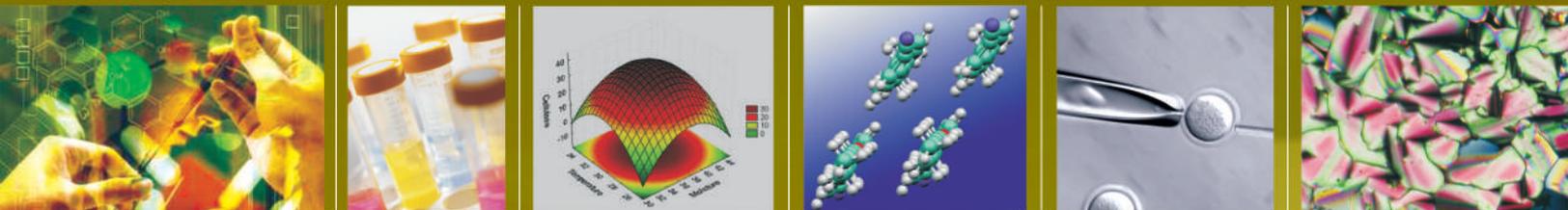


Annual Report 2008-09



Annual Report 2008-09
Annual Report 2008-09
Annual Report 2008-09



NATIONAL INSTITUTE FOR INTERDISCIPLINARY SCIENCE & TECHNOLOGY

(COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH)
THIRUVANANTHAPURAM

ANNUAL REPORT 2008-09

ANNUAL REPORT 2008-09



NATIONAL INSTITUTE FOR INTERDISCIPLINARY SCIENCE & TECHNOLOGY

(Council of Scientific & Industrial Research)

Thiruvananthapuram



Published by

The Director

National Institute for Interdisciplinary Science & Technology
Thiruvananthapuram

Editorial Committee

Dr. B.C. Pai | Dr. Suresh Das | Mr. P. Raghavan | Dr. Ashok Pandey
Dr. A. Sundaresan | Dr. K.G.K. Warriar | Dr. V.G. Mohanan Nair

Photography

Mr. P. Vijayakumar | Mr. G. Nagasrinivasu

Design & Printing

Akshara Offset | Thiruvanthapuram

NATIONAL INSTITUTE FOR INTERDISCIPLINARY SCIENCE & TECHNOLOGY

Council of Scientific and Industrial Research, Industrial Estate P.O.

Thiruvananthapuram – 695019, Kerala, India

Tel: +91-471-2490674 / 2490811 / 2490224

Fax: +91-471-2491712 / 2490389

Email: contact@niist.res.in, director@niist.res.in

Website: <http://www.niist.res.in>



Contents

Foreword	05
Highlights	07
Agro-processing & Natural Products	17
Biotechnology	23
Chemical Sciences & Technology	31
Materials & Minerals	51
Process Engineering & Environmental Technology	72
Research Planning & Business Development	86
Knowledge Resource Centre	101
General Information	131



Foreword

It is great pleasure for me to present the Annual Report of the Institute for the period 2008-09. It has been a productive year for the Institute with good progress in most of the activities of the Institute.

The Institute published record number of publications numbering to 244 out of which 233 were in Science Citation Indexed (SCI) journals ranking first among the CSIR laboratories for highest number of papers per scientist published in SCI journals. We are also second best for the total impact factor per scientist for the papers published in SCI journals during the same period. Two Indian and 22 foreign patents were filed during the year whereas 7 Indian and an equal number of foreign patents were granted during this year. The ECF generated through contract research works/grants during the year was 708.27 lakhs. The number of research students (CSIR NET qualified) pursuing for Ph.D. have substantially increased.

Under TIFAC-CSIR support programme an R&D centre for Bio Fuels has been established with the total support grant of Rs. 632 lakhs. Work has been carried out to establish 10 tons per day for fresh ginger processing plant in Sikkim under an engineering consultancy and a nano rare earth phosphate-production facility of 10 kg/batch at IRE campus, Kollam. A clean bio process developed in the laboratory for the production of white pepper has been licensed and well accepted by the entrepreneurs for the value additions. A zero discharge treatment system developed in the laboratory for parboiling rice mill has helped the industry for making the process environment friendly.

International collaborations and consultancy work were also taken during the year. National and International coveted awards were received by our scientists. CSIR young scientist award for the second consecutive year was possible by Dr. Satyajit Shukla receiving it in the Engineering Sciences. One of our research students had meetings with Nobel Laureate on invitation in Landau, Germany.

The R&D capabilities of the Institute have been strengthened by the installation and commission of modern sophisticated equipment facilities. Further, details are given in R&D highlights and in the report. I congratulate all the members of the staff who have made it possible and look for sustained growth of the Institute in the coming years.

Dr. B. C. Pai



प्रस्तावना

वर्ष 2008-09 की अवधि के लिए संस्थान की वार्षिक रिपोर्ट प्रस्तुत करने में मुझे अत्यंत प्रसन्नता है। अधिकांश गतिविधियों में अच्छी प्रगति के साथ यह वर्ष संस्थान के लिए एक उत्पादक वर्ष रहा है।

संस्थान ने रिकार्ड संख्या में यानि 244 पत्र प्रकाशित किए हैं, जिनमें से 233 प्रकाशन विज्ञान प्रशस्ति पत्र सूचन(एस सी आई) जर्नलों में हैं। हमारा संस्थान सीएसआईआर प्रयोगशालाओं के बीच एस सी आई पत्रिकाओं में प्रकाशित प्रति वैज्ञानिक पत्रों की सबसे बड़ी संख्या के साथ प्रथम स्थान पर है। वर्ष के दौरान 22 विदेशी तथा 2 भारतीय पेटेंट फाइल किए गए, जबकि 7 भारतीय तथा समतुल्य विदेशी पेटेंटों को स्वीकृती दी गई। संविदा अनुसंधान कार्य तथा अनुदान के लिए बाह्य साधनों से 708.27 लाख रुपए प्राप्त हुए। पी एच डी के छात्रों की संख्या (सीएसआईआर नेट उत्तीर्ण) में भी काफी वृद्धि हुई है।

जैव ईंधन के लिए टीआईएफएसी-सीएसआईआर समर्थित कार्यक्रम के अधीन 632 लाख रुपए के कुल अनुदान से एक अनुसंधान एवं विकास केंद्र की स्थापना की जा रही है। एक अभियांत्रिकी परामर्शिता के अधीन सिक्किम में प्रतिदिन 10 टन ताजा अदरक संसाधन संयंत्र तथा आई आर ई कैपस, कोल्लम मे प्रति बैच 10 किलोग्राम नैनो रेअर अर्थ्स फोस्फेट उत्पादन सुविधा के लिए कार्य किया गया। सफेद मिर्च के उत्पादन के लिए प्रयोगशाला में विकसित एक परिष्कृत जैव प्रक्रिया का लाईसेंस दिया गया है और उपक्रमियों द्वारा मूल्य वर्धन के लिए प्रक्रिया स्वीकृत हो गयी है। सेला चावल मिलों के लिए प्रयोगशाला में विकसित जीरो डिस्चार्ज अभिक्रिया पद्धति ने उद्योगों को अपनी प्रक्रिया को पर्यावरण हितैषी बनाने में सहायता दी है।

वर्ष के दौरान अंतरराष्ट्रीय सहकारिता तथा परामर्शी परियोजना के कार्य भी लिये गए हैं तथा हमारे वैज्ञानिकों को राष्ट्रीय तथा अंतरराष्ट्रीय प्रतिष्ठित पुरस्कार मिले हैं। लगातार दूसरे वर्ष के लिए सीएसआईआर का युवा वैज्ञानिक पुरस्कार हमारे संस्थान को मिला है(डॉ. सत्यजित वी शुक्ला को इंजीनियरिंग विज्ञान में)। हमारे शोध छात्रों में से एक ने लान्डो, जर्मनी में निमंत्रण पर नोबल पुरस्कार विजेता के साथ बैठक की।

आधुनिक परिष्कृत उपस्करों एवं सुविधाओं की संस्थापना तथा कमीशनिंग से संस्थान की अनुसंधान एवं विकास क्षमताएं मजबूत हुई हैं। अनुसंधान एवं विकास के मुख्य अंश तथा रिपोर्ट में आगे और ब्यौरे दिये गये हैं।

में सभी स्टाफ सदस्यों को बधाई देता हूँ, जिन्होंने इसे संभव बनाया है और आनेवाले वर्षों में संस्थान के सतत विकास की कामना करता हूँ।

डि. सी. पै

डॉ. वी. सी. पै



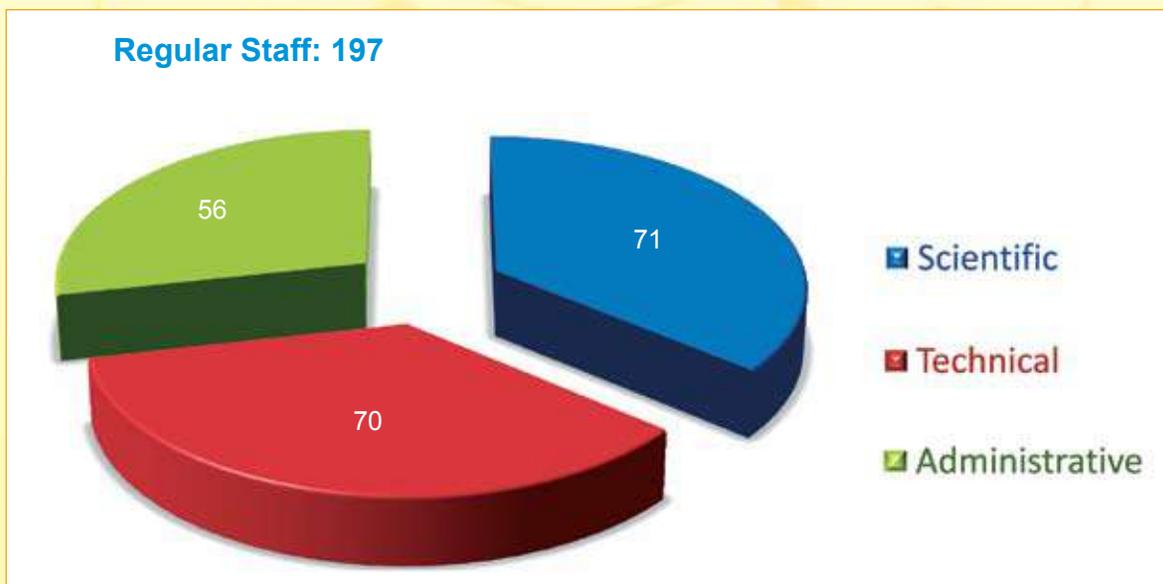
ANNUAL REPORT 2008-09

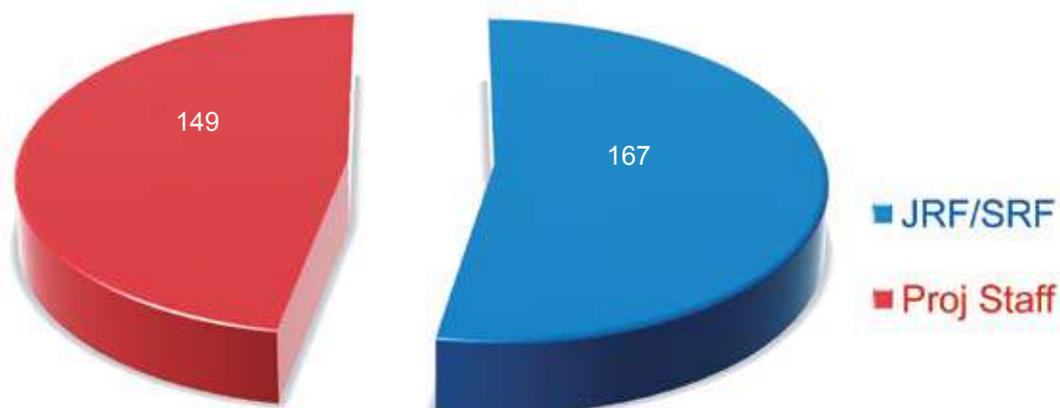
Highlights

The year witnessed a steady growth in the R&D performance and infrastructure facilities of the Institute with lower budgetary support. The number of publications was 244 of which 233 were in science citation index journals. Two Indian and 22 foreign patents were filed and 14 patents including seven foreign were granted during the year. The Institute initiated 16 new contract research projects and 14 consultancy projects. The total ECF generated was Rs 708.27 lakhs. Under a TIFAC-CSIR supported program, a Centre for Biofuels has been established with an estimated initial funding of Rs. 632 lakhs for first three years. Efforts are being made to acquire a central and leading status for the NIIST in the bioethanol program.

The R&D capabilities of the Institute were further strengthened by the installation and commissioning of modern sophisticated equipment facilities. Some of the major facilities installed during this period are Confocal microscope, Scanning probe microscope, PANalytical X'Pert Pro-X-ray diffractometer, Nanosecond Laser Flash photolysis system, AXIMA-CRF-Plus MALDI-TOF system etc. The 500 MHz NMR facility was also upgraded with installation of QNP probe and autosampler system. As the modern equipment facilities needed constant power supply, the existing electric sub-station (MD 420 kVA) was upgraded with programmable logic control (PLC) indoor sub-station as well as motorized HT control panel having a maximum demand allocation of 700 kVA and three generators.

The regular staff strength, which stood at 222 as on 1st April, 2007 was reduced to 197 by the end of March, 2009 as the intake of fresh staff was limited due to many reasons. The R&D work was little affected as the recruitments of project fellows and JRF/SRF were given special emphasis and by year end there were 167 JRF/SRF and 149 project fellows in position.



**Research Fellows/ Project Staff : 316****R&D achievements**

Some of the significant R&D achievements are summarized below.

A ten ton per day fresh ginger processing plant in Sikkim, under an engineering consultancy project is expected to be commissioned during the coming season and initial work on design of equipments, layout and equipment drawings were completed. Civil work and infrastructure development at site including laying of 11kVA line are in progress.

Under the Golden Triangle Partnership (GTP) project, formulations and plant materials were tested and chemical markers quantified. A reverse phase HPTLC method was also developed to estimate "EMBELIN", a marker compound in *Embelia ribes* and poly herbal formulations.

Gold nanorod dimers synthesized and coupled plasma absorption were studied in these systems as a function of distance & orientation. These systems have potential application in integrated nanoscale photonic devices. The chemical group also developed a donor acceptor dyad exhibiting long-lived charge separated state and having potential application in solar energy harvesting.

Luminescent dyes were developed for selective detection of various analytes such as amino thiols in blood, copper and DNA. A new NIR squaraine dye based probe selectively responds to thiols and amino thiols which allow their ratiometric detection due to the generation of new, non-interfering absorption and emission bands. A study to assess the photosensitizing potential of an iodosquaraine for skin cancer therapy *in vivo* showed that the progression/cure can also be visualized by the naked eye.

Environmentally benign yellow pigment based on samarium & molybdenum oxides developed as alternative to the existing chromium & cadmium based toxic pigments. The synthetic method is simple and inexpensive. The pigment has high thermal & chemical stability and is suitable for colouration of plastics.

Cyclopentane fused heterocycles are important intermediates in the synthesis of biologically important molecules. A novel one pot strategy for the cyclopentannulation of heterocycles was developed and a number of cyclopentene fused benzofurans & indole derivatives have been prepared using this strategy.

The removal of Uranium, a persistent inorganic pollutant, from mining industry feed simulant and natural water solutions was accomplished with mesoporous uranyl ion imprinted polymer material



prepared based on TRAPPING concept employing formamidoxime and 4-vinyl pyridine.

Preparation of a transparent, colourless, crystal clear, nontoxic, biodegradable, biocompatible gel named 'Chitam gel' was made by modifying the xyloglucan to form dialdehyde of xyloglucan and making a co-polymer with chitosan to form a gel which is stable at temperature -20 to 90 °C, UV radiation and pH from 3 to 7. The yield of the gel from the raw material is very high, since 10 gm raw material produces 1Kg of gel, which is 100 fold yield and hence cost effective. The chitam gel can be used as a zero calorie food ingredient, and supplement for functional foods. It also has applications in the area of personal care products, and in pharmaceutical preparations.

The Minerals & Material group successfully developed the process flow sheet for 10 kg batch nano rare earth phosphate and procured all the process equipments, orders placed for civil and erection to commission the plant in Indian Rare Earths Ltd. campus in Kollam, in 2009.

Layered nano coatings were developed on multi channel one meter long porous tubes at BHEL based on the data generated last year in the laboratory for a semi commercial, all-ceramic ultra filtration plant. The input and out put quality of water and the molecular cut off data were analyzed & fed back to BHEL.

A facile process for synthesizing clay-based inorganic-organic hybrid (PCN) was developed which yields micro-vesicles (3-10 micrometer) by solvent-assisted self-assembly properties and capable of encapsulating guest-compounds from their solutions by membrane diffusion or during vesicle formation. The vesicle is thermally stable over 250° C, impermeable to water, permeable to alcohol and unstable in low-dielectric solvents. PCN vesicle can be a potential candidate for use as micro-storage system and may find micro-encapsulation/delivery applications in cosmetics, paints etc. Possibility exists for hydrophile modification of the vesicle so as to find pharmaceutical application also.

Ex-situ Graphite and *in-situ* primary silicon reinforced hybrid functionally graded Aluminium composites have been synthesised by centrifugal casting. The hard particle reinforcement by primary silicon improved the strength and abrasive wear resistance. Soft particle reinforcement by graphite improved the adhesive wear resistance and acted as solid lubricant.

Dielectric ceramic compositions having quality factor Qf as high as 10⁶ GHz developed for increasing selectivity in microwave communication systems. The lithium magnesium silicate had a relative permittivity of 5 and loss tangent of 1x10⁻⁴ at 8 GHz. The preparation temperatures of these silicates were lowered by the addition of a small amount of low melting glasses.

A suitable method to produce white pepper, a dream of pepper sector has been possible by development of the **clean bioprocess** which was licensed to 9 entrepreneurs (7 pepper growers and 2 dealers). It resulted in increasing white pepper production in the country (>10 times). Using this new process more than 50 MT white pepper has been produced and mostly exported. When all the licensed plants (few more are licensing) become fully operational the production of white pepper would be thousands of tons/annum. This value addition attracts increased export value from pepper and higher (20% to 80%) income to farmers and rural community.

Process water from paddy parboiling of rice mills is a serious environmental pollution. The Institute has developed a zero discharge treatment system (process water recycling) for the Kalady Rice Millers' Consortium, Ernakulam District of Kerala. On successful performance of the pilot plant, a full scale effluent treatment plant was set up. This employs anaerobic technology to treat process water of 200 m³/day from a rice mill processing 240 MT paddy/day. The new process enables reuse of the process water in the parboiling and generates biogas.

Indo-German collaborative project to construct and analyze a recombinant pentose-utilizing



Corynebacterium glutamicum strains for amino acid production from hemicellulose-containing agro-waste materials has been initiated with University of Muenster, Germany. The derived strains will be subjected to develop a laboratory scale fermentation process for producing L-glutamate and L-lysine from various hemicellulosic hydrolysates prepared from the hemicellulosic waste materials such as wheat and rice straw, sugar bagasse, cassava bagasse, wood pith, etc.

Another international collaborative project on microbial production of L- Arginine from cost effective starch based natural feed stocks using *C. glutamicum* and *E. coli* cultures was also initiated with Colgate Palmolive, USA. Attempts will be also made for down stream processing for arginine, probable crystallization and recovery via chromatography approaches.

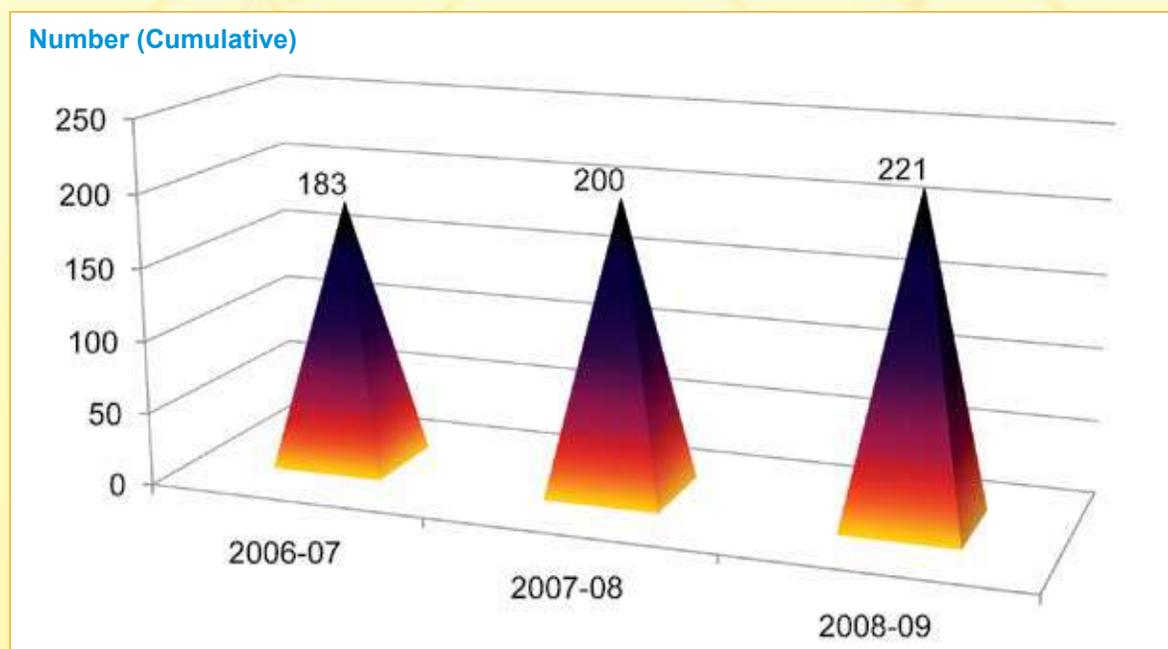
Under the UNIDO funded project as a first step to implement the Stockholm Convention on Persistent Organic Pollutants, measurements in relation to unintentionally produced POPs (Dioxins & Furans) was initiated to prepare inventory on industrial and non industrial sources of unintentionally produced POPs in 5 Southern States of India. The project will result in a survey report on major industries in Andhra Pradesh, Karnataka, Kerala, Pondicherry and Tamil Nadu regarding unintentionally produced POPs.

Honors & Awards and Human resource development

Meritorious work of eleven NIIST staff and five research fellows were recognized by different bodies in the form of awards. The Institute was bestowed with another CSIR Young scientist award for the second consecutive year. Dr. Satyajit Shukla received this award in the Engineering Sciences. Some of the other coveted awards were Thomson Reuters Research Excellence- India Research Front Award (Dr. Ajayaghosh), Fellow, International Organization for Biotechnology and Bioengineering (Prof. Ashok Pandey), CRSI Silver Medal (Dr. Suresh Das), MRSI Medal (Dr. M.T. Sebastian), IIF Research Award (Dr. T.P.D. Rajan) etc.

