; Dr M.O. Garg, Director, Indian Institute of Petroleum (IIP), Dehra Dun, and Prof. K.V. Subba Rao, University of Hyderabad, Drs R. R. Sonde and Peter McGrail gave an overall view of science and technology of carbon sequestration in India and USA, respectively. Dr M.O. Garg focused on CO_2 separation for capture of CO_2 from flue gases. An excellent overview of Deccan Traps was presented by Prof. K.V. Subba Rao. Dr Arabinda Mitra gave a presentation on Indo-US Science and Technology Collaboration.

The present workshop gave a valuable opportunity for Indian and US scientists to exchange the knowledge on carbon sequestration, to mitigate the global climate change. Dr B. Kumar, recommended that three centers of excellence on geological sequestration, carbon capture and biological and chemical sequestration technologies should be set up at different national laboratories and universities in India. Dr K. Prased Saripalli, Co-Convenor proposed that NGRI and PNNL can work together to set up a Centre of Excellence on Geological Sequestration of CO_2 at NGRI. Dr Peter McGrail emphasized the opportunities to define the road map of geological sequestration of CO_2 in basalt formations of India. It was recommended by the organizers that a second workshop on the theme shall be planned in the next two years.

High-level Nigerian Delegation visits NISCAIR

A Nigerian delegation comprising Dr David Akosa Okongwu, Director General, National Office for Technology Acquisitions and Promotion, Abuja, Nigeria; Dr T. F. Okujagu, Director/Chief Executive and Mr S. O. Etatuvie, Chief Research Officer, Nigeria Natural Medicine Development Agency, Victoria Island, Lagos, visited the National Institute of Science Communication And Information Resources (NISCAIR), New Delhi, on 6 February 2006. The NISCAIR Director made a lively presentation on Traditional Knowledge Digital Library and related Intellectual Property Right issues. The delegation also visited the project site and interacted with the team working on TKDL.

The Nigerian delegation showed keen desire to collaborate with NISCAIR in replicating TKDL for Nigeria. It would be working out plan of action in this regard.

Training Course on Finite Element Method (FEM) and Finite Difference Method (FDM) with Applications to Heat Transfer and Fluid Flow

HEAT transfer and fluid flow processes are associated with a variety of geological and engineering problems which are of complex nature. However, the physics and chemistry of these processes are described by a set of conservation statements for mass, energy and momentum, which leads to a set of coupled partial differential equations. These conservation equations are derived from one or more empirical laws such as the Darey's law of fluid flow, the Fourier's law of heat conduction, the Fick's law of diffusion equation, etc. which express the flux of mass and energy in terms of driving force and proportionality constant that incorporates properties of the medium. In mathematical modeling, these equations are solved analytically/numerically to understand the associated processes quantitatively. Solutions of complex problems are difficult to obtain by analytical methods because of inhomogeneous and anisotropic character of the systems. Such problems are effectively solved by numerical methods. Two numerical methods, namely Finite Element and Finite Difference methods are commonly used to get the approximate solution of a problem.

Seen during the training course on The Finite Element Method (FEM) and Finite Difference Method (FDM) with Applications to Heat Transfer and Fluid Flow *(from left)* are: Dr S.N. Rai, Scientist 'F', NGRI; Dr V.P. Dimiri, Director, NGRI; and Prof. J.N. Reddy, Mechanical Engg. Department, Texas A&M University (TAMU), USA

The National Geophysical Research Institute (NGRI), Hyderabad, recently organized a short course on the FEM & FDM methods with applications to heat transfer and fluid flow. The course was sponsored by NGRI and was conducted by Dr S.N. Rai, Scientist 'F'. The course was inaugurated by Dr V.P. Dimri, Director, NGRI.