Many staff members and students were deputed for various training programs/seminars/symposia/conferences during the year, giving them an exposure to the recent developments in their respective fields. The cumulative number of Ph. Ds awarded to research fellows has reached 221 by this report period. Short-term training facilities were also extended to students and staff of academia and industry.

Ph. Ds awarded





Events/Seminars/Symposia

The Institute celebrated the National days and arranged many seminars as well as conferences during the year giving an opportunity to the staff and students to the recent developments in related subjects. Some important activities are given below.

Dr A Sivathanu Pillai, Distinguished Scientist & Chief Controller (R&D), DRDO, CEO & MD Brahmos Aerospace, delivered the National Technology Day lecture on 13th June, 2008. CSIR foundation day celebrations were held on 26th September and Prof. P. Ramachandra Rao, Raja Ramanna Fellow, DAE International Advanced Research Centre for Powder metallurgy & New Materials (ARCI) Hyderabad delivered the CSIR Foundation Day Lecture. Prof. E.D. Jemmis, Director, IISER, Thiruvananthapuram delivered the NIIST foundation day (6th October) lecture. National Science Day celebration was held on 4th march, 2009. Prof A Jayakrishnan, Vice Chancellor, University of Kerala was the Chief Guest who delivered the Science Day Lecture.

R&D-Industry Meet on Clean Bioprocessing of Natural Fibres was held on 17th April, 2008 and Dr S.L. Govindwar, Adviser, DBT, Govt. of India inaugurated the programme. The International seminar on Mineral Processing Technology was held from 22nd to 24th April, 2008. A five day National workshop on Electron microscopy and allied techniques (WEMT-2008) was arranged jointly with Electron Microscope Society of India (EMSI).

In addition, the student community of the Institute celebrated their day as "Radiance 2008" on 30th December, 2008. Dr. V. Adimurthy, Associate Director, VSSC, Trivandrum inaugurated the function and delivered keynote address.





वार्षिक रिपोर्ट-2008-09

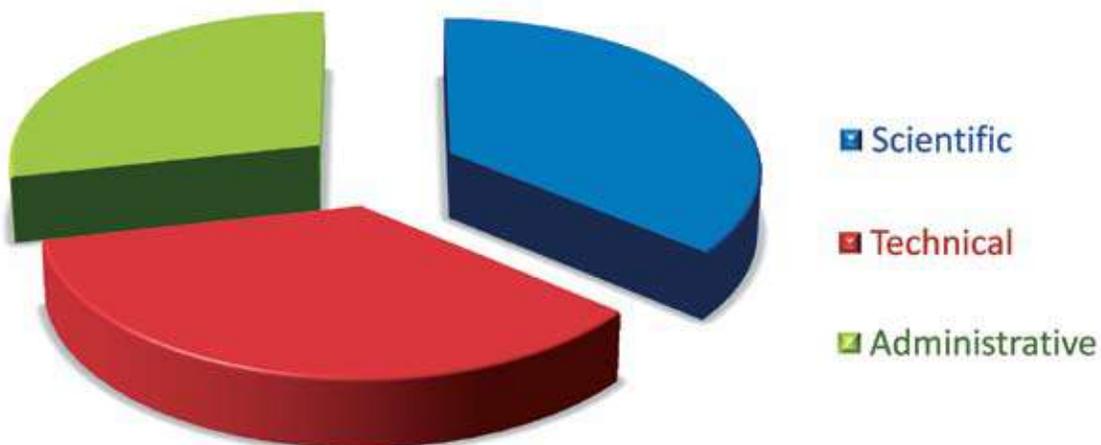
अनुसंधान एवं विकास के मुख्य अंश

इस वर्ष के दौरान संस्थान में कम बजटीय साधनों के बावजूद बुनियादी सुविधाओं तथा अनुसंधान एवं विकास निष्पादन में वर्ष के दौरान संस्थान में लगातार वृद्धि हुई। शोध प्रकाशनों की कुल संख्या 244 रहीं, जिनमें से 233 प्रकाशन विज्ञान प्रशस्ति पत्र सूचन (एस सी आई) जर्नलों में हुए। दो भारतीय तथा 22 विदेशी पेटेंटों काईल किए गए तथा 7 विदेशी पेटेंट सहित 14 पेटेंट के लिए स्वीकृति प्राप्त हुई। संस्थान ने 16 नई संविदा आधारित परियोजना तथा 14 परामर्शी परियोजनाएँ प्रारंभ की। कुल बाह्य नकद प्राप्ति 708.27 लाख रुपए हुई। से आई एफ ए सी- सी एस आई आर समर्थित कार्यक्रम के अधीन तीन वर्ष के लिए 632 लाख रुपए के अनुमानित प्रारंभिक घन के साथ जैव ईंधन के लिए एक केंद्र की स्थापना की गई है। बायोएथनॉल कार्यक्रम के लिए संस्थान द्वारा एक केंद्रीकृत तथा अग्रणी स्थान प्राप्त करने के लिए प्रयास किए जा रहे हैं।

अत्याधुनिक एवं परिष्कृत सुविधाओं की संस्थापना तथा कमीशनिंग द्वारा संस्थान की अनुसंधान एवं विकास सक्षमता को आगे और मज़बूत किया गया है। रिपोर्ट अवधि के दौरान संस्थापित कुछ प्रमुख सुविधाएं ये हैं – कॉन्फोकल माइक्रोस्कोप, स्कैनिंग प्रोब माइक्रोस्कोप, पानलिटिकल एक्स पेट प्रो-एक्स रे डिफ्रैक्टोमीटर, नैनोसेकण्ड लेजर फ्लैश फोटोलिसिस सिस्टम, ए एक्स आई एम ए- सी आर एफ- प्लस एम ए एल डी आई – टी ओ एफ सिस्टम, आदि। 500 मेगाहर्ट्स एन एम आर सुविधा को क्यू एन पी प्रोब तथा स्वतः प्रतिदर्शित्र प्रणाली की सुविधा के साथ आधुनिक किया गया। आधुनिक उपस्करों एवं सुविधाओं के लिए निरंतर विद्युत आपूर्ति की जरूरत होने के कारण मौजूदा बिजली उपस्टेशन (एम डी 420 किलो वॉल्ट) को क्रमबद्ध लॉजिक नियंत्रण इन्डोर उपस्टेशन तथा 700 किलोवोल्ट के अधिकतम मांग आबंटन युक्त मोटोरीकृत एच टी नियंत्रण पैनल तथा तीन जनरेटरों के साथ उन्नयन किया गया है।

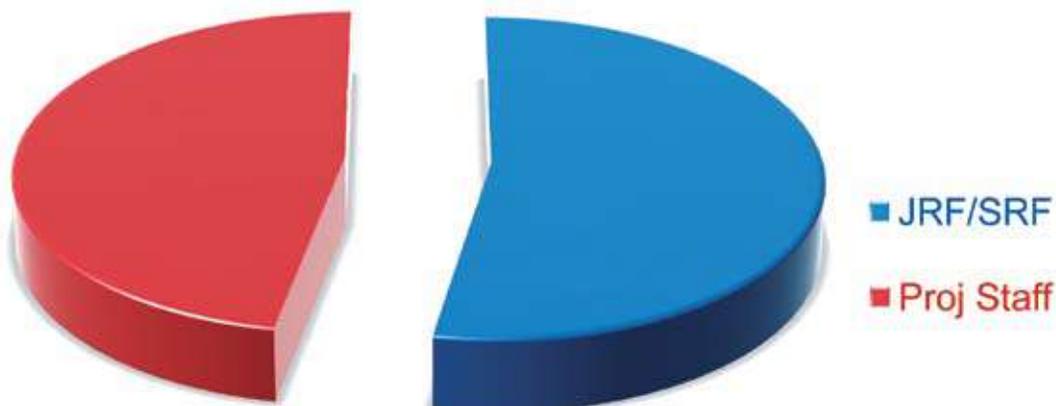
नियमित कर्मचारियों की संख्या 1 अप्रैल 2007 को 222 थी, जबकि मार्च 2009 के अंत तक यह 197 तक कम हो गई क्योंकि अनेक कारणों से नई नियुक्तियाँ सीमित रखी गईं। परियोजना फेलो तथा जे आर एफ की नियुक्ति पर विशेष ज़ोर दिए जाने के कारण अनुसंधान एवं विकास कार्यों पर इससे कोई बुरा प्रभाव नहीं पडा और वर्ष के अंत तक जे आर एफ / एस आर एफ की संख्या 167 थी। इस अवधि के दौरान परियोजना फेलो की संख्या 149 थी।

नियमित स्टाफ: 197





अनुसंधान फेलो/परियोजना स्टाफ : 316



अनुसंधान एवं विकास उपलब्धियाँ

कुछ महत्वपूर्ण अनुसंधान एवं विकास उपलब्धियों के संक्षिप्त ब्यौरे निम्न प्रस्तुत हैं –

एक अभियांत्रिकी परामर्शिता के अधीन सिविकम में आगामी मौसम में प्रतिदिन 10 टन ताज़ा अदरक संसाधन करने योग्य संयंत्र कमीशन करने के लिए उपस्करों के डिज़ाइन, लेआउट तथा उपकरणों के चित्र आदि से संबंधित प्रारंभिक कार्य पूरे किए गए। सिविल निर्माण कार्य तथा साइट पर 11 किलोवोल्ट लाइन के रखाव सहित बुनियादी सुविधाओं के विकास के कार्य प्रगति पर हैं।

गोल्डन ट्रायांगिल साझेदारी परियोजना के अधीन (जी टी पी) फॉर्म्युलेशन्स तथा पादप पदार्थों का परीक्षण किया गया और रासायनिक मार्करों की मात्रा निर्धारित की गई। इंबिलिन- जो *इंबिलिया राइब्स* तथा पॉली हर्बल फॉर्म्युलेशन्स में मार्कर मिश्रित है, का अनुमान लगाने के लिए एक रिवर्स चरण एच पी टी एल सी पद्धति विकसित की गई।

स्वर्ण नैनो रॉड द्वितय का संश्लेषण किया गया और दूरी तथा अभिविन्यास के अभिलक्षक के रूप में इन पद्धतियों में युग्मित प्लाज्मा अवशोषण अध्ययन किया गया। एकीकृत नैनोस्केल फोटोनी डिवाइजों में इन पद्धतियों का शक्तिशाली अनुप्रयोग होता है। रासायनिक गुप ने सौर ऊर्जा संरक्षण में प्रभावी अनुप्रयोग होनेवाले दीर्घ जीवित चार्ज वियुक्त स्थिति दर्शानेवाला एक दाता- आदाता द्वयक विकसित किया।

विभिन्न विश्लेष्य जैसे रक्त, ताँबा, तथा डी एन ए में वर्तमान ऐमिनोथाइओल के चयनित संसूचन के लिए संदीप्तिशील रंजकें विकसित किये गए। एक नया एन आई आर स्क्रैनिंग आधारित प्रोब, थाइओल तथा ऐमिनोथाइओल, जो नये अव्यतिकरण अवशोषण तथा उत्सर्जन बैंड के उत्पादन के कारण अपने अनुपातमात्रिक पहचान को अनुमत करते हैं, की ओर वरणात्मक प्रतिक्रिया दर्शाता है। त्वचा कैंसर के उपचार में एक आयोडोस्क्रैनिंग की फोटोसुग्राही शक्यता के मूल्यांकन के लिए किए गए अध्ययन से पता चला है कि नंगी आंखों से रोगमुक्ति देखी जा सकती है। वर्तमान में प्रयुक्त क्रॉमियम तथा कैडमियम आधारित विषैले वर्णकों के विकल्प के रूप में समेरियम तथा मॉलिब्डेनम ऑक्साइडों पर आधारित पर्यावरण सौम्य पीले रंजकें विकसित किए गए। यह कृत्रिम पद्धति अत्यंत सरल एवं सस्ती है। वर्णक को उच्च तापीय तथा रासायनिक स्थिरता प्राप्त है और प्लास्टिक की रंगाई के लिए उचित भी है।

साइक्लोपेन्टन संयोजित हेट्रोसाइकिलें जैव सक्रिय प्रमुख अणुओं के संश्लेषण में महत्वपूर्ण मध्यवर्तियाँ हैं। हेट्रोसाइकिलों के साइक्लोपेन्टानुलेशन के लिए एक नयी योजना विकसित की गई और इस योजना का इस्तेमाल करके असंख्य साइक्लोपेन्ट संयोजित बेन्ज़ोफुरेन तथा इंडोल संजातें विकसित किये गये हैं।



फार्मेमिडॉक्सिम तथा 4- विनैल पैरिडिन के प्रयोग से तथा ट्रापिंग संकल्पना के आधार पर तैयार किए गए मीसोपोरस युरानैल ऑयन अध्यंकित पॉलिमर पदार्थ ने खनन उद्योग फीड अनुकारक तथा प्राकृतिक जल विलयन से सतत अकार्बनिक प्रदूषक, युरेनियम को हटाने का कार्य निष्पन्न किया है।

जाइलोग्लूकान को जाइलोग्लूकान के डाईऐलेल्डिहाइड के रूप में परिवर्तित करके तथा काइटोसैन के साथ एक सह पॉलिमर तैयार करके काइटम जेल नामक पारदर्शी, रंगहीन, क्रिस्टल स्पष्ट, आविषैले, जैव निम्नीकरणीय तथा जैव अनुकूल काइटम की तैयारी के लिए प्रक्रिया विकसित की गई, जो -20 डिग्री सें. से 90 डिग्री सें. तक यू वी विकरण तथा पी एच 3 से 7 तक की अवस्था में स्थिर रहता है। कच्चे माल से बेहतर जेल की लब्धि होती है- 10 ग्राम कच्चे माल से 1 किलो जेल उपलब्ध होते हैं, जो 100 गुना उत्पाद हैं, अतः लागत प्रभावी है।

काइटम जेल को जीरो कैलोरी खाद्य इन्ग्रेडियन्ट तथा फलन खाद्य संपूरकों के रूप में (पोषणज संपूरक) उपयोग किया जा सकता है। काइटम जेल की वैयक्तिक संरक्षण उत्पादों के क्षेत्र में तथा औषधीय तैयारियों में भी उत्कृष्ट उपयोगिता है।

पदार्थ एवं खनिज प्रभाग ने 10 किलोग्राम बैच नैनो रेअर अर्थ्स फोस्फेट के लिए प्रक्रिया प्रक्रम चित्र सफलतापूर्वक विकसित किया तथा सभी प्रक्रिया उपकरण भी खरीद लिए हैं। वर्ष 2009 तक इंडियन रेअर अर्थ्स लिमिटेड कैंपस, कोल्लम में सिविल निर्माण कार्य तथा संयंत्र के कमीशनिंग के लिए आदेश दिया गया है।

प्रयोगशाला में पिछले वर्ष एक अर्ध वाणिज्यिक, संपूर्ण सिरेमिक अल्ट्रा निस्स्यंदन संयंत्र के लिए तैयार किए गए डेटा के आधार पर बी एच ई एल में बहु चैनली एक मीटर लंबी संरंधी नलियों पर स्तरित नैनो विलेपन विकसित किया गया। पानी की निवेशा तथा निर्गम गुणता तथा आणविक अंतक डेटा का विश्लेषण किया गया तथा बी एच ई एल को प्रतिपुष्टि दी गई।

मृत्तिका आधारित कार्बनिक- अकार्बनिक संकरों (पी सी एन) के संश्लेषण के लिए एक सरल प्रक्रिया विकसित की है जो विलायक समर्थित स्वतः समुच्चय गुणधर्म से (3-10 माइक्रोमीटर) माइक्रोकोशों का उत्पादन करता है। झिल्ली विसरण के द्वारा या कोश निर्माण के दौरान अपने विलयन से अभ्यागत संयुक्तों के संपुटन के लिए ये सक्षम हैं। कोशों को 250 सेंटीग्रेड से ऊपर तापीय स्थिरता प्राप्त है और जल में ये अपारगम्य है, ऐल्कोहॉल में पारगम्य है और निम्न डाईइलेक्ट्रिक विलायकों में अस्थिर है। माइक्रो संग्रहण पद्धति में उपयोग के लिए पी सी एन कोश सक्षम है तथा सौन्दर्यवर्धकों, रंगों आदि के माइक्रो संपुटन / डिलिवरी में इसका अनुप्रयोग होता है। औषधीय अनुप्रयोगों के लिए कोशों के जलरागी संशोधन के लिए भी संभावना है।

अपकेंद्रीय संचकन से पूर्व स्वस्थानी ग्राफाइट तथा स्वस्थानी प्रथमिक सिलिकोन प्रबलित संकर के द्वारा फलनतः श्रेणीकृत एलुमिनियम संयुक्तों का विश्लेषण किया गया। प्राथमिक सिलिकोन द्वारा कठिन कण के प्रबलीकरण ने अपघर्षक प्रतिरोध तथा तीव्रता में सुधार लाया गया तथा ग्राफाइट द्वारा नरम कण के सुट्टीकरण ने आसंजी प्रतिरोध में सुधार लाया गया तथा इसका ठोस स्नेहक के रूप में प्रयोग किया गया।

माइक्रोवेव संचार पद्धतियों में वरणात्मकता बढ़ाने के लिए 10^6 जी एच इसड तक उच्च गुणता खंड युक्त पराविद्युत सिरेमिक संयोजन विकसित किए गए। 8 जी एच इसड पर लीथियम मैग्नीशियम सिलिकेट की आपेक्षिक पारगम्यता 5 तथा हानि स्पर्शता 1×10^{-4} था। छोटी मात्रा में गलनशील कांच डालने से इन सिलिकेटों की तैयारी तापमान कम हो गया।

सफेद मिर्च के उत्पादन के लिए एक उपयुक्त पद्धति का विकास मिर्च क्षेत्र का स्वप्न था। एक परिष्कृत जैव प्रक्रिया विकसित करके संस्थान ने उनके स्वप्न को साकार किया। नौ उपक्रमियों (7 मिर्च कृषक तथा 2 डीलेर्स) को इसके लिए लाइसेंस दिये गये। इस नयी प्रक्रिया के इस्तेमाल से 50 एम टी से ज्यादा सफेद मिर्च



उत्पादित की गयी, जिसका अधिकांश निर्यात हुआ। जब लाइसेंस दिए सभी संयंत्र (कुछ और संयंत्र का लाइसेंसिंग किया जा रहा है) के प्रचालन संपूर्णतः हो जायेंगे, तो सफेद मिर्च का उत्पादन प्रतिवर्ष हजारों टन से ज्यादा होगा। यह मूल्य वर्धन वर्धित आयात मूल्य को आकर्षित करता है (20 प्रतिशत से 80 प्रतिशत तक) , जिससे कृषकों तथा ग्रामीण समुदाय को उच्च आय की प्राप्ति होगी।

चावल मिलों में चावलों के अंश क्वथन से उत्पन्न प्रक्रम जल एक गंभीर पर्यावरणीय समस्या है। केरल के एरणाकुलम जिले के कालडी राइस मिल्लेर्स कण्सोर्षियम के लिए संस्थान ने एक जीरो डिस्चार्ज अभिक्रिया पद्धति (प्रक्रम जल पुनः चक्रण) विकसित की। प्रारंभिक संयंत्र के सफलतापूर्वक निष्पादन के बाद संपूर्ण स्केल बहिः स्राव प्रतिपादन संयंत्र की स्थापना की गयी। इसमें प्रतिदिन 240 मे. टन चावल संसाधन करने योग्य चावल मिल से प्रतिदिन उत्पन्न 200 एम³ प्रक्रम जल की अभिक्रिया के लिए अवायवीय तकनॉलजी का इस्तेमाल होता है। इस नयी प्रक्रिया ने अंश क्वथन में उत्पन्न प्रक्रम जल की पुनः प्रयुक्ति के लिए रास्ता खोला है और अपजल से बायोगैस भी उत्पन्न कर सकता है।

म्यून्स्टर विश्वविद्यालय, जर्मनी के साथ हेमीसेलुलोज युक्त कृषिय- रद्दी पदार्थों से एमिनो एसिड उत्पादन के लिए कोरीनेक्टोरियम ग्लूटामिकम स्ट्रेन का इस्तेमाल करके पुनर्योजन पेन्टोस के निर्माण एवं विश्लेषण के लिए इंडो- जर्मन सहयोग परियोजना प्रारंभ की गई। गेहूँ , भूसा, चीनी खोई, कसावा खोई, लकड़ी की मज्जा, जैसे हेमीसेलुलोजिक रद्दी पदार्थों से तैयार किए गए विभिन्न हेमीसेलुलोजिक हाइड्रोलाइसेट से एल ग्लूटामेट तथा एल लाइसीन के उत्पादन के लिए प्रयोगशाला स्केल किण्वन प्रक्रिया विकसित करने के लिए व्युत्पन्न स्ट्रेन्स को विषय बनाया गया है।

कोल्गेट- पॉमोलिव (यू एस ए) के साथ सी. ग्लूटामिकम तथा ई. कोलै संवर्धनों के इस्तेमाल करके तथा लागत प्रभावित स्टार्च आधारित प्राकृतिक पशुचारा से एल अर्जिनिन के माईक्रोबियल उत्पादन के लिए परियोजना प्रारंभ की गयी है। अर्जिनिन के डारुण- स्ट्रीम प्रक्रमण, क्रिस्टलाइसेशन की संभाव्यता तथा क्रोमेटोग्राफी उपगमन के द्वारा शुद्धीकरण किया जा रहा है।

सतत कार्बनिक संदूषक, अनजाने में उत्पादित पी ओ पी (डाइऑक्सीन तथा फ्यूरान्स) के संबंध में मापन तथा भारत के पांच दक्षिण राज्यों में अनजाने में उत्पादित पी ओ पी के गैर औद्योगिक तथा औद्योगिक स्रोतों की सूची की तैयारी के लिए यूएनआईडीओ के वित्तीय समर्थन में स्टॉकहोम औपचारिक समझौता के कार्यान्वयन के प्रथम चरण रूप में परियोजना प्रारंभ की गई। परियोजना आंध्र प्रदेश, कर्नाटक, केरल, पॉडिचेरी तथा तमिलनाडु के प्रमुख उद्योगों में अनजाने में उत्पादित पी ओ पी के संबंध में सर्वेक्षण रिपोर्ट तैयार करेगी।