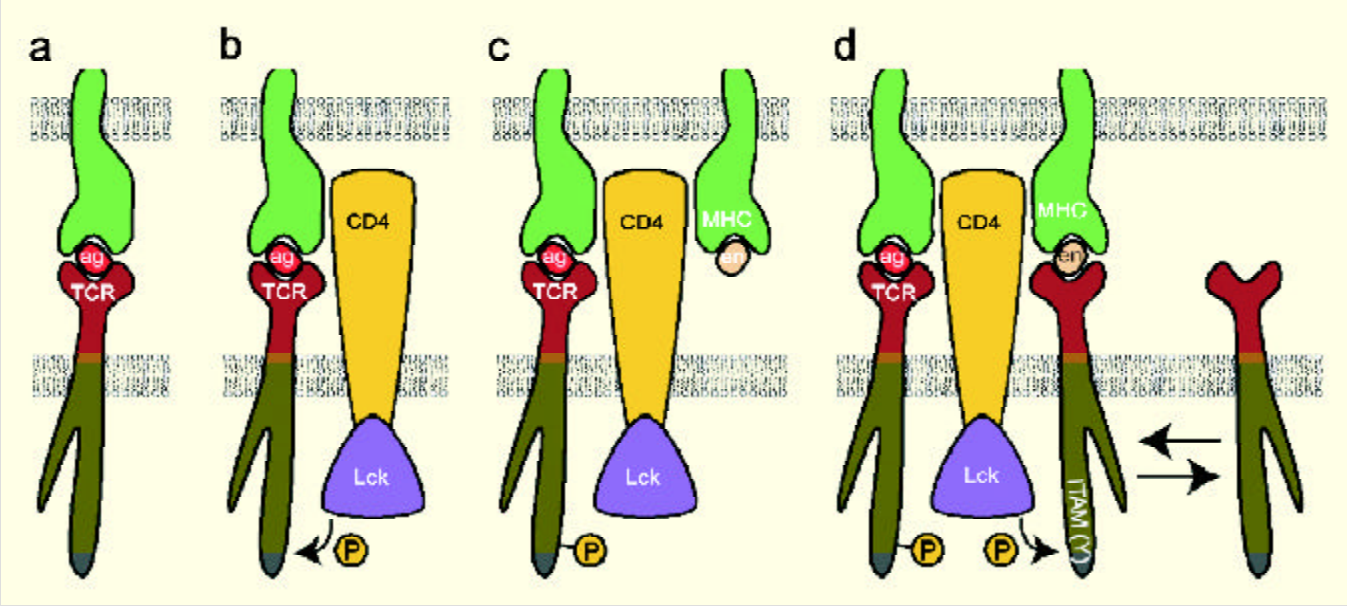
Prof. J.N. Reddy from Mechanical Engg. Department, Texas A&M University (TAMU), USA, delivered 12 lectures on different aspects of FEM methods which include introduction to the FEM method and its application to 1D and 2D problems of steady state and time dependent heat transfer and fluid flow processes, numerical integration and isoparametric formulations, 2D Mixed and Penalty models for viscous and incompressible flows, and Least Square Finite Element models. Dr P.K. Ramancharla from Indian Institute of Information Technology (IIIT), Hyderabad, delivered two lectures dealing with the FEM modeling of earthquake induced fracture propagations and deformation of buildings. Dr S.N. Rai delivered a lecture on introduction to the FDM and its applications to the solution of groundwater flow problems. Seventy participants from NGRI, IIIT, Osmania University, Andhra University, and IIT, Kharagpur, participated in the course. Participants received certificates from Prof. J.N. Reddy during valedictory function.

Prof. Arup Chakraborty delivers Prof. Doraiswamy Endowment Lecture at NCL

PROF. Arup Chakraborty delivered the seventh Prof. L. K. Doraiswamy Endowment Lecture in Chemical Engineering at Ethe National Chemical Laboratory (NCL), Pune, in the recent past. Dr L. K. Doraiswamy Endowment Lecture is a joint programme between NCL and Iowa State University (ISU), USA. The selected internationally recognized scientists or engineers deliver lectures at ISU and NCL.