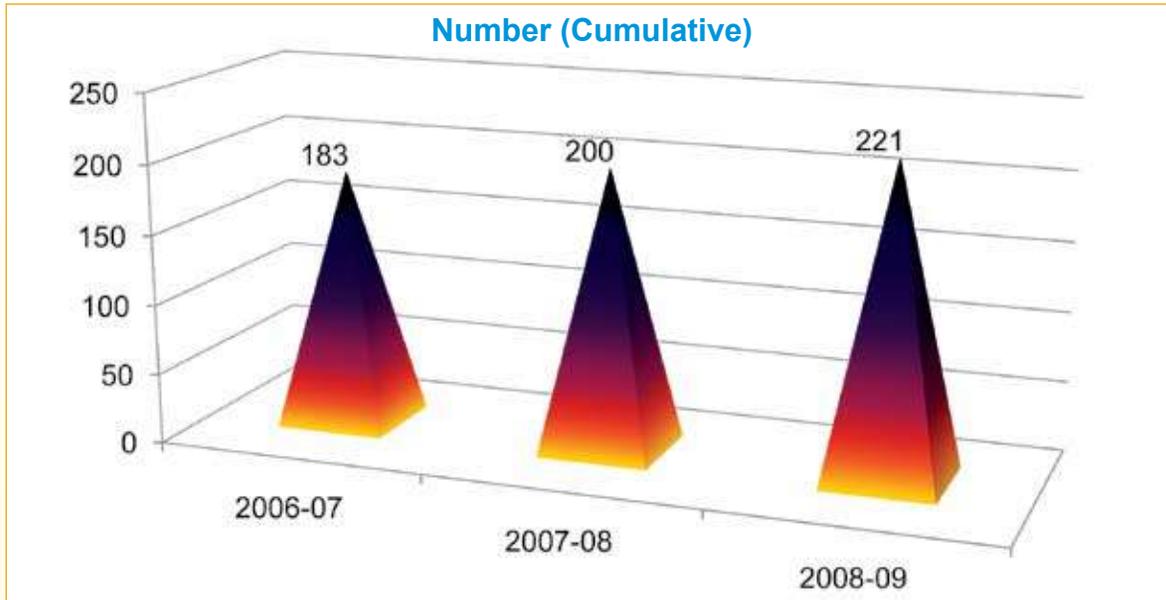
सम्मान, पुरस्कार तथा मानव संसाधन विकास

ग्यारह निस्ट स्टाफ तथा पांच अनुसंधान छात्रों द्वारा किए गए सराहनीय कार्य को विभिन्न संस्थाओं द्वारा पुरस्कार के रूप में मान्यता दी गई। संस्थान को लगातार दूसरे वर्ष के लिए एक और सीएसआईआर युवा वैज्ञानिक पुरस्कार दिया गया। डॉ. सत्यजित वी शुक्ला ने इंजीनियरिंग विज्ञान में यह पुरस्कार प्राप्त किया। अन्य प्रतिष्ठित कुछ पुरस्कारों ये हैं – थॉमसन रायटर अनुसंधान उत्कृष्टता, - इंडिया रिसर्च फ्रन्ड पुरस्कार(डॉ. ए. अजयघोष) फेलो, अंतरराष्ट्रीय संगठन, जैवप्रौद्योगिकी तथा जैवइंजीनियरी (प्रो.अशोक पाण्डेय) ,सी आर एस आई रजत पदक (डॉ. सुरेश दास) एम आर एस आई पदक (डॉ. एम.टी. सेबास्टीन) आई आई एफ अनुसंधान पुरस्कार (डॉ. टी पी डी. राजन) आदि।

वर्ष के दौरान अनेक स्टाफ सदस्यों तथा छात्रों को अपने संबंधित क्षेत्र के हाल के विकास से परिचित कराने के लिए विभिन्न प्रशिक्षण कार्यक्रम, सेमिनार, परिचर्चा, सम्मेलन, आदि में भाग लेने के लिए प्रतिनियुक्त किया गया। रिपोर्ट अवधि तक पीएच डी अवाई किए गए अनुसंधान छात्रों की कुल संख्या 221 हैं। विद्यार्थियों, शिक्षाविदों तथा उद्योगों के कर्मचारियों के लिए अल्पकालीन प्रशिक्षण सुविधा उपलब्ध करायी गई।



पीएच डी सम्मानित किया गया



घटनाओ / सेमिनारों / संगोष्ठियों

संस्थान में राष्ट्रीय दिवस मनाये गये और अपने संबंधित क्षेत्रों के हाल के विकास से परिचित कराने के लिए स्टाफ सदस्यों तथा छात्रों के लिए अनेक सेमिनार तथा सम्मेलन आयोजित किए गए। कुछ महत्वपूर्ण क्रियाकलाप निम्न दिए गये हैं –

डॉ. ए. शिवताणु पिल्लै, विख्यात वैज्ञानिक तथा मुख्य नियंत्रक, (आर आन्ड डी) डीआरडीओ तथा सीडओ एवं प्रबंध निदेशक, ब्राह्मोस ऐरोस्पेस ने 13.06.2008 को राष्ट्रीय प्रौद्योगिकी दिवस व्याख्यान दिया।

26 सितंबर को सीएसआईआर स्थापना दिवस मनाया गया और प्रो. पी. रामचन्द्र राव, रामन्ना फेलो, डी ए ई, तथा अंतरराष्ट्रीय पाठडर धातुकर्म तथा नया पदार्थ उन्नत अनुसंधान केंद्र (एआरसीआई) हैदराबाद ने स्थापना दिवस व्याख्यान दिया।

6 अक्टूबर को प्रो. ई. डी. जेम्मीस, निदेशक, आईआईएसईआर, तिरुवनंतपुरम ने एनआईआईएसटी स्थापना दिवस व्याख्यान प्रस्तुत किया।

4 मार्च 2009 को राष्ट्रीय विज्ञान दिवस मनाया गया। प्रो. ए जयकृष्णन, उपकुलपति, केरल विश्वविद्यालय समारोह में मुख्य अतिथि थे और उन्होंने विज्ञान दिवस व्याख्यान दिया।

17 अप्रैल 2008 को प्राकृतिक तंतुओं की परिष्कृत जैवप्रक्रिया पर अनुसंधान व विकास- उद्योग मिलन आयोजित किया गया और डॉ. एस.एल गोविन्दवर, सलाहकार, डी बी टी ने कार्यक्रम का उद्घाटन किया।

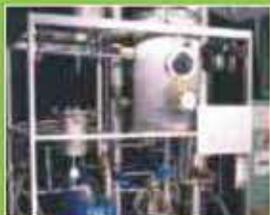
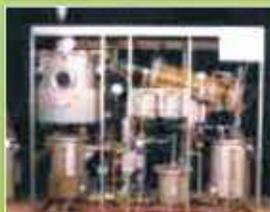
22-24 अप्रैल 2008 के दौरान खनिज संसाधन प्रौद्योगिकी पर अंतरराष्ट्रीय सेमिनार आयोजित किया गया ।

इलेक्टॉन माइक्रोस्कोपी तथा संबद्ध तकनीकों पर इलेक्टॉन माइक्रोस्कोप सोसाइटी ऑफ इंडिया के साथ संयुक्त रूप से पांच दिवसीय कार्यशाला (डब्लयु इ एम टी-2008) आयोजित की गई।

इसके अतिरिक्त संस्थान के छात्र समुदाय ने 30 दिसंबर 2008 को अपना दिवस- रेडियन्स- 2008 मनाया । डॉ. वी. आदिमूर्ती, सह निदेशक, वीएसएससी, तिरुवनंतपुरम ने समारोह का उद्घाटन किया और मूल व्याख्यान दिया।



AGROPROCESSING AND NATURAL PRODUCTS DIVISION



HIGHLIGHTS

- ◆ 2.5 ton FFB/hr Palm oil mill established for M/s Lakshmi Balaji oils at Attada village, Rayagada district in Orissa
- ◆ Technology transfer for integrated spices processing to horticulture department, Mizoram
- ◆ Steady progress in Supra Institutional Project on “Evidence based herbal / nutraceuticals products for preventive health and disease management”
- ◆ Participating in Golden Triangle project on standardization and validation of botanicals
- ◆ New Cell culture facility established and put to optimal use



The major thrust areas of research of the division are Lipid science and technology, Spices and flavor technology and Natural products. The major activities of the division for the past many years were oriented towards process development, process chemistry, transforming the process into technology package and commercial exploitation of the technologies. The division was very successful in accomplishing the goals through the aforementioned activities. To sustain the growth path and to remain globally competitive, the focus of the division has been shifted and strengthened towards development of functional food products, nutraceuticals and bio active bio-molecules along with the existing activities.

Commissioning of 2.5 ton FFB/hr palm oil mill in Orissa

Palm oil extraction technology developed by the division was transferred to M/S Lakshmi Balaji oils for commercial exploitation and all the plant and machinery was supplied and erected by the project engineering company earlier. This year the plant was commissioned and tested for the performance characteristics of each unit & the plant in total and the product quality. The capacities of individual units, integration of the units, material flow and over all capacity of the plant were found to be satisfactory. Samples were collected at each step for stream analysis and the oil losses through the major streams were within the limits. The overall process efficiency was 93% and the palm oil quality was with less than 3% FFA and 0.1% moisture. The plant was handed over to M/S Lakshmi Balaji oils for commercial production and the plant is operational.

Studies on the effect of individual micro nutrients on the stability of rice bran oil

Rice bran oil is rich in micro nutrients such as oryzanols, tocopherols, tocotrienols and sterols. The first three are strong anti oxidants which prevent the oxidative reactions and formation of harmful compounds which leads to rancidity. But the effect of individual anti oxidants are different. In order to understand this, micro nutrients were removed from rice bran oil and kept this oil as control and then individual micro nutrients at different concentrations were added to rice bran oil devoid of these micro nutrients to study the effect of individual micro nutrients. The micro nutrients were removed by column chromatography and analyzed using HPLC and HPTLC. Schall oven test was conducted and the samples were analyzed for peroxide value, paraanisidine value and diene value, which are the indicators of oxidative reaction levels. The results showed that tocopherol and tocotrienol had very strong effect in controlling oxidative reactions, whereas oryzanol had comparatively lesser effects. But sterols alone had negative effect with respect to peroxide value.

Virgin coconut oil process optimization

Virgin coconut oil is obtained through coconut milk from fresh coconuts. Thermal treatment, pH treatment and combined thermal and pH treatment are the parameters influencing the virgin coconut oil yield. Large number of experiments were carried out to optimize the process conditions. The results showed that combined thermal and pH treatment (pH 4.0 & 70° C) gave about 1.5 times more yield of virgin coconut oil compared to thermal treatment alone (90-100° C). More over the virgin coconut oil quality is also superior due to lesser thermal intensity. The byproduct coconut residue contained about 75% proteins, which can be developed into a value added product.



Setting up of Ginger processing facility in Sikkim and Mizoram

As part of the efforts to commercialize the Fresh Ginger processing technology, the laboratory entered into an agreement with the Department of Horticulture and Cash Crop Development, Government of Sikkim to provide engineering assistance for the setting up of the unit. The specifications and details of the equipment required for the unit were provided to the sponsor, based on which engineering companies were identified for the turn key execution of the project. The division extended its engineering expertise in the identification and selection of machinery, detailed engineering, layout etc. The plant is fast approaching completion and is expected to be commissioned during 2009/10. The uniqueness of the project is that ginger powder is also being proposed to be included in as one of the value added products to be produced and marketed by this unit.

Government of Mizoram had also asked for a similar facility to be set up in the state and the technology transfer agreement was signed during this period. The detailed project report (DPR) based on the inputs provided by the Mizoram agency is under preparation. The laboratory will also be assisting the state government in its efforts to add value to the ginger grown in the region. The Institute is actively considering the prospects for extending its expertise in processing ginger and other spices for essential oils to some foreign clients also.

Effect of heat treatment on curcuminoid, colour value and total polyphenols of fresh turmeric rhizome

Studies were made to examine the effect of heat treatment to fresh turmeric rhizome on total phenolic content (TPC), colour value (yellowishness and brightness), polyphenol oxidase (PPO) activity and curcuminoid. Fresh turmeric rhizomes when subjected to heat treatment at different temperatures (60°C-100°C) for different time intervals (10-60 minutes) caused a reduction in browning which was evident from the improved yellowishness and brightness. Activity of PPO was also decreased during heat treatment and almost inactivated completely when heated at 80°C for 30 minutes. TPC of heat treated turmeric after drying (powder) is significantly higher than that of fresh process. TPC values gradually increased from 60°C to 80°C. At 90°C and 100°C, TPC values were almost identical. Maximum brightness and yellowishness were obtained when turmeric was heated above 80°C. Quantification of curcuminoids in turmeric sample was done with HPTLC. There was no significant change in the concentration of curcuminoids among the heat treated samples. But in the sun dried samples, a significant reduction of curcuminoid content was observed.

Nutraceutical studies on Indian Honey

Honey is a highly complex mixture of at least 200 phytochemicals and the medicinal quality, taste, texture, color and aroma of honey varies with geographical area, the honey bee species and plants from which nectar has been collected. Studies of the enhanced antioxidant power of human serum indicate that consumption of honey alone or with other antioxidant beverages significantly increases the antioxidant capacity of human serum. The antioxidant capacity of honey samples (24 No) were examined by comparing to that of the known antioxidants, gallic acid, catechin by employing the following three complementary *in vitro* assays: Total phenolic content, Anti radical activity (DPPH) and Hydroxyl radical scavenging assay. The TPC of samples ranged between 202 to 307.8 mg_{gallic acid}/kg of honey. IC₅₀ values ranged between 4.5 to 66.05 µg/ml when tested by DPPH radical scavenging method. Hydroxyl radical scavenging activity varied from 20.2% to 80.1% inhibition at the tested concentration. Further, studies to characterize the phenolics and other components and *in vitro* biological activities of Indian honey are in progress.

Golden Triangle Partnership (GTP) Project

During the report period 4 formulations containing *Commiphora mukul* were tested and the marker compounds E-guggul sterones and Z-guggul sterones were quantified. Another formulation containing ginger and *Embelia ribes* and the plant materials were tested and chemical markers quantified. One formulation containing *Semecarpus anacardium* and the plant material was tested and chemical marker quantified. A reverse phase HPTLC method was also developed to estimate "EMBELIN", a marker compound in *Embelia ribes*

Isolation of a new biflavanoid from seeds of *Semecarpus anacardium* and simultaneous quantification of two major biflavonoids by HPTLC

Isolation of a biflavanoid, tetrahydro amentoflavone (THA), was reported earlier. Further to that another biflavanoid amentoflavone was isolated from *Semecarpus anacardium* seeds. The amentoflavone was identified by NMR, FTIR, FAB-MS spectral data. A simple, accurate and rapid TLC method was developed for simultaneous determination of the two major biflavanoids THA and amentoflavone. The method was validated as per the ICH guidelines. This method has been successfully employed for the determination of these compounds in different commercial formulations.

Ameliorative effect of *Centella asiatica* on iron induced lipid peroxidation in liver homogenate

Centella asiatica, a well known medicinal plant, was investigated for its antiperoxidative effect. The present study was undertaken to evaluate the protective effect of *Centella asiatica* extract against lipid peroxidation in liver homogenate via its superoxide and hydroxyl radical scavenging activities. Lipid peroxidation is the most common pathological condition of many metabolic diseases and it refers to the oxidative degradation of lipids. It is the process whereby free radicals steal electrons from the lipids in cell membrane, resulting in all damage. The protective effects were also evaluated by studying various antioxidant enzymes, scavenging of nitric oxide radical, and inhibition of peroxidation of linoleic acid. The overall results showed that ethanolic extract of *Centella asiatica*, rich in polyphenols, ameliorate the oxidative stress under *in vitro* conditions.

Antioxidant potential, cytotoxic & antimicrobial activities of *Boerhaavia diffusa* L

The antioxidant potency of methanolic extract of *Boerhaavia diffusa* (BDE) was investigated employing various *in vitro* model systems such as DPPH, superoxide, nitric oxide radical, hydroxyl radical scavenging, reducing power and iron chelating activity. Antiperoxidative activity of *Boerhaavia diffusa* was studied in linoelic acid emulsion system. Cytotoxic activity was evaluated using HCT-116 and K-562 cell lines and antimicrobial activity was evaluated against bacterial, fungi and yeast species. The results showed that polyphenols and flavanoids from methanolic extract of *Boerhaavia diffusa* can effectively scavenge reactive oxygen species including superoxide and hydroxyl radical as well as other free radicals under *in vitro* conditions. *Boerhaavia diffusa* also exhibits chelation and reducing property. The significant antioxidant activity of BDE showed that it might ameliorate oxidative damage induced by radicals and this can be employed as main ingredient in functional food/nutraceutical for disorders due to oxidative stress.

Nutraceutical product development based on sprouted legumes

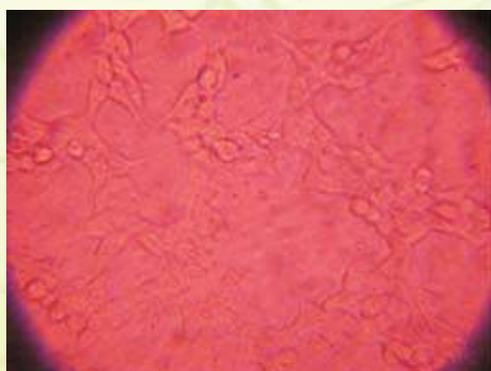
Sprouting is the practice of soaking, draining and then rinsing seeds at regular intervals until they germinate or sprout. Experiments were conducted using a few legumes, such as, two varieties of mung



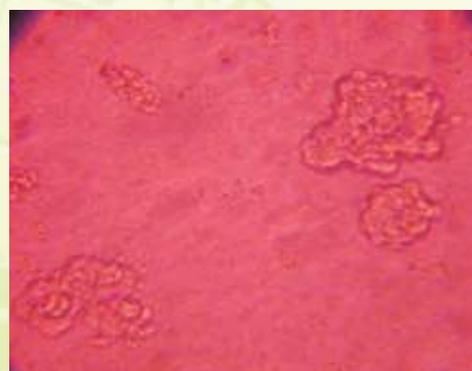
beans (green and brown) and bengal gram (white and dark). These were sprouted to increase the concentration of proteins, crude fiber, minerals and polyphenols. Antioxidant potential and nutritional values of sprouted legumes were more when compared to that of non sprouted legumes. Biscuits containing flour of sprouted legumes were prepared and compared with the conventional biscuits in terms of its nutritive content. The product development using sprouted legumes is in progress.

Anti cancer activity of glycoside derived from *Odollem cerbram*

Odollem cerbram is a mangroove plant which contains cardio glycosides and glycosides and the fruit kernel of this plant is poisonous in nature. The glycoside isolated from the leaf of this plant showed anticancer activity. The purified compound was chemically characterized and subjected to biological studies. The MTT assay showed that two glycosides isolated from the leaf had maximum activity with almost 100% inhibition. The HEK-293 cell lines showed better response in 10 µg concentrations. Further studies are on to purify and isolate the bio molecules and study their biological activities.



Control cell

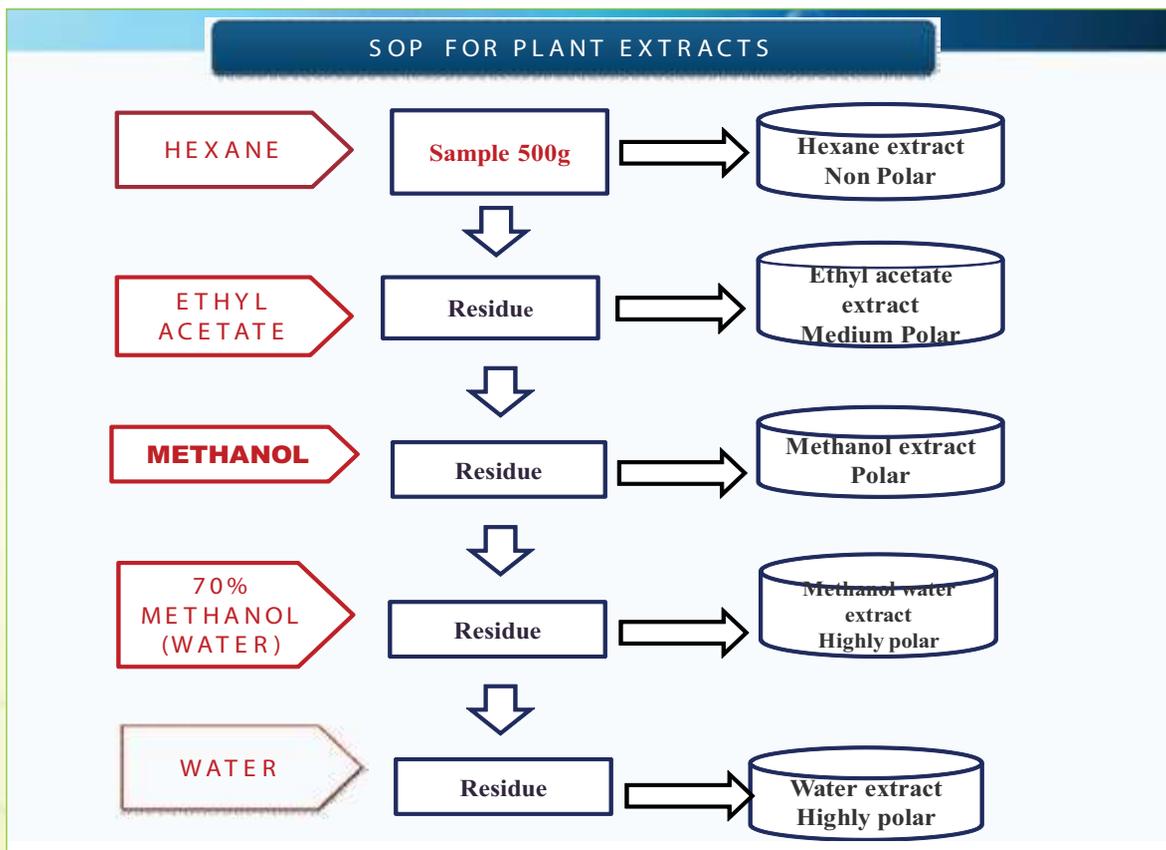


Treated cell

Evidence Based Nutraceutical/Herbal Products for Preventive Health and Disease Management (Supra Institutional Project)

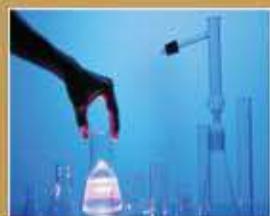
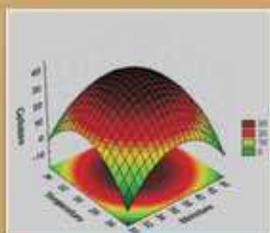
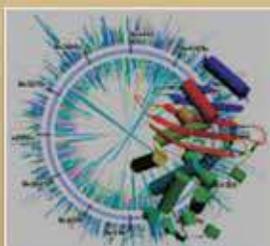
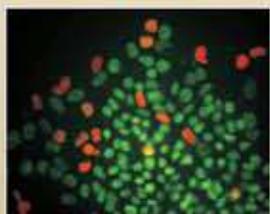
During the current reporting period, extraction of plant ingredients, preliminary screening for anti oxidant activities, activity guided fractionation, *in vitro* studies using chemical assays and cell line studies were carried out. Ten plants were selected for the study and common protocol following Standard Operating Procedure (SOP) was evolved. The approach is to extract the botanicals based on their polarity sequentially and screen them for their anti oxidant activity. The SOP for sequential extraction is given on next page.

Sequential extraction was carried out and all the fractions were collected. The yield varied from 0.12 to 48% for hexane extract, 0.4 to 6.0% for ethyl acetate extract, 3.2 to 64% for methanolic extract, 4.8 to 20% for methanol-water extract and 0.5 to 8.6% for water extract for the selected ten plants. This showed that the nature of components present in the extract is in variance over a wide range. The TPC content varied from 0.1 to 9.3, 1.9 to 71.8, 2.6 to 66.5, 1.2 to 72.2 and 0.48 to 70 respectively for hexane, ethyl acetate, methanol, methanol-water and water extracts. These fractions were screened for antioxidant activity by DPPH, ABTS, Super oxide radical anion scavenging, hydroxyl radical scavenging and total reducing power. The IC_{50} (µg/mL) value obtained for a few of the fractions were even better than the standards or closer to that. Such fractions were selected for further fractionation, *in vitro* chemical assay studies and cell line studies which are in progress.