Prof. Chakraborty is the Robert T. Haslam Professor of Chemical Engineering, Professor of Chemistry, and Professor of Biological Engineering at MIT, USA. The central theme of his research is the development and application of quantum and statistical mechanical approaches to study complex bio-systems of practical importance. Higher organisms, like humans, have an adaptive immune system that can respond to pathogens that have not been encountered before. T lymphocytes (T cells) orchestrate such adaptive immune response. These interact with antigen presenting cells (APC), which display molecular signatures of pathogens on their surface with great sensitivity. How T-cells discriminate between 'self' and 'non-self' with extraordinary sensitivity and how intracellular signaling leading to committed activation is regulated are the central questions in fundamental understanding of immune system.

Finding answers to these questions will also aid the development of intervention protocols for a host of diseases. During this lecture on 'Intercellular Communication in the Adaptive Immune System', Prof. Chakraborty discussed his recent work involving synergy between theory and computation in conjunction with laboratory experiments to propose a novel sequence of molecular events that lead to amplify the T cell response to very few agonist pMHC



A sequence of molecular events that can amplify the T cell response to a few agonist pMHC complexes. (a) The TCR binds to an agonist (ag) pMHC complex. (b) CD4 (and thus Lck) is recruited and binds to the MHC. (c) CD4 binds to another MHC that is statistically most likely to be an endogenous pMHC complex. This spatially localizes agonist pMHC complexes, endogenous (en) pMHC complexes, CD4 and Lck. (d) The TCR binds to an endogenous pMHC complex and can be triggered despite the small half-life of this interaction, because Lck is 'ready and waiting'. P (in circle), phosphorylated. ITAM (Y), phosphorylation at the tyrosine of ITAM. (From Nature Immunology, 2004, 5, 791-799)

molecules. In the context of an immune response, antigen-presenting cells (APCs) typically display both exogenous antigen–derived peptide–major histocompatibility complex (pMHC) molecules and a much larger number of endogenous (self) pMHC molecules. T-cells are selected such that their T-cell receptors (TCRs) bind endogenous pMHC molecules (self) much more weakly than antigen-derived pMHC molecules (non-self, agonists). *In vitro*, even one to ten agonist pMHC molecules can result in sustained generation of immunological signal in presence of a 'sea' of endogenous (self) peptides and this is amazing.

Several models have been proposed in literature to explain this phenomenon, but each with some lacuna and so not universally accepted. Prof. Arup Chakraborty has proposed a novel model taking into account several apparent anomalies of the earlier models. In his model, CD4 affects the responsiveness of T helper cells by controlling spatial localization of tyrosine kinase (LCK) in the synapse. This in turn enables endogenous pMHC molecules to trigger many T-cell receptors and thus the endogenous (self) and agonist (non-self) act co-operatively to amplify T-cell receptor (TCR) signaling. Simultaneously, activation due to endogenous (self) pMHC molecules alone is inhibited. This co-operative model was supported by *in silico* experiments using statistical mechanics and chemical engineering concepts and *in vitro* experiments using genetic, biochemical and imaging experiments.

During his lecture, Prof. Chakraborty also discussed the broader implications of T-cell biology, including thymic selection, diversity of the repertoire of self pMHC molecules and serial triggering. A clear understanding of the mechanistic aspects of intracellular communication in the adaptive immune system will aid the development of intervention of a host of immune system related diseases.

Earlier, Dr B. D. Kulkarni, Deputy Director, NCL and Head, Chemical Engineering and Process Development Division, NCL, welcomed the gathering and also introduced Prof. Chakraborty to the audience.