Capacity building - Cell Culture facility

State of art cell culture facility with supporting instrumentation was put into use. The facilities include pathway bio imager, Flow cytometer with sorter, multi mode detector, RT PCR, Gel Doc, Electrophoresis, Ultra centrifuge, Lyophiliser etc. Cell lines were obtained from NCCS, Pune, IMTECH, Chandigarh and RGCBT, Trivandrum and standardized culture of cell lines. This is a unique facility in this region for screening of natural products for their activity.



BIOTECHNOLOGY DIVISION

HIGHLIGHTS

- ◆ Centre for Biofuels established at NIIST.
- ◆ An industrial consultancy project on nitrilase and hydantoinase successfully completed.
- ◆ A new industrial consultancy project for a US company on microbial production of L-arginine from cost effective starch based natural feed stocks using bacterial cultures undertaken.
- ◆ A new international collaborative project undertaken on construction and analysis of recombinant pentose-utilizing *Corynebacterium glutamicum* strains for amino acid production from hemicellulose containing agro-waste materials.
- ◆ Microbial biodiversity activity from the Western ghats soils:
 - Several new isolates were identified (related to the α - and β - Proteobacteria)
 - The phylogenetic tree based on 16S rRNA gene sequences and other characteristics confirmed novel species with potential activity

The activities of the Division continued to centre around the theme of Bio-based processes and products development. The research program of the Division has three major areas, which include (i) Bio-based process and products development, (ii) Bioenergy, and (iii) Health and genomics. A partnership link has been established with the TIFAC, New Delhi to establish the Centre for Biofuels at NIIST. Efforts are being made to acquire a central and leading status for the NIIST for the bioethanol program.

BIOPROCESS AND PRODUCTS DEVELOPMENT

Industrial enzymes

Leucine aminopeptidase

Leucine amino peptidase (LAP) biosynthesis was achieved from *Streptomyces gedanensis* IFO13427 under submerged fermentation. A second-order quadratic model and response surface method showed that the optimum conditions were soy bean 0.3 %, NaCl, 0.03M and initial pH 7, which resulted in the improvement of LAP production (25.69 IUml^{-1}) as compared to initial level ($12.17 \pm 0.23 \text{ IUml}^{-1}$) after 72 h of fermentation. The predicted value by the quadratic model was 24.56 IUml^{-1} . Analysis of variance (ANOVA) showed a high coefficient of determination (R^2) value of 0.9799, ensuring a satisfactory adjustment of the quadratic model with the experimental data. LAP produced by *S. gedanensis* was thermo stable for about 60 min in presence of Co^{2+} at 60°C .

Methionine aminopeptidases

Methionine aminopeptidases (MAP) biosynthesis was achieved by *Streptomyces gedanensis* IFO13427 in solid-state fermentation (SSF) using polyurethane foam as an inert support. The MAP, partially purified in two steps using ammonium sulphate precipitation and ion exchange chromatography, showed a 32-folds increase in purity with a specific activity of 11.86.

Peptide processing enzymes of *Mycobacterium tuberculosis*

Hypothetical genes of peptide deformylase (Rv0429c) and methionine aminopeptidases (Rv0734, Rv2861c) of *M. tuberculosis* H37Rv were cloned in to pET 28 a and over-expressed in *E. coli*. The active

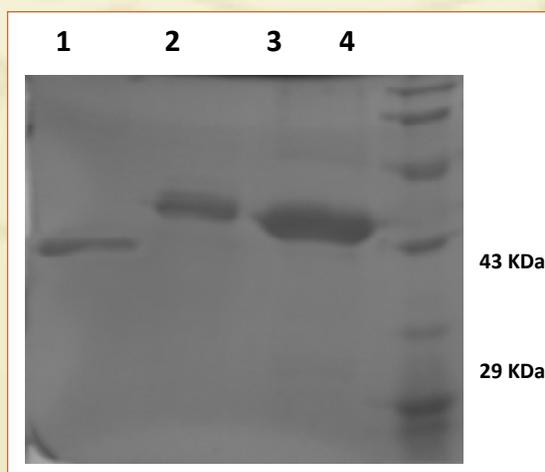


Figure 1. 12% SDS- PAGE showing the purified recombinant proteins of *Mycobacterium tuberculosis*; Lane 1: Purified PDF protein (29 KDa); Lane2: Purified MAP B protein (32 KDa); Lane 3: Purified MAP A protein (30 KDa) and Lane 4: Molecular weight marker.



recombinant proteins were purified to homogeneity (Fig 1). Peptide deformylase was studied in detail both biochemically and biophysically. Site directed mutants were created to study the structure-function relationship and to identify the residues important in catalysis. Peptide deformylase showed moderate thermal stability and resistance to oxidative stress and was found to be inhibited by known peptide deformylase inhibitors and metal chelators. Among the two hypothetical methionine aminopeptidase genes, the gene product of MAP B (Rv2861c) showed activity up on co-expressing with chaperonin.

Beta glucosidase

Aspergillus niger NII 8121 (MTCC 7956, BTCF 5) produced 185 U/gds (3700 U/ml) beta glucosidase (BGL) by solid-state fermentation employing wheat bran as the substrate. The enzyme could be well isolated from the solid fermented media and precipitated using acetone, which was then partially purified by ROTOFOR and ion exchange chromatography. A strain of *Penicillium funiculosum* also produced BGL in SSF using wheat bran as a substrate but enzyme units were low (55U/gds, or 1100 U/ml). Kinetic studies revealed the KI of BGL as 35mM.

Nitrilase and hydantoinase

About two hundred microorganisms isolated from Western Ghats soil samples and were subjected for nitrilase and hydantoinase activity out of which four strains, viz. *Bacillus sphaericus* NII 838, NII 9103, NII 9177 and NII 9128 showed the good nitrilase activity. Eight cultures were strong positive and ten as medium based on the intensity of color change in agar plates for hydantoinase.

Food grade alpha amylase

Kinetic parameters studies of alpha amylase production by *Aspergillus oryzae var brunneus* under solid-state fermentation (SSF) and submerged fermentation (SmF) exhibited a specific growth rate of 0.245 h⁻¹ under SSF and 0.144 h⁻¹ for SmF with corresponding doubling times 2.83 and 4.81h, respectively. Specific enzyme formation rates (q_E) were 8.19 and 1.95 U/mg h, for SSF and SmF, respectively. These results suggested that alpha amylase was synthesized at a faster specific rate (4 times) in the SSF system. SSF was a better fermentation technique for alpha amylase production as it supported both better productivity and higher biomass levels. By UV mutation on *A. oryzae var brunneus*, two potent mutants M9 and M14 were obtained which produced 23,740 and 28,658 U/gds which was much higher than that produced by the parent strain (15,105 U/gds).

Scale-up studies for alpha amylase production by *Bacillus amyloliquefaciens* in submerged fermentation

Scale-up studies for the production of the alpha amylase by *B. amyloliquefaciens* in submerged fermentation were done in Infors HT Parallel fermenter and BIOSTAT B fermenter. The studies on the effect of aeration on enzyme production (aeration between 0.2, 0.5 and 1.0 vvm) using INFORS HT parallel fermenter showed the maximum biomass and enzyme titer at 1 vvm. In BIOSTAT B, the biomass yield and productivity of alpha amylase was highest at 12h of fermentation, the initial log phase. The biomass yield remained constant throughout the post logarithmic phase and stationary phase indicating efficient substrate utilization by the microorganism till it reached the stationary phase. The study also clearly demonstrated the growth related pattern of enzyme production. The maximum production of enzyme was achieved at 42h of fermentation.

L-asparaginase

Studies were carried out to screen the organism producing L asparagines, isolation of Asn gene from the asparaginase producing cultures by PCR amplification using the designed primers and cloning of the asparaginase gene in TA cloning vector. Three asparaginase producing colonies were selected, two from Western *ghats* soil samples (named Asn 176 and Asn 184) and one from water sample (BTW1). Among the known *E. coli* cultures screened, the DH5alpha was also asparaginase positive. Genomic DNA was isolated from all these positive cultures and asparaginase gene was isolated from Asn 184, BTW1 and DH5 alpha by PCR amplification (Fig 2). The amplicons were extracted from the gel and cloned in to cloning vector pTZ57R/T plasmid and transformed into competent JM109. The clones were confirmed by plasmid isolation and insert release (Fig 3). The confirmed clones have been sent for sequencing.

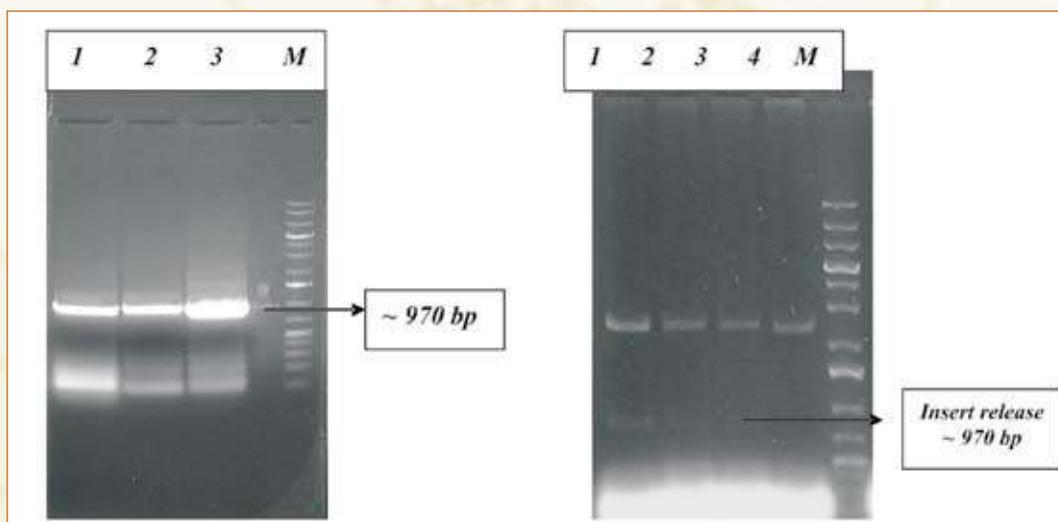


Fig 2: PCR amplification

Fig 3: Double Digestion

Development of thermo stable and low pH tolerant phytase

Gene encoding phytase (*Phy A*) and acidphosphatase (*app A2*) was isolated from *Aspergillus niger* and *E. coli* by PCR using degenerate primers designed and cloned in pJET cloning vector. The confirmed clones for *Phy A* gene from *A. niger* BTCF 5 and *A. ficuum* NRRL 3135 and *app A2* gene from *E. coli* were sequenced by primerwalking. Up on the BLAST analysis, the sequences were highly similar to known histidine acidphosphatases. Pair wise alignment of *phy A* gene with cds of *A. niger* revealed the presence of single intron and pre, pro signal sequences. Since the single intron did not interrupt the coding region, specific primers with restriction sites were designed to isolate and mobilize the *phyA* mature peptide sequence to suitable prokaryotic and eukaryotic expression vectors. Similarly primers were designed to isolate the sequence encoding *appA2* mature peptide, excluding signal sequence. PCR amplicons were cloned in TA cloning vector pTZ57R/T and the clones were confirmed by insert release from the vector.

Beta-glucosidases (BGL)

Aspergillus niger NII 08121 produced 185 U/gds (3700 U/ml) BGL by solid-state fermentation (SSF) employing wheat bran as the substrate. Though the activities of partially purified (by iso-electric concentration and ion exchange chromatography) BGL were very high, the enzyme was not glucose tolerant. Electrophoretic analysis revealed that only one isoform of BGL indicating that the glucose



tolerant isoform was not expressed under the conditions of study.

The production of BGL from *Penicillium funiculosum* under SSF with wheat bran as substrate showed 55 U/gds (1100 U/ml). Glucose inhibition studies revealed that the *P. funiculosum* BGL had a K_i of 35mM glucose.

Studies on the production of BGL by *Aspergillus crystallinus* in submerged fermentation (SmF) using wheat bran as carbon source resulted a glucose tolerant BGL (50 % activity retention at 0.5M Glucose). However, in SSF, the yield of BGL was higher (~1000 U/ml) but glucose tolerance was low for the enzyme preparation. Cloning and sequencing of partial gene sequence of family 1 BGL showed significant homology to a putative family 1 BGL gene from *A. oryzae*.

Novel esterase from the bacterial isolate BT-L1

A novel bacterial isolate BT-L1 showed high titers of esterase activity, active at 50°C. The enzyme was alkali active, thermo-stable and solvent tolerant. The enzyme maintained 90% of its original activity after being treated at a temperature of 70°C for 1 h. The partially purified enzyme had optimum temperature and pH of 60°C and 8.0, respectively, which retained 97% of its original activity in presence of 25% methanol and 80% activity in the same strength of ethanol. Nine-fold improvements in esterase production were obtained through the process optimization. The enzyme seems very valuable for trans-esterification processes.

Biopolymers

Production of polyhydroxybutyrate (PHB) by *Bacillus sphaericus*

A bioprocess was developed on the production PHB in batch submerged fermentation (SmF) using a bacterial culture of *B. sphaericus*, which showed the maximum cell density (4.1g/l) and PHB concentration (1.82g/l) when glucose was used as the substrate. It was interesting to note that the jack fruit seed hydrolyzate could be effectively used by the culture yielding 3.63 g/l cell biomass and 1.74 g/l PHB, which could bring major economic benefits. Further improvement in the yields could be achieved by response surface methodology (Central Composite Design) which yielded 4.5 g biomass and 2.22 g PHB per liter (Figs 4 and 5). Solid-state fermentation (SSF) using wheat bran, cassava bagasse and jack fruit seed powder as carbon source and poly urethane foam as solid inert support gave mixed results and the best results were obtained with PUF (Impregnated with jack fruit seed hydrolyzate) resulting 0.35 g biomass and 0.12 g PHB per gram PUF, respectively.

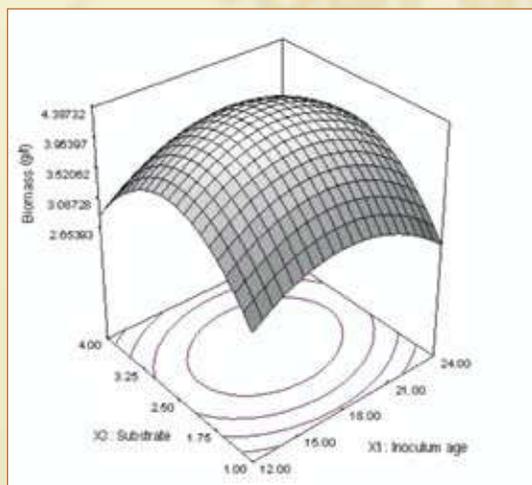


Fig.4 Response surface graph showing interaction between inoculum age and substrate concentration on biomass production

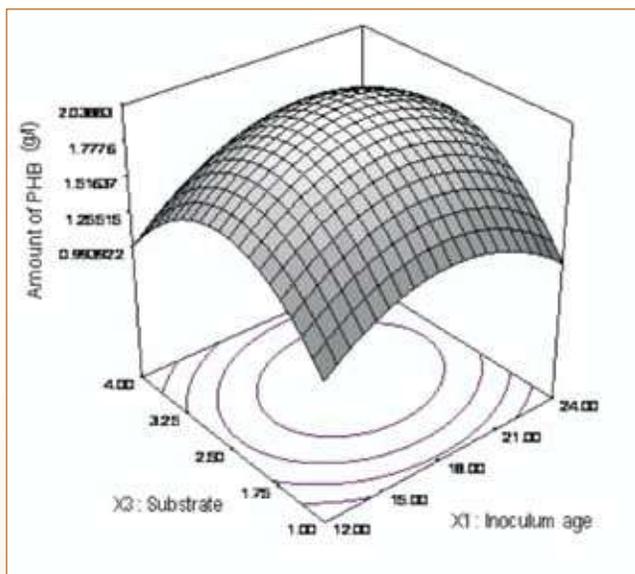


Fig. 5 Response surface graph showing interaction between inoculum age and substrate concentration on PHB production

BIOENERGY

Bioethanol from lignocellulosic feedstocks

Penicillium funiculosum was evaluated for cellulase production under solid-state fermentation (SSF). While the filter paper activity of the culture was very low, the culture produced better amounts of a non-glucose tolerant (K_i -35mM) BGL. BGL production from *Aspergillus niger* NII 08121 was optimized and a final yield of 3700 U/ml was obtained. The enzymes cocktails were developed for the hydrolysis for rice straw, and high saccharification efficiency (~650mg of reducing sugar/g biomass) was obtained. The saccharification efficiencies obtained with NIIST cocktail for pretreated rice straw was significantly higher than the commercial enzyme preparation.

Cellulase enzyme production using non conventional biomass, such as water hyacinth under SSF resulted in 22 FPU/gds (1.24 FPU/ml). Saccharification of water hyacinth biomass was optimized using NIIST enzyme cocktail and a yield of 817 mg reducing sugar/g biomass was obtained.

Bioethanol from lignocellulosic biomass

A major program was initiated by establishing the Centre for Biofuels supported by the Technology Information, Forecasting and Assessment Council (TIFAC) and CSIR. The major goals are to identify major lignocellulosic feedstocks for the country available in different regions and establish their potential for bioethanol production, as well as to evaluate different pretreatment and hydrolysis methods for these biomass. A process flow was designed and formulated for vessel sizing and layout for construction of a biomass-ethanol pilot plant. A survey of secondary data sources was conducted to analyze the availability of biomass residues in India and to determine the most potent feedstock for bioethanol production. Primary data collection on biomass availability, current uses and prices across the country for generating data for a techno economic analysis are in progress.

HEALTH AND GENOMICS

Nutraceuticals from lactic acid bacteria

Newly isolated lactic acid bacteria (LAB) identified as *Lactobacillus plantarum* was used for the production of exo-polysaccharide (EPS). The culture showed interesting probiotic characteristics



such as acid tolerance, bile tolerance, hydrophobicity and salt tolerance. The nutrient and process parameters for maximum EPS production showed lactose and yeast extract as the best carbon and nitrogen sources, respectively and a maximum of 1.21 ± 0.04 g/l EPS (secreted) was obtained after 72 h incubation.

A total of 123 lactic acid bacterial isolates were screened for the production of folate, among which 10 were significant folate producers (>2 ng/ml). The ability of these isolates to be used as a probiotic was studied by analyzing their tolerance to low pH, bile salts, phenol and sodium chloride. The emulsification index and hydrophobicity was analyzed to determine their cell adherence efficiency. Reconstituted skim milk media (5%) supplemented with 1% glucose was used for the folate production by the isolates CM 22 and CM 28, which resulted a maximum of 15-20ng/ml folate.

Microbial production of amino acids

Starch containing agro residual materials such as cassava bagasse and jack fruit seed powder were hydrolyzed successfully to make the hydrolysate where nearly 68 % of the substrate was converted to reducing sugars. Both *C. glutamicum* and *E. coli* cultures were capable of growing in the hydrolysate based medium and they consumed reducing sugars effectively (most of the sugars were consumed in 120 h fermentation). The amino acid L-Arginine was detected in the fermentation broth of *E. coli* NRRL B 12427 and *C. glutamicum* ATCC 21493

Xylose and arabinose generally comprise a significant fraction of hardwoods, agricultural residues, and grasses and must be utilized to make the economics of biomass processing feasible. The wild type amino acid producer, *Corynebacterium glutamicum* is lacking the pentose sugar (xylose, arabinose) assimilating genes and hence it has become a bottle neck as far as the amino acid bioprocess is concerned. Attempts were initiated to construct a genetically altered derivative of *C. glutamicum* capable of producing L-glutamate and L-lysine by utilizing the hemicellulosic hydrolysates which contains xylose and arabinose as the major constituents.

Exploitation of microbial biodiversity for enzyme inhibitors and plant growth promoters

Soil samples from the Western *ghats* in Kerala were screened to isolate microbes with diverse characteristics such as enzyme inhibitors, especially inhibitors of peptide deformylase (PDF) and inhibitors of wide spectrum beta lactamases. Forty five soil microorganisms with an ability to convert the insoluble forms of phosphorus to an accessible form, isolated from Western *ghats* forest soils showed mineral phosphate solubilizing (MPS) activities and other plant growth promoting attributes, such as auxin production, siderophore production and phytopathogenic activity. Based on the identification and phylogenetic analysis of the isolates by 16S rRNA sequencing, they were grouped together into 15 genera, in which eleven isolates belonged to *Bacillus* sp, seven to *Serratia* sp, six to *Acinetobacter* sp, five to *Enterobacter* sp, three to *Pantoea* sp, two to *Staphylococcus* sp and *Stenotrophomonas* and one each to *Oceanobacillus*, *Paenibacillus*, *Exiguobacterium*, *Micrococcus*, *Arthrobacter*, *Pontibacter*, *Alicyclophilus*, *Citrobacter* and *Paracoccus* sp. The sequences of representative strains were deposited in the GenBank nucleotide sequence data library.

Construction and screening of environmental DNA libraries for novel lipases

About 2000 clones from the metagenomic library constructed earlier from Western *Ghats* soils were screened for lipases. Most of the clones showed fluorescence under UV, conferring lipolytic



activity. Assays conducted for the selected clones also showed considerable lipase activity. But randomly selected positive clones on gram staining appeared as cocci rather than the expected rod cell morphology of its host strain. Hence, further studies on these clones were not conducted inferring that there might be a chance of contamination in the constructed library. To construct the new library in fosmid as well as pET vectors, improved quality soil DNA were isolated, which showed the absorbance ratio 260/280 of the DNA as 1.88 and 260/230 as 2.04.

Microbial mediated removal of iron mineral impurities from kaolin for value addition

Bioleaching studies to remove Fe from Koraput clay (containing 3.63% Fe) using three different bacterial strains (*Acidithiobacillus ferrooxidans*, *Leptospirillum ferrooxidans* and *Acidithiobacillus thiooxidans*) showed that *A. ferrooxidans* could leach out iron effectively from Koraput clays. However, the iron from the medium was adsorbed which ruled out the use of this culture for leaching. *L. ferrooxidans* also leached out iron from Koraput clay (40.8% in 30 days). Best bioleaching results were achieved by using *A. thiooxidans*, which showed that the iron removal as 64.5%.

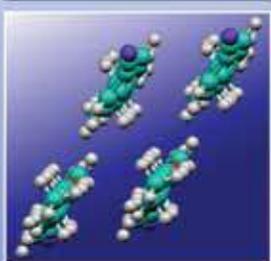
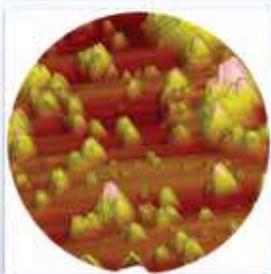




CHEMICAL SCIENCE & TECHNOLOGY

HIGHLIGHTS

- ◆ Developed novel photoresponsive fluophores and liquid crystals for imaging applications.
- ◆ Developed luminescent dyes for selective detection of various analytes such as aminothiols in blood, copper and DNA.
- ◆ OPV/C60 composite films deposited in glass with superhydrophobic properties developed.
- ◆ Demonstrated the use of squaraine dye for treatment of skin cancer by photodynamic therapy *in vivo* using male Swiss albino mice.
- ◆ Gold nanoparticle functionalized carbon nanotubes for light induced charge separation.
- ◆ Designed a dual optoelectronic sensor for nitrite.
- ◆ A two-dimensional biomimetic optode (solid state sensor) for Uranyl ion and a process for removal of persistent inorganic pollutant developed.
- ◆ Designed a non-toxic yellow inorganic pigment based on mixed oxides of samarium and molybdenum compounds, and a low cost green colorant from mixed rare earth and molybdenum compounds for surface coating.
- ◆ Palladium catalyzed tandem ring opening-ring closing reaction of diazabicyclic alkenes as a facile one pot strategy for cyclopentannulation of heterocycles developed.

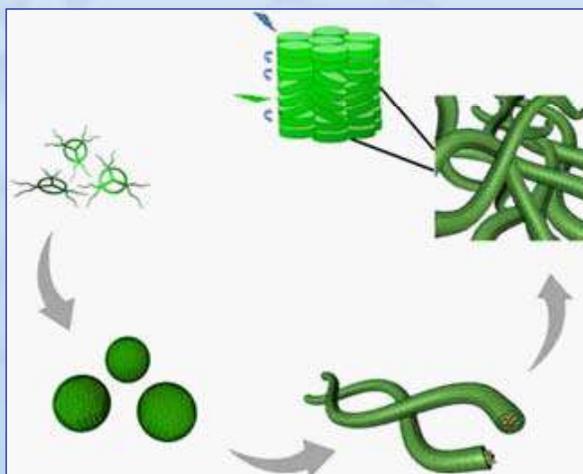


The Chemical Sciences and Technology Division comprises of three sections, namely Photosciences and Photonics, Inorganic and Polymeric Materials and Organic Chemistry and has continued its good record of high impact publications, as well as interactions with industries such as a project with Corning SAS, France. The Division is coordinating a CSIR Network Project on “Functional Organic Materials for Energy Efficient Devices” with NCL, Pune and CLRI, Chennai as partners and is participating in three other Network programmes of CSIR. The division’s activities are also supported by contract research programmes from agencies such as DST, DRDO and BRNS as well as international collaborative projects with France, Italy and Germany.

PHOTOSCIENCES AND PHOTONICS

Luminescent columnar architectures from octupolar oxadiazole derivatives

A novel class of highly luminescent octupolar oxadiazole derivatives exhibiting columnar liquid crystalline phases was developed. 1,3,4-Oxadiazole was incorporated in the core of the discotic molecules in view of its excellent electron transporting and luminescent properties as well as its ability to undergo efficient π -stacking. These molecules were capable of spontaneous concentration dependent hierarchical self-assembly leading from hard spheres to fibers possessing columnar organization of the molecules. Both the derivatives formed stable, highly luminescent transparent gels in nonpolar solvents such as decane and toluene. Concentration dependent luminescence spectral studies indicated that the change in morphology from spheres to fibrous aggregates was associated with a shift in chromophore packing from predominantly H-type to J-type aggregates. Time resolved anisotropic investigations revealed that the columnar stacking of molecules in the aggregated state provided a pathway for excitation energy migration to the lower energy J-traps. The ability of these materials to form fluorescent nano fibers wherein these n-type molecules self-assemble into a π -stacked columns makes them potentially useful as candidates for investigation as molecular wires and emitters in the developing area of supramolecular electronics. (*Adv. Funct. Mater.* **2009**, DOI: 10.1002/adfm.200801902)

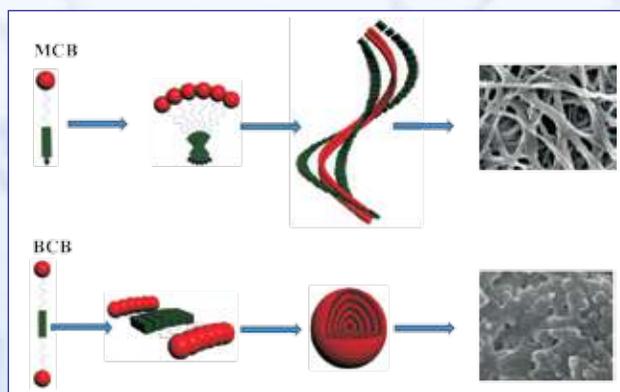


Tuning microstructures in organogels

The ability of the organo-gelators to self organize into three dimensional networks which trap large amounts of solvents in the gelation process also has significant ramifications for the development of functional self-assembled nanomaterials. Understanding the factors responsible for the evolution of various types of superstructures which eventually leads to gel formation is essential for the controlled

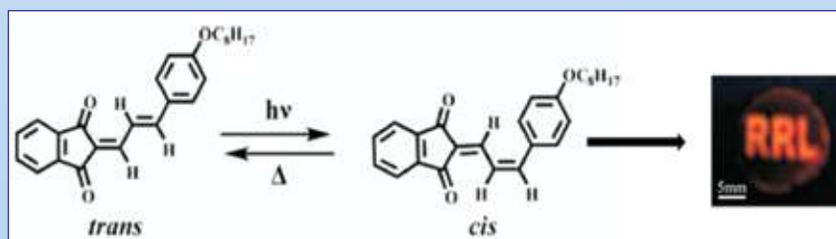


design of such nano-structures. In this context gelation and photophysical properties of mono- and bis-cholesterol derivatives linked to diphenylbutadiene have been investigated. Scanning electron microscopy of xerogels of the monocholesterol derivatives indicated that these molecules self-assemble into 3D networks consisting of helically twisted fibers. In contrast, the morphology of xerogels of the bis-cholesterol derivatives indicated agglomerated spheres. An investigation of spectroscopic properties suggests that the morphology of the superstructures formed in these systems may be correlated to the nature of the molecular aggregates formed. Absorption and emission spectral studies as a function of concentration and temperature suggested the formation of predominantly J-type aggregates in the monocholesterol and H-type aggregates in the bis-cholesterol derivatives. (*Langmuir*, **2009**, DOI: 10.1021/la900438c.)



Correlation between solid-state photophysical properties and molecular packing

The synthesis and study of photophysical properties of organic π -conjugated materials has been attracting increasing attention, in view of their potential application in electronic and optoelectronic devices. In this context, the solid-state photophysical and photochromic properties and the molecular packing in single crystals of a series of donor-acceptor-substituted butadiene derivatives with alkoxy groups as donor and indane-1,3-dione have been investigated. These materials showed significant enhancement and red-shift in fluorescence in the solid state compared to that in solution. The single crystal analysis of these derivatives indicated that these effects could be attributed to both improved intramolecular charge transfer due to planarization of the molecules and to intermolecular exciton coupling between adjacent molecules leading to aggregate fluorescence. The character of the aggregate formed (H- or J-type) and extent of aggregation were strongly dependent on the length of the alkyl substituent, and these differences could be correlated to variations in the molecular packing observed in their single crystals. Some of the derivatives could be super cooled to a metastable glassy state with significantly different optical properties. Transformation from crystalline to a highly stable glassy form could also be induced by light, making these materials useful for recording optical images. (*J. Phys. Chem. C* **2009**, DOI: 10.1021/jp902482r.)

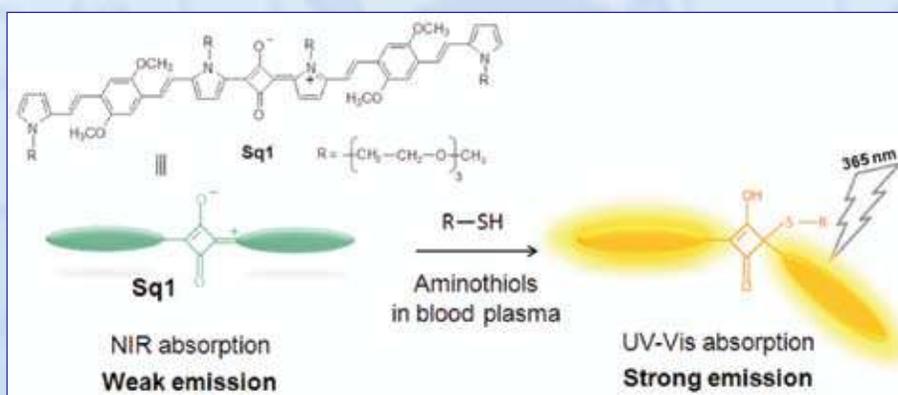


Photoresponsive liquid crystalline glasses for colour imaging applications

Novel photoactive cholesteric liquid crystalline materials consisting of cholesteryl-linked butadienes were designed. Selective exposure of the material in its liquid crystalline phase to light resulted in *trans-cis* photoisomerization of the butadiene chromophore. This resulted in a change of the pitch of the irradiated portion depending upon the intensity of the illuminating light, and consequently the wavelength of light reflected by the films. The coloured images thus formed could be stored for long periods by converting the films to glasses by sudden cooling. The images stored in the glassy state were stable over long periods of time (>one year). (*J. Photochem. Photobio.*, **2009**, DOI : 10.1016/j.jphotochem.2008.11.009.)

A near-infrared squaraine dye as a latent ratiometric fluorophore for the detection of aminothiols content in blood plasma

A new NIR squaraine dye has been found useful for the detection of total aminothiol level in human blood plasma. The detection is based on the latent activation of fluorescence by thiol induced breaking of conjugation in contrast to the usually used color bleaching or fluorescence quenching which has several drawbacks. The probe selectively responds to thiols and aminothiols which allow their ratiometric detection due to the generation of new, non-interfering absorption and emission bands. Application of the probe is illustrated with the detection of the total aminothiol level in human blood plasma which has tremendous biological relevance. Using the new probe it was found that aminothiol content was high in the blood of heavy smokers (*Angew. Chem. Int. Ed.*, **2008**, 47, 7883-87)

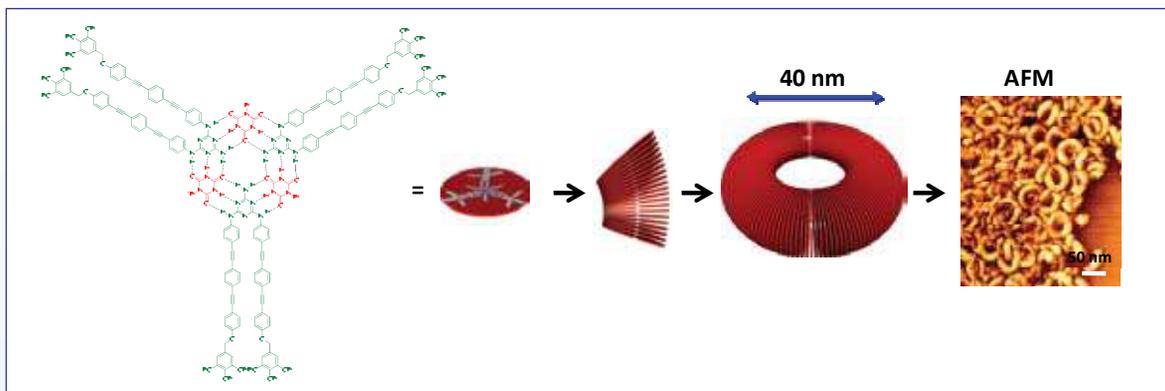


Toroidal nanostructure from hydrogen-bonded rosettes of melamine-linked oligo (*p*-phenyleneethynylene)s and cyanurates

Self-assembly of rigid π -conjugated oligomers into well defined nanostructures with controlled size, morphology and optical properties is a challenging task in the "bottom-up" construction of supramolecular architectures. Complimentary multiple H-bonding modules such as melamines and cyanurates are versatile synthons for the self-assembly of a variety of organic molecules to rosette (macrocyclic) and tape-like (linear or crinkled) architectures. Superstructures hierarchically organized from rosette and other related supramolecular macrocycles reported so far are limited to extended columnar architectures. Recently the Institute reported an unprecedented self-organization of hydrogen-bonded rosette assemblies of oligo(*p*-phenyleneethynylene) (OPE) attached melamine and a cyanurate derivative in aliphatic solvent, leading to the formation of toroidal objects of nanometer dimension. These molecular components forms organogels at more concentrated conditions whereas in the solvent-free state liquid

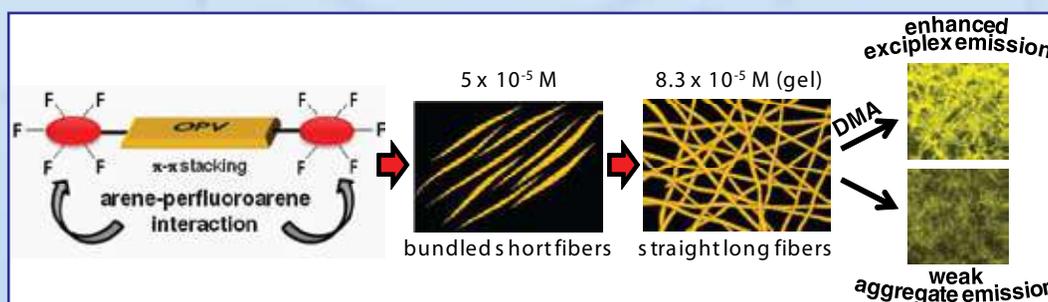


crystalline behaviour was observed, and hence a unique self-assembly system with multiple functional properties (*Angew. Chem., Int. Ed.* **2008**, 47,4691)



Self-assembly of oligo(para-phenylenevinylene)s through arene-perfluoroarene interactions: π gels with longitudinally controlled fiber growth and supramolecular exciplex-mediated enhanced emission

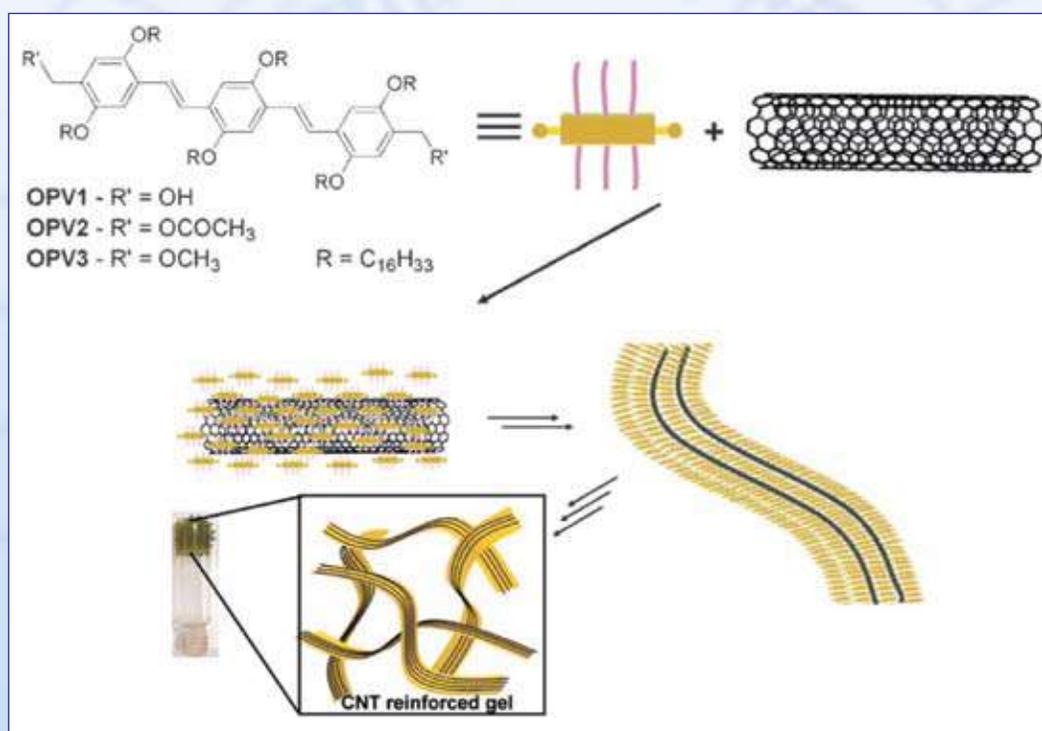
The arene-perfluoroarene (ArH-ArF) interaction, which has been extensively studied in the field of solid state chemistry, is exploited in the hierarchical self-assembly of oligo(*p*-phenylenevinylene)s (OPVs) with controlled longitudinal fiber growth that leads to gelation. The size of the self-assembled fibers of a pentafluorophenyl-functionalized OPV could be controlled through C-F...H-C hydrogen bonding and π -stacking. The ability of fluoroaromatic compounds to form excited-state complexes with aromatic amines has been utilized to form a supramolecular exciplex, exclusively in the gel state, that exhibits enhanced emission. Thus, the commonly encountered fluorescence quenching during the self-assembly of OPVs could be considerably prevented by exciplex formation with *N,N*-dimethylaniline (DMA), which only occurred for the fluorinated OPV and not for the nonfluorinated analogue. In the former case, a threefold enhancement in the emission intensity could be observed in the gel state, whereas no change in emission occurred in solution. Thus, the spontaneous fiber growth and fluorescence self-quenching encountered in the self-assembly of OPVs could be controlled to a great extent by using the versatile ArH-ArF interaction (*Chem. Eur. J.*, **2008**, 14, 9577-84)



Carbon nanotube triggered self-assembly of oligo(*p*-phenylene vinylene)s to stable hybrid pi-gels

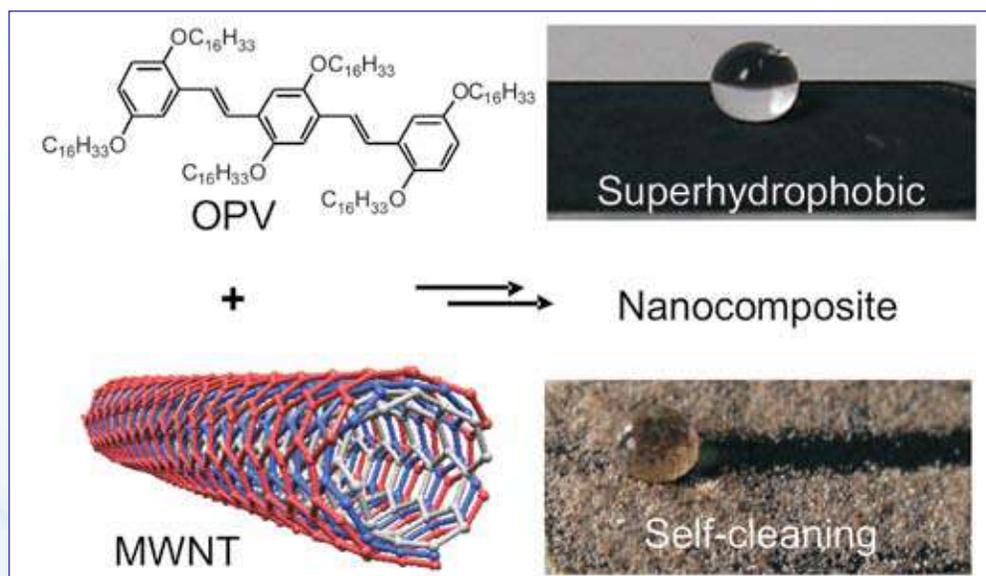
Single-walled carbon nanotubes (SWNTs) represent a novel class of quasi one-dimensional material that exhibits unique chemical and physical properties, allowing wide range of applications from optoelectronics to biology. The major limitation of SWNTs is their poor solubility in solvents. Covalent functionalization of SWNTs is known to modulate the chemical and physical properties which in many

cases may create defect sites thereby severely affecting the electronic properties. An alternative approach is physical interaction of organic molecules with carbon nanotubes (CNTs) leading to their dispersion in organic and aqueous solvents. It enables dispersion and processing while preserving CNTs intrinsic properties. Hybrid materials were prepared through self-assembly approach by interacting CNTs with oligo(*p*-phenylenevinylene)s (OPVs). OPVs are known to form self-assembled architectures with controlled size, shape, and function. Noncovalent interaction of CNT surfaces with OPVs leads to better dispersion of SWNTs in common organic solvents. SWNT is found to accelerate the self-assembly of OPVs in low concentrations leading to the formation of a hybrid pi-gel in hydrocarbon solvents. Remarkably, this phenomenon occurs below the normal critical gel concentration of OPVs. The gel stability is significantly enhanced by the addition of SWNTs leading to their uniform dispersion in the gel phase. Optical and morphological studies revealed the presence of exfoliated carbon nanotubes which are encapsulated within the gel matrix (*Angew. Chem. Int. Ed.*, **2008**, 47, 5746–49)



Bioinspired superhydrophobic materials

Nature inspires scientist through aesthetic creation of functional systems, wherein biology meets materials. One of such examples is the self-cleaning superhydrophobicity of plant leaves, particularly of lotus leaf. It is well-understood that a surface with micro- and nanostructured roughness imparts superhydrophobic property with water contact angle (CA) > 150°. The dispersed OPV-CNT composite was coated on glass substrate and found to be superhydrophobic. TEM and AFM analyses revealed a surface topography consisting of micrometer-sized hills and valleys with a nanoscale paraffin coating of hairy hydrocarbon chains akin to lotus leaves. The CNT-OPV nanocomposite surface gives high water contact angle of 165° and very small sliding angle of less than 2°, which allows the rolling of water droplets, thus imparting a self-cleaning ability with liquids having varying pH values and ionic strengths (*Angew. Chem. Int. Ed.* **2008**, 47, 5750–54).



Phenothiazine attached $Ru(bpy)_3^{2+}$ derivative as highly selective “turn-ON” luminescence chemodosimeter for Cu^{2+}

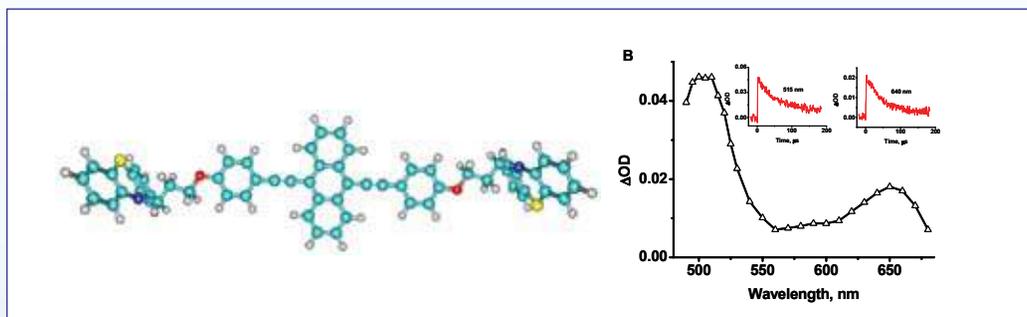
Using the ability of Cu^{2+} ions to oxidize aromatic amines in acetonitrile solution, a highly selective “turn-ON” luminescence chemodosimeter for Cu^{2+} was designed. The aromatic amine employed here is a phenothiazine moiety which is covalently linked to one of the bipyridine units of $Ru(bpy)_3^{2+}$. Excitation of the $Ru(bpy)_3^{2+}$ lead to electron transfer from the phenothiazine moiety to the MLCT excited state of $Ru(bpy)_3^{2+}$ which resulted in efficient quenching of the luminescence. In the presence of excess Cu^{2+} , phenothiazine moiety was oxidized to a stable entity which was incapable of electron donation to the MLCT excited state of $Ru(bpy)_3^{2+}$. The emission of the $Ru(bpy)_3^{2+}$ moiety was thus restored. Only Cu^{2+} was capable of this reaction, making this an interesting, hitherto unexplored strategy for the selective detection of micromolar amounts of Cu^{2+} (*Dalton Trans.* **2009**, 1180).