Dr Rakesh Tuli takes over as Director, NBRI

DR Rakesh Tuli, Scientist-G has taken over as Director of the National Botanical Research Institute (NBRI), Lucknow, with effect from 1 February 2006. Till recently he was the senior most scientist and Head, Molecular Biology and Genetic Engineering group of NBRI. Dr Tuli (born in 1953) did his graduation in Agriculture & Animal Husbandary in 1974, and Post Graduation in Genetics/ Biochemistry Plant Breeding with merit from G.B. Pant University of Agriculture & Technology, Pantnagar, Uttar Pradesh (now in Uttaranchal) in 1976. As a meritorious student he got National Science Talent Scholarship Award, Merit Scholarship. INSA Young Scientist Medal and Swedish International Development Agency Fellowship during this period.

Dr Tuli started his career as Scientific Officer C in 1976 at Bhabha Atomic Research Centre, Bombay, where he rose to become Scientific Officer (SF). While at BARC, he submitted his thesis for Ph.D. degree from Gujarat University in 1982. In 1992, Dr Tuli joined as Scientist-F at NBRI, in the Molecular Biology and Genetic Engineering Laboratory and became Scientist-G in 1997. Under his leadership and guidance; molecular biology and genetic engineering research at NBRI captured national and international attention. He has made remarkable contributions to the basic and applied research in the area of Transgenic Plants for Agricultural and Medical Biotechnology, Molecular Genetics for Crop Resistance to Biotic Stresses, Biochemistry and Molecular Genetics of Agriculturally and Medicinally Important Plants, Plant-based Vaccines, Genomic Diversity in Plants & Computational Analysis, Biological Nitrogen Fixation, Secondary Metabolism and Regulation of Gene Expression. He is the Coordinator, Principal Investigator and Advisory Consultant to a number of projects

of CSIR, different scientific agencies and private industries.

He was responsible for developing the first Indian technology for the development of commercialisable Bt-cotton cultivars. For this indigenous effort of developing various components of the technology for genetic engineering of crop plants for resistance to insect pests. Dr Tuli and his team of four students were awarded the prestigious CSIR Technology Prize – 2005.

Dr Tuli has been honoured with All India Biotech Association, New Delhi – AIBA Award 2001-2002, for his outstanding contributions in the field of Agricultural Biotechnology. He is the elected fellow and member of several learned professional societies/associations, such as Indian National Science Academy, New Delhi; Indian Academy of Sciences, Bangalore; National Academy of Sciences, Allahabad; National Academy of Agricultural Sciences, New Delhi; UNESCO sponsored Member of International Society for Plant Molecular Biology, Athens, USA and Member, Guha Research Conference. Dr Tuli has been serving on several advisory, expert and technical commi ttees in private and government agencies.

He has encouraged inter-disciplinary scientific programmes that involve good science and promoted partnerships with industry.

Honours & Award

Dr R.C. Boruah gets FNASc Fellowship

DR R.C. Boruah Scientist 'F' and Head, Medicinal Chemistry Division, Regional Research Laboratory (RRL), Jorhat, has been conferred the Fellowship of National Academy of Sciences (FNASc), India, from the year 2005. Dr Boruah has been honoured with this national distinction for the outstanding contributions he made to Chemical Sciences for his research carried out during the last five years at RRL, Jorhat. He is the Second scientist from the North East India to have become Fellow of this Academy in chemical sciences. Earlier to this he also received the Professor H.C. Goswami Memorial Fellowship of Assam Science Society for the year 2003-2005, and the Bronze Medal of Chemical Research Society of India, Bangalore, in 2005 for his significant contribution in Chemistry.

NAL Paper wins Award

THE paper titled: 'electroless deposition of nanocrystalline ternary and quarternary nickel based alloys containing tin and tungsten' by J. N. Balaraju, A Millath Jahan and K. S. Rajam of the Surface Engineering Division won the second best merit certificate at the Fifteenth National Symposium on Thermal Analysis (THERMANS-2006), held at the University of Rajasthan.

NEERI awarded Environmental Leadership Award

THE National Environmental Engineering Research Institute (NEERI), Nagpur, has been awarded the United States—Asia Environmental Partnership 'Environmental Leadership Award' in recognition of outstanding contributions made through working in partnership to improve the environment and quality of the life for the people of Asia.

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