Long-lived photoinduced charge separation in flexible 9,10-bis-(phenylethynyl)anthracene – phenothiazine dyads

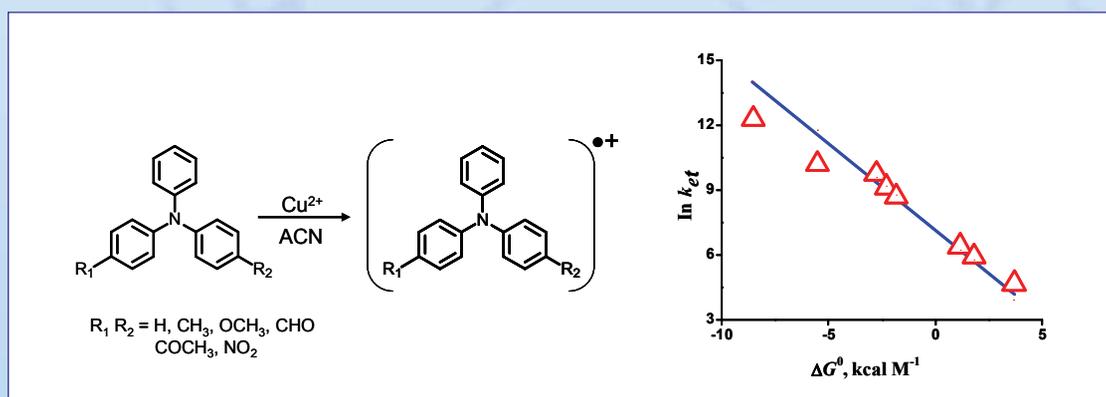
Covalently linked dyads were designed with bis(phenylethynyl)anthracene as light absorber and acceptor and one or two phenothiazine units as donors. Absorption spectra of the dyads obtained by adding contributions due to the donor and acceptor moieties indicated that the constituents did not interact in the ground state. Fluorescence of bis(phenylethynyl)anthracene core was efficiently quenched by the donor moieties and this was attributed to electron transfer from the phenothiazine to bis(phenylethynyl)anthracene. Femtosecond transient absorption studies suggested formation of a charge separated state directly from the singlet excited state of bis(phenylethynyl)anthracene. Nanosecond flash photolysis experiments gave long-lived transient absorptions assignable to

phenothiazine radical cation and bis(phenylethynyl)anthracene radical anion. These assignments were confirmed by oxygen quenching studies and secondary electron transfer experiments. Electron transfer in these systems was analyzed in the light of Marcus theory and the slow back electron transfer exhibited was attributed to inverted region effects (*J. Phys. Chem. B*, **2009**,113,1606).



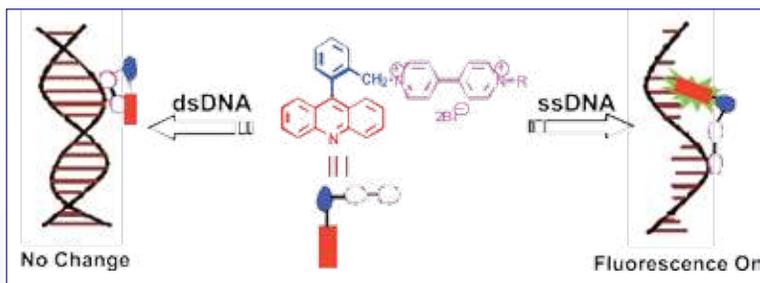
Generation of triarylamine radical cations through reaction of triarylamines with Cu(II) in acetonitrile. A kinetic investigation of the electron transfer reaction

Triphenylamine derivatives react with Cu^{2+} in acetonitrile to give radical cations, which subsequently undergo dimerization to provide tetraphenylbenzidine derivatives. Kinetic aspects of radical cation formation were examined by stopped-flow spectrophotometry. A broad range of triphenylamine derivatives were studied and the driving force for the electron transfer reaction ranged from +3.67 to -8.56 kcal M^{-1} with rate constants varying from 1.09×10^2 – $2.15 \times 10^5 \text{ M}^{-1} \text{ s}^{-1}$ for these systems. Reorganization energy for the electron transfer reaction was estimated using experimentally determined activation parameters. Fitting of the rate data to the Marcus equation using different values of the electronic coupling matrix element H_{ei} provided a good fit using $H_{ei} = 100 \text{ cm}^{-1}$ suggesting that electron transfer in the TPA/ Cu^{2+} system conforms to the Marcus type electron transfer. Further, the high reorganization obtained from these studies was consistent with significant bond cleavage in the transition state and proposed a mechanism consistent with the experimental data (*J. Phys. Chem. A*, **2009**,113,6477).



Selective recognition of single-strand DNA through fluorescence enhancement

Single strand DNA (ssDNA) forms an important intermediate in processes such as DNA replication, recombination, and repair. Unlike the compact structure of the double strand DNA (dsDNA), ssDNA is flexible and is reported to exhibit sequence-dependent conformations and to exist as random coil or helical structures formed by the stacking interactions between the nucleobases. Hence, it is of

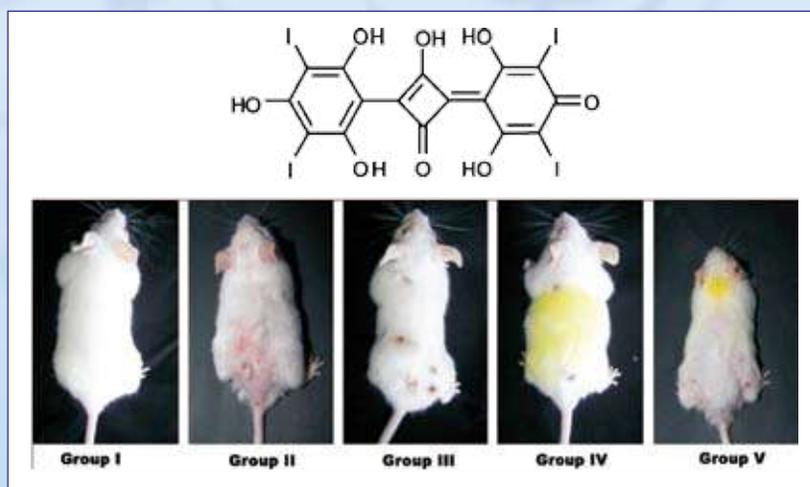


great interest to understand such conformational dynamics and to have an idea about the nature of interaction of small molecules with ssDNA. Besides this, the selective interactions of small molecules with ssDNA have great interest for biological and analytical purposes,

for example, in DNA labeling, development of DNA based probes such as molecular beacons, detection of hybridization of single strands, and ssDNA detection and quantification. In this respect, a series of novel viologen linked tolylacridine dyads were synthesized and investigated their interactions with ssDNA and dsDNA. Of these, the *para*-isomer showed efficient quenching of fluorescence intensity in presence of both dsDNA and ssDNA, while the *ortho*-isomer exhibited sequence selective interactions with ssDNA with enhanced fluorescence intensity (ca. 3-11-fold depending on the sequence of the DNA). The DNA binding mode of the *ortho*-dyad is proposed to be predominantly involving electrostatic interactions through the viologen moiety and partial intercalative binding of the acridine chromophore (*Org. Lett.* **2008**, *10*, 4295-98).

Squaraine dyes for photodynamic therapy for skin cancer models *in vivo*

Squaraines form a class of dyes possessing sharp and intense absorption in the near to infrared region. The intramolecular charge-transfer (CT) character of the S_0-S_1 electronic excitation combined with an extended conjugated π -electron network gives rise to the intense bands observed in the near-infrared region for the squaraine dyes. Photodynamic therapeutic (PDT) application is based on the



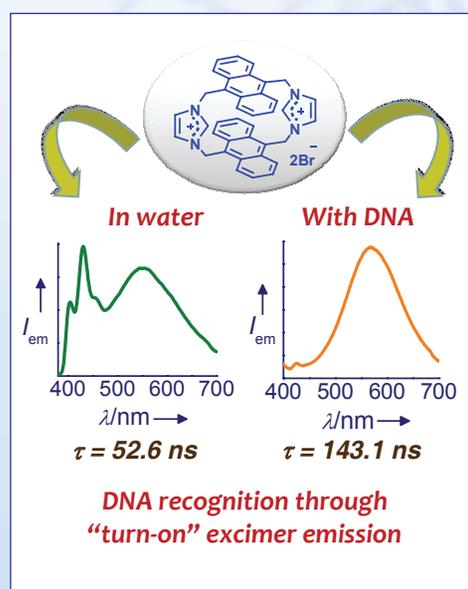
light-induced activation of a photosensitizer generating highly reactive oxygen species that induce tissue destruction in malignant tissues. A study was carried out to assess the photosensitizing potential of an iodosquaraine in PDT trials *in vivo*. Male Swiss albino mice were divided into five groups and skin tumor was induced using standard protocol in animals of groups II, III, IV and

V, while animals of group I served as the control. At the completion of 20 weeks of induction, the tumor bearing mice from groups III, IV and V were given an intraperitoneal injection with the squaraine dye. After 24 h, in the animals of groups IV and V, the tumor area was exposed to visible light from a 1000 W halogen lamp. The mice from groups I to IV were sacrificed two weeks after the PDT treatment and the marker enzymes (myeloperoxidase [MPO], b-D-glucuronidase, rhodanese, lactate dehydrogenase [LDH], hexokinase, sialic acid and caspase) were assayed in tumor and normal tissues. Animals from group V were sacrificed after 90 days of PDT treatment and the above parameters were recorded. Reduction in tumor volume and reversal of biochemical markers to near normal levels were observed

in the treatment groups. The study assumes importance as it is the first report on PDT—a novel modality, using a squaraine dye for skin cancer therapy *in vivo*. In skin cancer models, the progression/cure can be visualized by the naked eye which is another point of advantage, while seeking new modalities for the treatment of cancer (*J. Photochem. Photobiol. B Biol.* **2008**, *92*, 153-59).

DNA detection uniquely through formation of a novel and stable excimer

The chemistry of cyclophanes has been an area of interest because of the potential applications of functionalized cyclophanes in numerous fields. Even though several cyclophane derivatives have been effectively utilized for host–guest complexation, the design of functional cyclophanes that are soluble in the aqueous media and undergo specific interactions with biomacromolecules such as oligonucleotides, DNA, and proteins has been challenging. In this context, a few novel anthracene based cyclophanes were synthesized and their interactions with DNA, proteins and micelles were investigated.

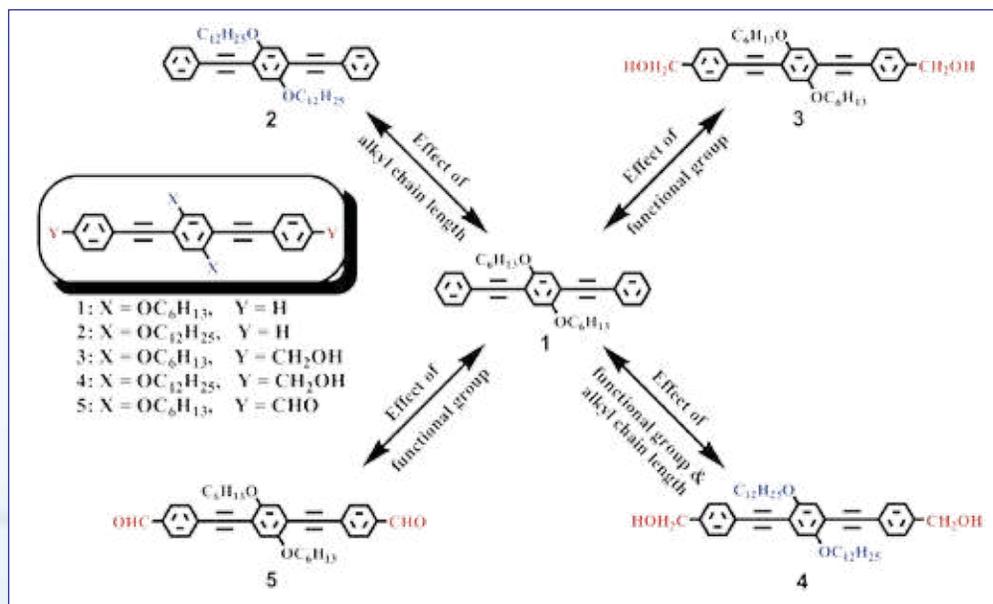


In methanol and acetonitrile, these cyclophanes exhibited characteristic anthracene absorption and fluorescence maxima at 375 and 430 nm, respectively. However, in the aqueous medium, the symmetric cyclophane showed similar absorption spectra as observed in methanol and acetonitrile but exhibited a dual emission consisting of a structured band having λ_{max} at 430 nm and a broad band centred at 550 nm, due to the monomer and excimer, respectively. In contrast, the unsymmetrical cyclophane in the aqueous medium showed structured anthracene absorption and emission spectra similar to those obtained in methanol and acetonitrile. DNA binding studies indicated that as compared to the unsymmetrical cyclophane, the symmetrical cyclophane undergoes sequence selective interactions with DNA, resulting in the exclusive formation of a highly organized sandwich-type excimer having bathochromic shifted emission at 570 nm and significant

enhancement in intensity and lifetime. This is the first report wherein DNA assists the formation of an excimer which has the longest lifetime at 25 °C. The uniqueness of the symmetric cyclophane is that it selectively recognizes DNA as compared to micelles and proteins in buffer and under agarose gel electrophoretic conditions and signals the event through “turn on” excimer emission mechanism (*Angew. Chem. Int. Ed.* **2008**, *47*, 8407–11)

Functional control on the 2D self-organization of phenyleneethynylenes

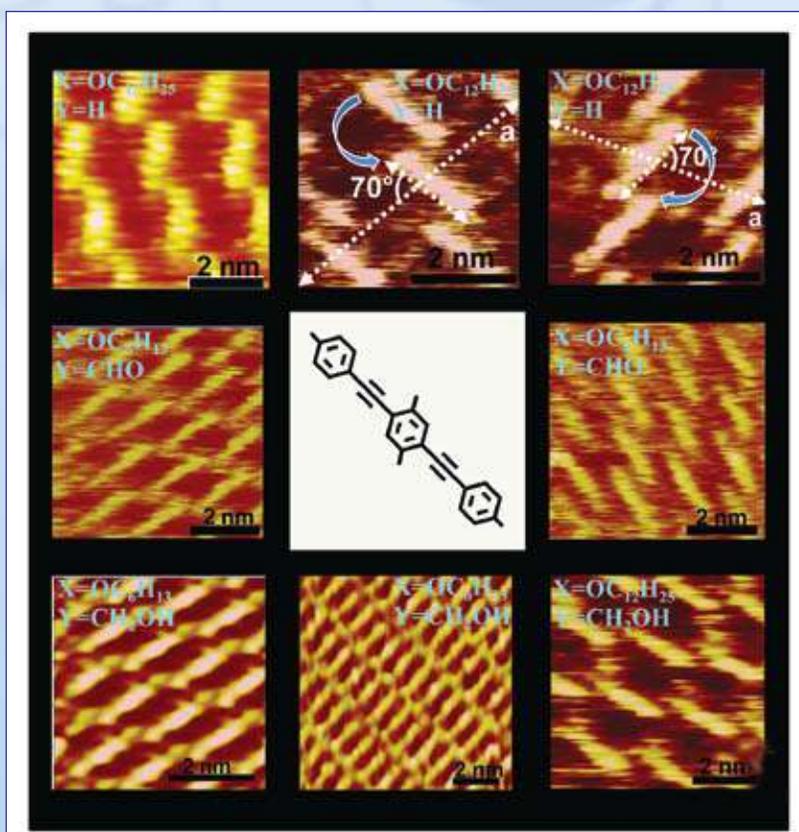
Two-dimensional self-organization of a series of phenyleneethynylenes was investigated, at ambient conditions, by varying the length of alkoxy chain and introducing functional groups at the terminal positions using high resolution scanning tunneling microscopy (STM). Phenyleneethynylene derivatives form well-organized assemblies on HOPG surface and their organization was modulated by (i) by replacing hexyloxy (C_6) chains with dodecyloxy (C_{12}) chains and (ii) introducing functional groups such as aldehyde and hydroxyl at the terminal positions. The initial step of the self-organization in all the systems under investigation was the formation of a α -strip, assisted by the $CH \cdots \pi$ interaction. The $CH \cdots \pi$ interaction could occur through ortho and meta positions leading to the formation of type-I and



type-II arrangements. The distance between two molecules in a-strip could be varied by increasing the alkoxy chain length. Interlocking of a-strips resulted in the formation of 2D assembly through the weak intermolecular interactions. The functional groups at the terminal positions of phenyleneethynylenes played a decisive role in the way in which they interlock.

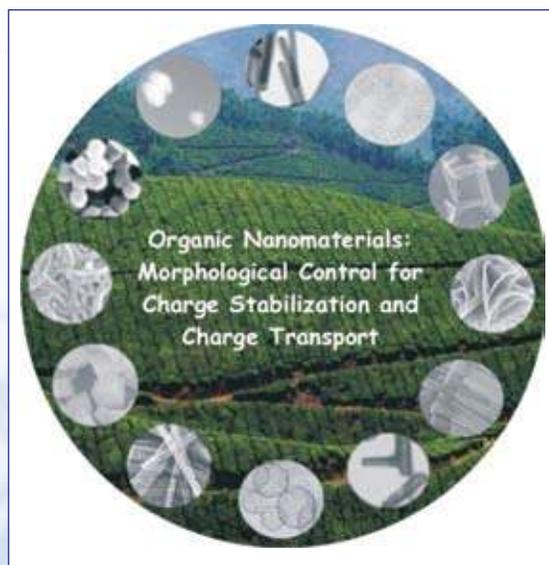
In the case of unsubstituted phenyleneethynylenes (**1** and **2**), the extent of interlocking of a-strips was more effective in type-I arrangement. In contrast, aldehyde substituted phenyleneethynylene

molecule **5** showed more efficient interlocking in the type-II arrangement resulting from the interaction between the carbonyl oxygen atoms of aldehyde group and hydrogen atom of hexyloxy chain. Interestingly an end-to-end organization was observed in the case of hydroxyl substituted phenyleneethynylenes (**3** and **4**) through OH...OH hydrogen bonding interaction between a-strips. These results clearly indicated that it is possible to fine-tune the arrangement of the a-strip by varying the length of the alkoxy chain and the b-strip by introducing proper functional groups (*J. Phys. Chem. C*, **2009**, DOI: 10.1021/jp901884v)



Design of organic nanomaterials for charge stabilization and charge transport

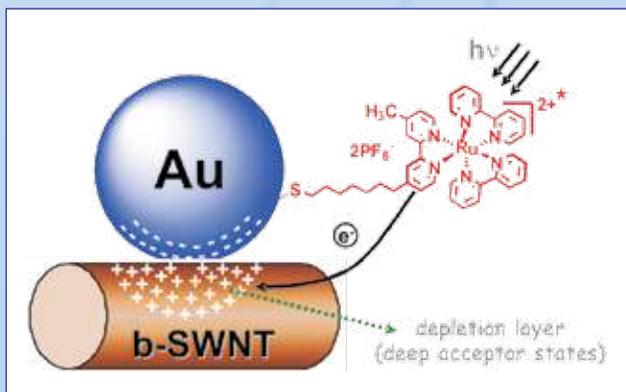
Chromophoric systems with proper recognition motifs can organize into well-defined arrays forming supramolecular assemblies and further into nanoscopic materials. The optical and electrical properties of organic nanomaterials depend upon the stacking modes of organic molecules and also on the kind of interaction between different chromophore units. These types of aggregates can dramatically alter the opto-electronic properties of organic nanostructures. The enhanced emission of siloles through the formation of spherical aggregates having an average size of 300 nm was studied. These spherical aggregates converted to inorganic-organic hybrid nanowires (25 nm width) of micrometer length upon addition of CdTe nanorods.



Efforts are currently directed towards manipulating the morphology of these organic nanomaterials, particularly on their size and shape by adopting different techniques. Initial studies have shown that such hybrid organic nanostructured materials possess excellent charge stabilization properties and these aspects are under investigation.

Gold nanoparticle functionalized carbon nanotubes for light induced electron transfer process

Photoactive hybrid nanomaterials were synthesized by functionalizing ruthenium trisbipyridine ($\text{Ru}(\text{bpy})_3^{2+}$) chromophores on to single walled carbon nanotubes (SWNT), both in the presence and absence of gold nanoparticles. On the basis of the steady state and time resolved studies, it was concluded that the electron transfer take place from $^* \text{Ru}(\text{bpy})_3^{2+}$ to Au nanoparticle decorated SWNT. However, no electron transfer process was observed from the photoexcited chromophores to SWNT or Au nanoparticles when these components were linked directly. The electronic properties at the heterojunctions of SWNT-Au nanoparticles were distinctly different from that of the isolated components due to the charge redistribution at the interface. The localized depletion layer at the bundled SWNT walls may act as acceptor sites for electrons from the excited chromophores, leading to forward electron transfer. The charge separated intermediates in these multicomponent system were stable for several



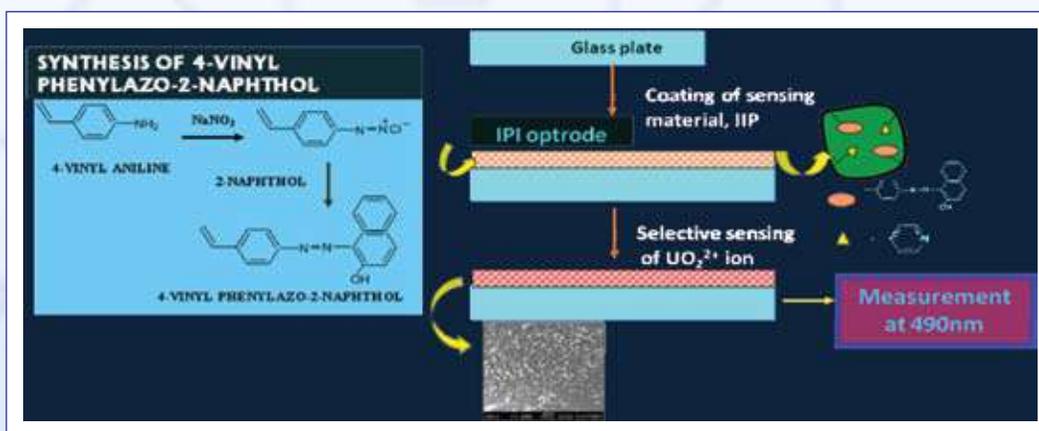
nanooseconds and the high ratio of forward electron to back electron transfer ($k_{\text{ET}}/k_{\text{BET}} = 10^2$) make these hybrid nanosystems promising for energy conversion and optoelectronic applications. The intriguing electronic properties of the heterojunctions can be further modified by decorating SWNT with suitable metal nanoparticles and photoresponsive units which can lead to the development of a new generation of photoactive hybrid nanomaterials.



INORGANIC AND POLYMER MATERIALS

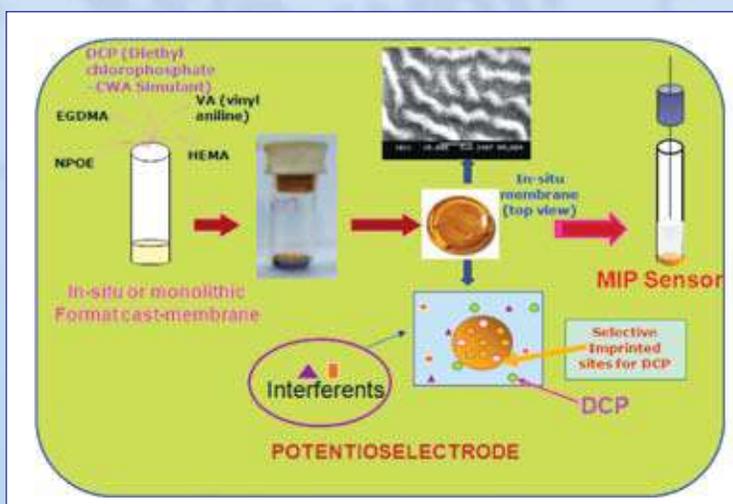
Uranyl optode

A two-dimensional biomimetic optode was designed by the inclusion of uranyl ion imprinted polymer particles into polymethyl methacrylate followed by casting a thin film on a glass slide. This solid state sensor though applied for analysing ground, lake and tap-water samples collected in the vicinity of uranium deposits, is only useful for routine monitoring of uranium contaminated samples as the limit of detection is 0.18 ppm (much higher than maximum permissible level(MPL) in drinking water of approximately 30 ppb). (*Talanta*, **2008**, 74, 1420–27).



Potentiometer

The successful design and development of imprinted polymer inclusion membrane (IPIM) based portable and field monitoring sensors for pesticides (atrazine & phorate), organophosphate chemical warfare agents simulant/degradation product (pinacolyl methyl phosphonate/methyl phosphonic acid) and inorganic (uranyl ion) toxins were reported earlier. The above type of sensors were first introduced by Prof. Murray's group of John Hopkins University, USA. NIIST group has now come out successful in developing in-situ or monolithic format cast membrane (IMFCM) based on semi-covalent and non-covalent strategies in addition to IPIM. The integration of above membrane with potentiometric transducer enabled rapid, reliable and selective detection and quantification of as low as 0.2 ppm of diethyl chlorophosphate (*Electroanalysis*, **2009**, 21 1048-56).



Nitrite sensor

A highly selective and reusable chemical switch based dual optoelectronic sensor, for monitoring traces of nitrite in environmental and food samples was developed. The sequential addition of nitrite and sulphamic acid to Rhodamine 6G in sulphuric acid medium resulted in switching "ON" and "OFF" absorbance. The sensor enabled the determination of as low as 20 ppb of nitrite in presence of $\sim 10^4$ fold amounts of extraneous cationic and anionic species. In a quest for design of a solid state test strip sensor for nitrite, a water soluble dye Rhodamine 6G was entrapped in sol-gel film by condensation of alkoxy silanes. (*Anal.Chim.Acta*, **2008**, 623, 53-58).

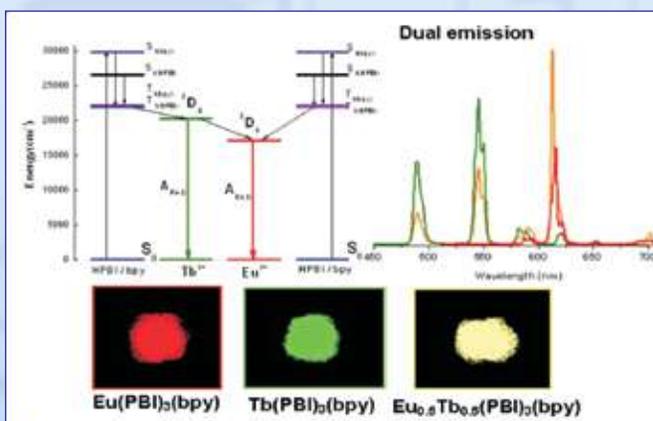


PIP (Uranium) removal

The removal of Uranium, a persistent inorganic pollutant, from mining industry feed simulant and natural water solutions was accomplished with mesoporous uranyl ion imprinted polymer material prepared based on TRAPPING concept employing formamidoxime and 4-vinyl pyridine. This material is capable of removing of uranium down to 7 ppb (*Microporous and Mesoporous Materials*, **2009** 119, 165–70).

Tuning of colors in mixed lanthanide β -diketonate complexes

The luminescence behavior of a series of stoichiometrically mixed lanthanide complexes was investigated and compared with that of analogous single lanthanide ion systems. The presence of a second Ln^{3+} ion in a mixed lanthanide system had a profound effect on the luminescent intensity and also exhibited interesting dual emission. This dual emission may find potential application in organic light emitting diodes (*J. Mater. Chem.* **2009**, 19, 1425).



Non-toxic yellow rare earth pigments

Non-toxic yellow inorganic pigments based on oxides of cerium, zirconium and tantalum, displaying colors ranging from white to yellow have been designed. The coloring mechanism is based on the strong absorptions of the pigments in the visible region which originated due to the introduction of an additional hybrid orbital energy level between O_{2p} valence and the

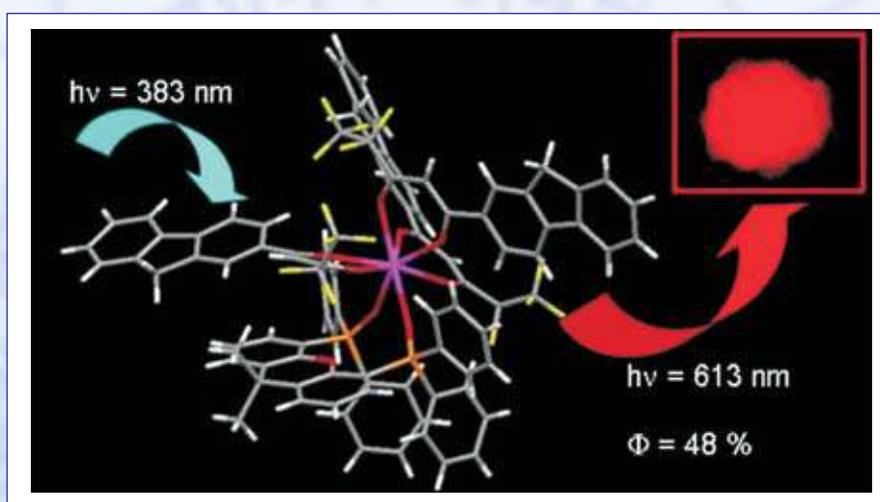




Ce_{4f} conduction bands. The pigments are economically viable and are potential alternatives to the classical toxic pigments (*Dyes and Pigments*, **2009**, 82, 53).

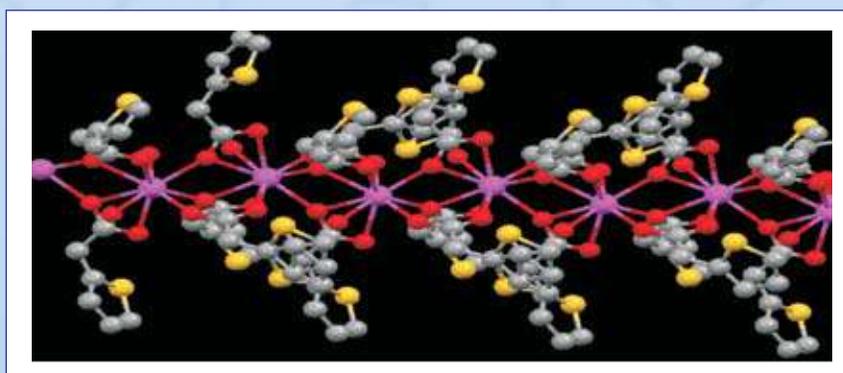
Novel photosensitizer for Eu^{3+} ion

A novel light conversion molecular device was designed based on Eu^{3+} -tris- β -diketonate and a chelate phosphine oxide. The luminescent study demonstrated that the replacement of solvent molecules in Eu^{3+} -tris- β -diketonate complex by chelate phosphine oxide ligand leads to a huge enhancement in overall quantum yield (from 3 to 48%) and 5D_0 lifetime (from 328 to 820 μ s). The substantial contribution of chelate phosphine oxide ligand for overall sensitization process of Eu^{3+} -centered luminescence was noted. This may be due to the fact that the existence of mezzo first triplet excited state energy level (T_1) between the first singlet excited energy level (S_1) and T_1 of β -diketone (*Inorg. Chem.*, **2008**, 47, 8091-100).



Bright green luminescent one-dimensional coordination polymer

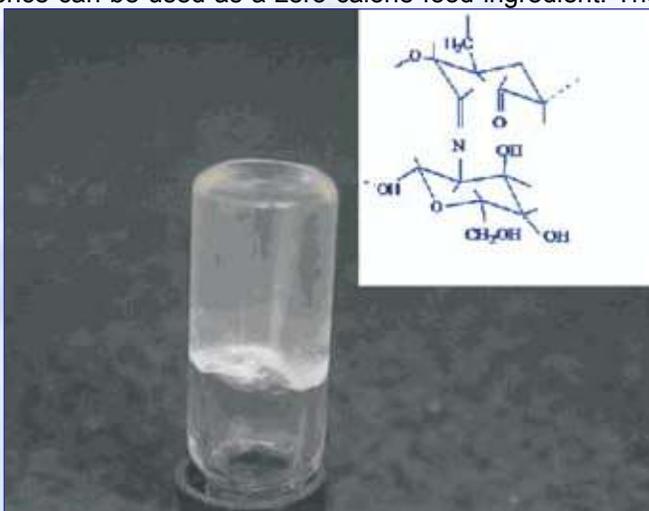
The X-ray crystal structure of Tb^{3+} -thiopheneacetate complex revealed that Tb^{3+} ion was connected to two neighboring ions by six thiopheneacetic acid ligands *via* the carboxylate groups to form an infinite one-dimensional polymer. Weak luminescence has been detected for the Tb^{3+} coordinated polymer due to the transfer of energy between the metal ions themselves which is a nonradiative process. The quantum yields of the ternary complexes were found to be significantly enhanced by the presence of the bidentate nitrogen donor ligands due to effective energy transfer from the secondary ligands (*Eur. J. Inorg. Chem.* **2008**, 28, 4387-94).



Chitam gel

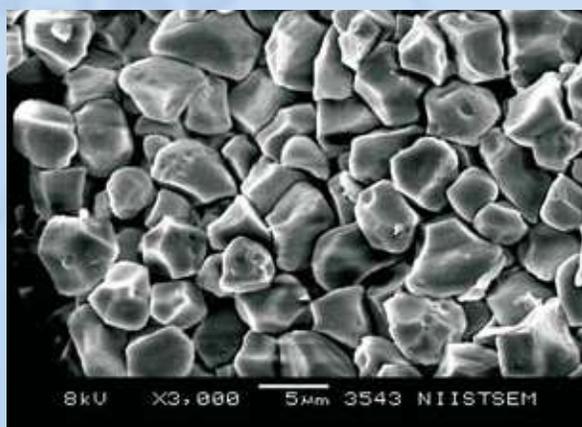
Pure xyloglucan extracted from tamarind seed, as such does not form a gel. A process was developed for the preparation of a transparent, colourless, crystal clear, nontoxic, biodegradable, biocompatible gel named 'Chitam gel' from xyloglucan and chitosan. The gel is made by modifying the xyloglucan to form dialdehyde of xyloglucan and making a co-polymer with chitosan in a definite ratio to form a gel which is stable at temperature -20 to 90 °C, UV radiation and pH from 3 to 7. This gel has a viscosity of 4100 centi Poises at 28 ± 2 °C. The yield of the gel from the raw material is 100 fold and cost effective.

Chitam gel, due to its beta linkage, is not broken down by digestive enzymes in humans and does not contribute to calorie intake and hence can be used as a zero calorie food ingredient. The gel has also applications in the area of cosmetic and personal care products, as a make-up cosmetic or basic cosmetic such as face wash, milky lotion, cream or foundation, with excellent elasticity and ageing stability, free from stickiness and having excellent usability, as a ultraviolet protective agent or as a tissue adhesive, and in pharmaceutical preparations including haemostasis, wound sealing, tissue engineering or localised or oral drug delivery as patches, capsules & tablets (patent pending)



Physico chemical rheological and thermal properties of Njavara rice (*Oryza sativa*) starch

Njavara rice starch was studied for its morphological, physicochemical, and thermal properties and was found to be different from the native Chamba variety rice. Njavara rice starch has bigger granule. It showed high (85 °C) gelatinization temperature and high thermal stability. The swelling power, solubility, water absorption capacity and enthalpy of gelatinization were found to be high compared to the native rice starch. The 6% (w/v) Njavara rice starch gel had 87.45% clarity and its pasting properties such as peak viscosity (957 cP), break down viscosity (324 cP) and set back values (421 cP) were also higher. It also had better freeze thaw stability and high gel strength springiness against shear stress. Other properties like hardness, gumminess, adhesiveness, cohesiveness, and chewiness of the gel were slightly higher than native rice starch. This inherent high thermal and pasting properties, makes njavara rice suitable as poultice for the body massage in the panchakarma treatment. (*J. Agri. & Food chem.*, **2008**, 56, 12105-13).



Njavara starch-SEM

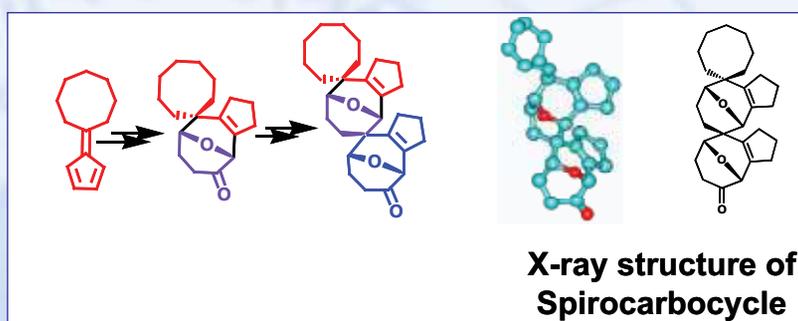


ORGANIC CHEMISTRY

Studies on utilization of pentafulvenes as synthons for the construction of fused cyclooctanoids

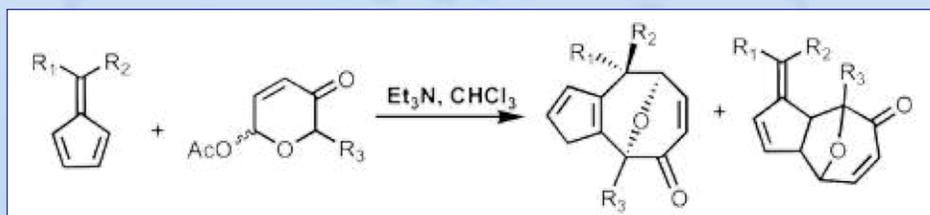
(i) Stereocontrolled synthesis of novel spirocyclic oxabridged cyclooctanoids through sequential transformations of pentafulvenes

The escalating need for novel and structurally interesting scaffolds to the library of non-natural macromolecules has stimulated the development of suitable functional handles for their synthesis. Molecules possessing sterically constrained spirocyclic motifs, especially those containing oxabridges are ubiquitous in nature with many of them displaying interesting biological and odoriferous properties. They became hot spots in current drug discovery and delivery due to their effective interaction with biological receptors. A simple, novel and efficient methodology was developed for the synthesis of spirocyclic oxabridged cyclooctanoids having multiple spiro centres from pentafulvenes. The unique structure with the spirocarbocycle may find interesting applications in the design of novel macromolecules with complex shape (*Synthesis*, **2008**, 13, 2134).



(ii) Periselectivity in cycloaddition reactions of pentafulvenes with 3-oxidopyrylium betaines: effect of substituent on C-6 carbon

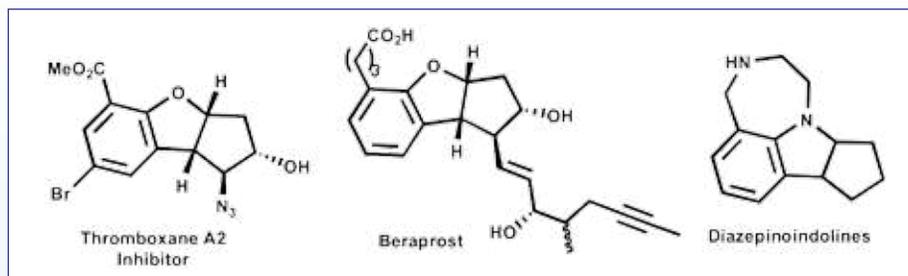
The non-functionalized carbon-carbon multiple bond systems are recognized as latent functional groups; however they are generally unreactive towards carbon nucleophiles due to their electron rich π -orbitals. A novel and versatile method towards the synthesis of 5-8 and 5-7 fused compounds was developed utilizing pentafulvenes as synthons. Periselectivity in cycloaddition reactions of pentafulvenes with 3-oxidopyrylium betaines was studied in detail and the results of our studies showed that depending on the substituent on the C-6 carbon, the reaction may proceed through either [6+3] or [2+5] pathway. (*Synthesis*, **2008**, 12, 1955)



Palladium catalyzed tandem ring opening-ring closing reaction of diazabicyclic alkenes: A facile one pot strategy for cyclopentannulation of heterocycles

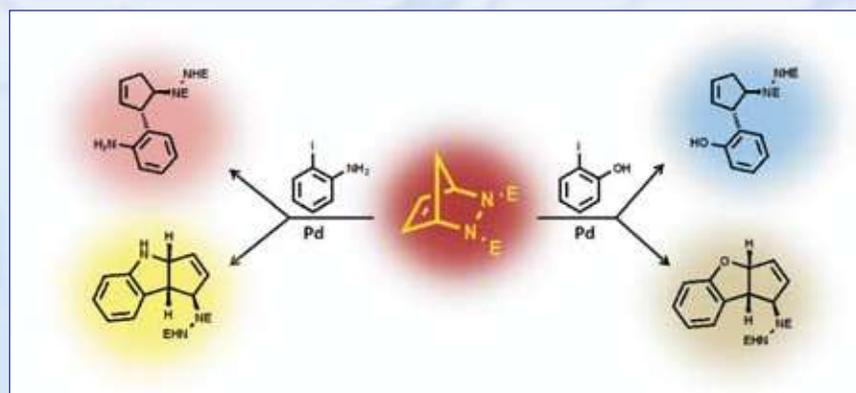
Catalytic tandem reactions constitute a powerful tool in synthetic organic chemistry due to its bond-forming economy, structure economy and eco-friendly nature. Cyclopentane fused heterocycles are

important intermediates in the synthesis of biologically important molecules such as thromboxane inhibitor, prostacyclin analogs, diazepinoindolines, antipsychotics, antiobesity agents, and 5-HT₂ receptor ligands



Biologically important cyclopentannulated heterocycles

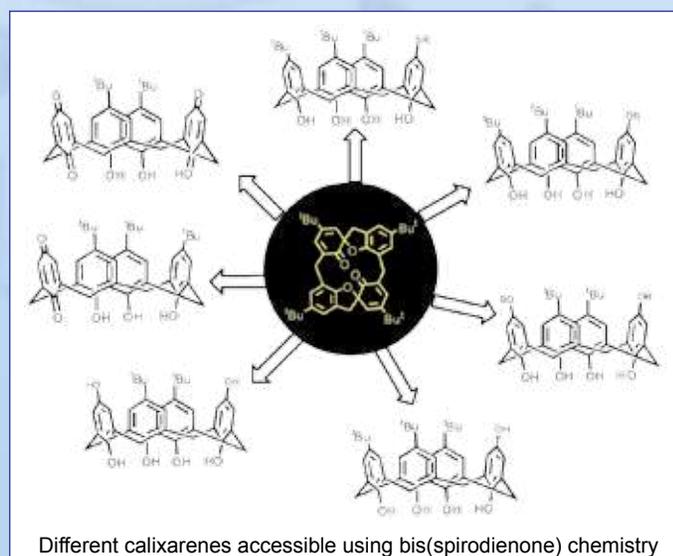
A novel one pot strategy for the cyclopentannulation of heterocycles was developed. Using this methodology, the reaction could be tuned to the formation of either 3,4-disubstituted cyclopentenes or cyclopentene fused heterocycles by careful manipulation of the reaction parameters (*J. Am. Chem. Soc.*, **2009**, *131*, 5042-5043).



Palladium Catalyzed Cyclopentannulation

A new protocol for the selective upper rim alkoxy/aryloxy substitution of calix[4] arene

A direct and efficient acid-mediated protocol for the upper rim alkoxy/aryloxy substitution of calix[4]arene *via* bis(spirodienone) chemistry has been opened up. The transformation is distinguished by mild reaction conditions, experimental simplicity and considerable generality. Moreover, this *ipso*-like nucleophilic substitution reaction of bis(spirodienone) furnishes upper rim modification of calix[4]arene without resorting to any protection/deprotection strategy involving the lower rim of calixarenes. A straightforward



Different calixarenes accessible using bis(spirodienone) chemistry



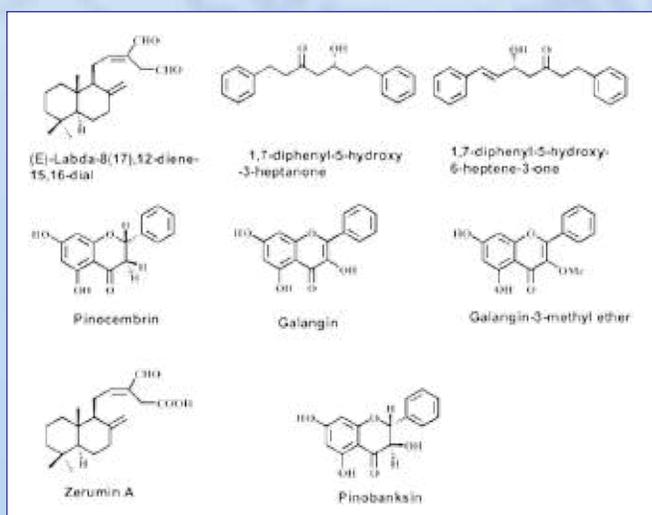
methodology for the selective introduction of thioether moiety at the upper rim of calix[4]arene has also been accomplished. The investigations have also uncovered a relatively simple and efficient strategy for the synthesis of 5-hydroxy and 5,23-dihydroxycalix[4]arene which are otherwise difficult to synthesize. Efforts are currently focused on exploring the use of this methodology in the synthesis of complex molecular receptors for ionic and molecular recognition (*Tetrahedron Letters*, **2009**,50,770-72)

Natural product isolation and biological activity screening

Screening of medicinal plants (which are extensively used in Kerala in the preparation of Ayurvedic medicines) for biological activity and bioactive phytochemicals is actively pursued at NIIST. Plants used for the treatment of chronic problems like rheumatism are expected to contain antioxidant molecules which can inhibit problems created in the human body through reactive oxygen species (ROS). ROS is understood to be involved in initiating inflammation, cancer, Alzheimer's and Parkinson diseases as well as all age related degeneration problems. Therefore, novel naturally occurring antioxidants are constantly sought after. Search for new antioxidant and anticancer compounds at NIIST centre around some of the plant species like *Alpinia*, *Curcuma*, *Kaempferia* and *Hedychium* belonging to the Zingiberaceae family which are used in a large number of medicinal preparations. Isolation of antioxidant compounds are followed by evaluation for NFκB inhibition and anticancer activity. Phytochemical investigation of *Alpinia calcarata* has been completed during last year and the components shown below identified. The antioxidant activity of *A. calcarata* has been established by several *in vitro* experiments. The diterpene coronarin D isolated from *Hedychium coronarium* and *Hedychium flavescens* which showed antiinflammatory activity in mice has been confirmed to be a potential inhibitor of nuclear factor κB (*Mol. Cancer Therapeutics*, **2008**,7, 3306-17; *Biochem. Syst.Ecol.*, **2009**,37,52-55)



Alpinia calcarata



Compounds isolated from *Alpinia calcarata*

Chemical prospecting of 'Njavara' (*Oryza sativa*, L.) and evaluation of antioxidant, radical scavenging and anti-inflammatory effects.

'Njavara' – is an important plant in indigenous medicine for arthritis, neurological and circulatory problems and in rejuvenation therapy (eg. in 'Panchakarma', ' Njavarakkizhi ' etc.)

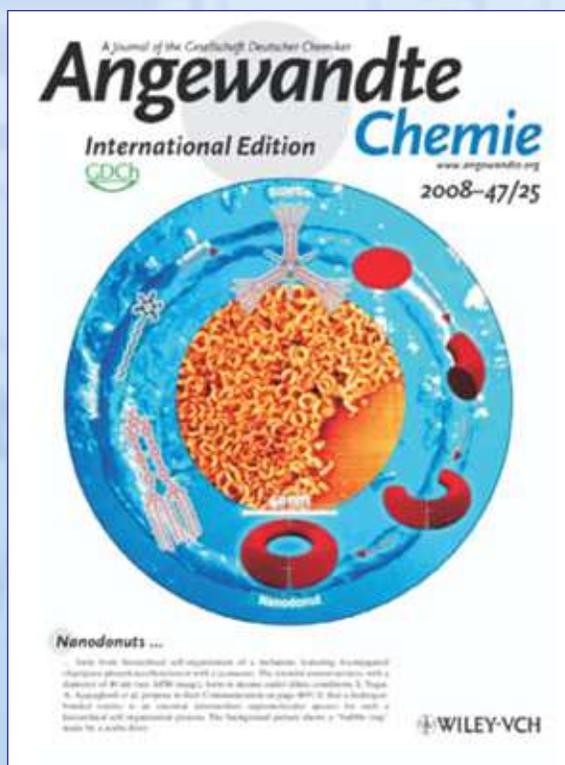
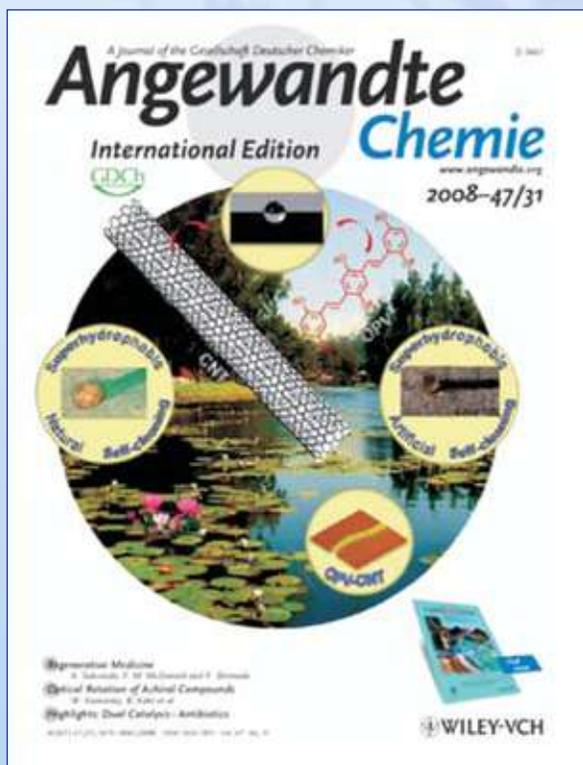


black glumed Njavara rice



Yellow - Njavara Rice

Studies conducted showed that Njavara Black and Yellow types had significantly higher antioxidant effect compared to non medicinal, staple rice variety 'Matta' (red pigmented). Several bioactive components have been isolated from black njavara.



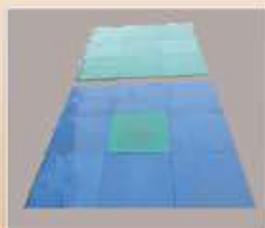
Cover page publications



MATERIALS AND MINERALS DIVISION

HIGHLIGHTS

- ◆ Successfully developed the process flow sheet for 10 kg batch nano rare earth phosphate and procured all the process equipments, orders placed for civil and erection to commission the plant in Indian Rare Earths Ltd. campus in Kollam, in 2009.
- ◆ Layered nano coatings were developed on multi channel one meter long porous tubes at BHEL based on the data generated last year in the laboratory for a semi commercial, all-ceramic ultra filtration plant. The input and out put quality of water and the molecular cut off data analysed & fed back to BHEL.
- ◆ Technical data compiled based on the laboratory experiments and scale up carried out for self cleaning, anti algal and anti bacterial titania nano coatings on terra cotta and glazed ceramics.
- ◆ Dielectric ceramic compositions having quality factor Q_f as high as 10^6 GHz developed for increasing selectivity in microwave communication systems.
- ◆ Novel powellite based red emitting phosphors prepared possessing strong red light compared to conventional counterparts.
- ◆ As part of a long term programme for making MgB₂ long length wires in collaboration with RRCAT (Indore), IPR (Gandhi Nagar) and JNCASR (Bangalore), bulk MgB₂ superconductor was developed having properties similar to international standards.
- ◆ Graphite and primary silicon reinforced hybrid functionally graded aluminium composites developed. The primary silicon improved the strength and abrasive wear resistance while the graphite improved the adhesive wear resistance.
- ◆ Polystyrene-clay nano composites synthesized by a novel technique with possibility of using as micro storage/reactor/delivery devices in long acting cosmetics, drugs and paints.
- ◆ Eco-friendly coir-rubber composites involving cashew shell liquid derived PCNSL (phosphorylated cashew nut shell liquid) adhesives demonstrated.





The Materials and Minerals Division, one among the five divisions of the laboratory, undertakes R&D work in various areas related to ceramics, metals and alloys, electronic and magnetic materials and composites. The major objectives are: Basic and applied research on advanced ceramics for structural and functional applications; Sol-gel synthesis of ceramic precursors for nano particles, coatings/membranes, catalysts as well as ceramic fabrication; Developmental work in the area of high T_c superconductivity, electronic ceramics and ceramics for communication; Exploitation and value addition of renewable and non-renewable material resources and mineral based technologies; Development of new light alloys, their metal matrix composites and functionally graded materials for strategic as well as societal needs; Microstructure and microchemical analysis of materials using EM; and Materials for societal applications.

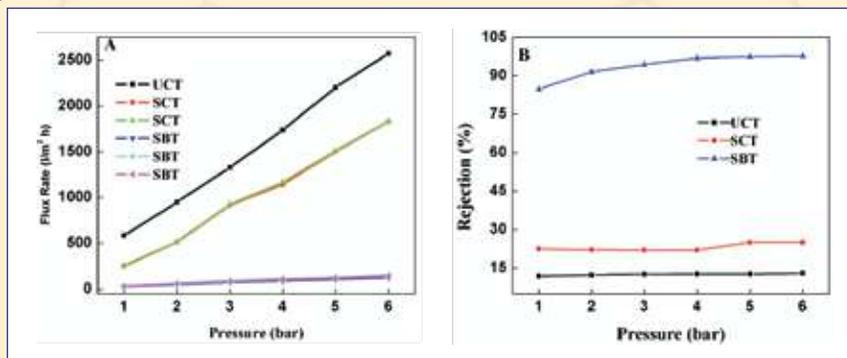
NANOMATERIALS PROGRAMME

Development and demonstration of multi functional ultra filtration ceramic membrane for industrial applications

Sol gel derived alumina-titania nano coating technique on multichannel porous alumina tubes of 500 mm length provided by BHEL, Bangalore to reduce pore size from initial $1.4 \mu\text{m}$ to $0.3 \mu\text{m}$ and further to $<50 \text{ nm}$ were developed for use in ultra filtration, and was further extended to 1 meter length this year. The coated tubes were characterized by SEM, flux measurement and molecular weight cut off (MWCO) experiment. The filtrate from such pilot plant modules were studied for performance.



A-Photograph of uncoated multi channel tube, **B**- photograph of small piece of final coated tube (left). SEM image of cross section of a multilayer coating and their high resolution images with intermediate layer marked as (I) and nanotitania coated top layer (T) on right.



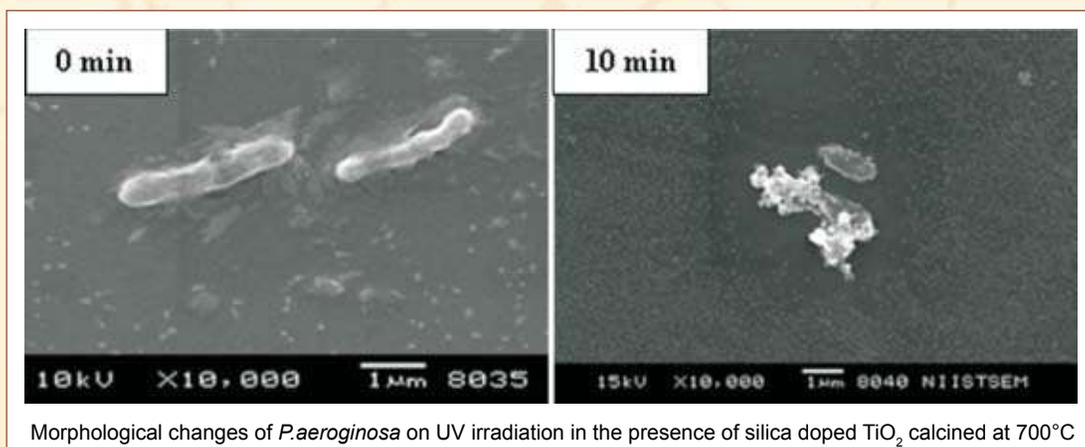
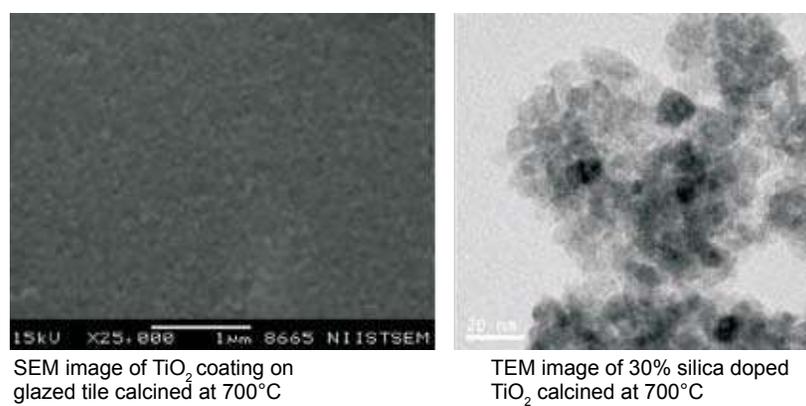
(A) Graph of flux measurement on uncoated tube (UCT), intermediate alumina coated tube-1 (SCT) and tube-2 (SCT) and final TiO_2 coat on slurry-boehmite coated on tube-1 (SBT), tube-2 and tube-3 (repeated on 3 tubes), **(B)** Rejection (%) of BSA against pressure, UCT uncoated tube, S-CT Precoated alumina tube, SBT- Precoat and final coat tube.



This extended work on 1 meter long tubes resulted in multi layered coating of first layer alumina pre-coat (~20 μm) and second layer of nano alumina-titania of thickness 4-5 μm . The flux rate decreased from 585.86 $\text{l/m}^2\text{h}$ (uncoated) to 252.54 $\text{l/m}^2\text{h}$ at one bar pressure after pre-coat with alumina. The alumina-titania layer decreased the flux rate further to 30.85 $\text{l/m}^2\text{h}$ on 19 channel tube. In the MWCO determination % rejection of Bovine serum albumin (BSA) on uncoated, intermediate alumina slurry coated (first layer), and the top nanolayer of alumina-titania was 12%, 25% and 97% respectively.

Nanosized photo catalytic titanium oxide coatings on glazed ceramic surfaces

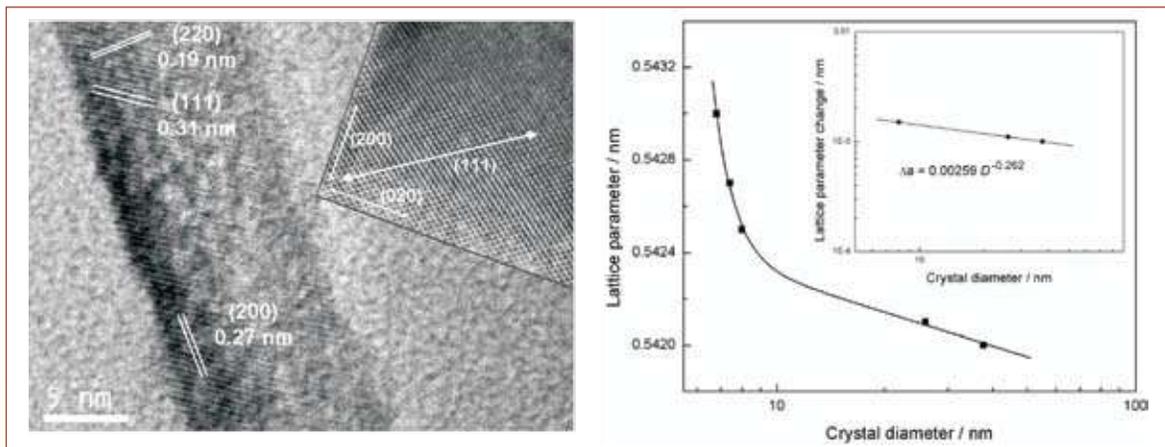
High silica-nano titania composite sol was synthesized using aqueous sol-gel route and was coated over commercially available glazed tiles by spray coating technique which is a commercially accepted technique compared to dip coating technique reported last year.



Silica addition increased photoactivity while suppressed the anatase to rutile phase transformation. Initial experiments carried out showed good antibacterial activity in the coatings.

Cerium oxide based nanomaterials for applications as chemical-mechanical planarisation/polishing (CMP) slurry

Nanosized cerium oxide was successfully produced in the size range 2-60 nm by different synthetic methods using $\text{Ce}(\text{NO}_3)_3 \cdot 6\text{H}_2\text{O}$. Large ceria crystals of different shapes were synthesised by hydrothermal technique. HR-TEM image of a portion of a nanorod indicated its growth in the (220) direction and a nanocube (inset) enclosed by (220) and (020) facets.

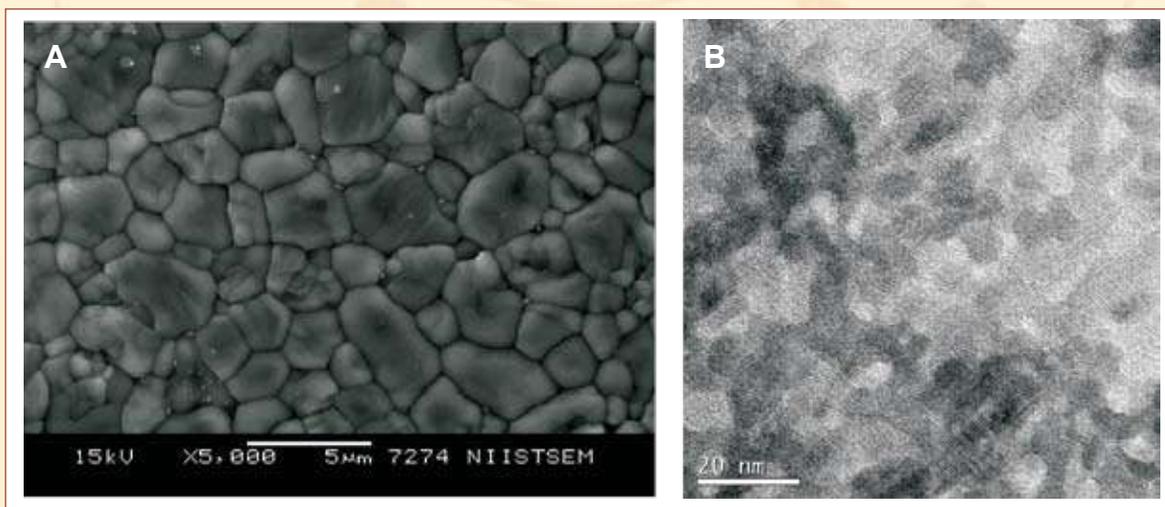


HR-TEM image of segment of a nanorod with a cuboidal CeO_2 crystal in the inset (left). Semilog profile of lattice parameters against the size of CeO_2 crystals of different shapes (right). Inset is the log-log plot of change in lattice parameters as a function of crystal diameter.

The variation of lattice parameter as a function of crystal diameter for CeO_2 particles of different shapes synthesised by hydrothermal technique was studied. Ultrasmall CeO_2 crystals (~ 2 nm) were produced by an organothermal process by the synthesis and decomposition of cerium oleate by using organic surface modifier. The Photon Correlation data indicated hydrodynamic diameter of ~ 2 nm for ultrasmall crystals of CeO_2 . The HR-TEM image of monodisperse spherical CeO_2 single crystals with average size ~ 5.2 nm supported the light scattering data (PCS). Slightly larger crystals of monodisperse ceria of size ~ 5.2 nm (as measured from HR-TEM image) was synthesised by precipitation in isopropyl alcohol-water mixture.

Sol-gel synthesis and sintering of $\text{LaPO}_4\text{-Y}_2\text{O}_3$ nanocomposite

Synthesized nano sized lanthanum phosphate and lanthanum phosphate yttria nano composite having particle size 77 and 110 nm respectively through aqueous sol-gel route. The composites were sintered to $>94\%$ theoretical density at 1600°C while the lanthanum phosphate was sintered to $>99\%$ at 1350°C .



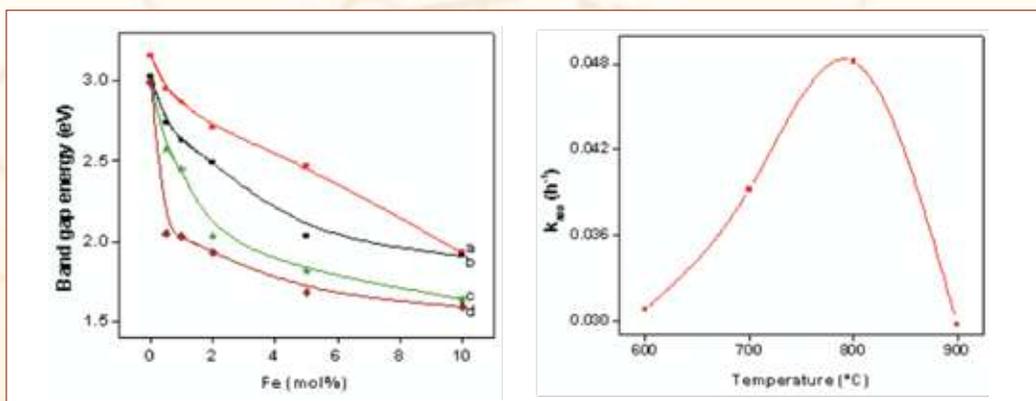
A) SEM image of $\text{LaPO}_4\text{-}20\% \text{Y}_2\text{O}_3$ sintered disc at 1600°C B) TEM image of $\text{LaPO}_4\text{-}20\% \text{Y}_2\text{O}_3$ powder heated at 500°C .



Sintered LaPO_4 -20% Y_2O_3 composite showed an average grain size $<3.5 \mu\text{m}$. TEM micrograph of the composite calcined at 1000°C showed rod shaped LaPO_4 with an aspect ratio of ~ 10 and near round shaped Y_2O_3 .

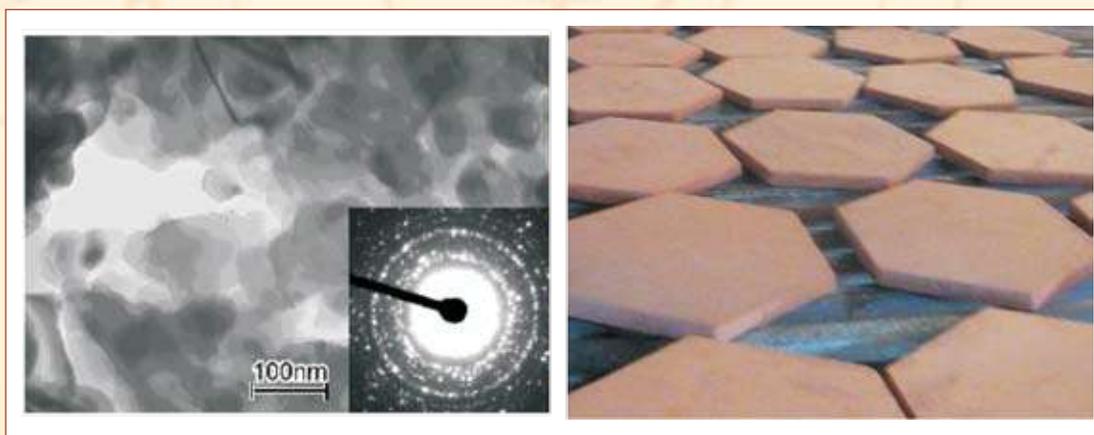
Photoactive titania nanocoatings on building components

Visible light active compositions of iron oxide doped titania 0-10% (TF 0-10%) was prepared by aqueous sol-gel method and was coated over sintered flyash products using spray coating technique. Band gap energy of titania reduced considerably from 3.2 eV by iron doping and thus absorption shifted from UV to visible region. Average crystallite sizes for titania and TF 0.25% samples were 15 and 20 nm respectively.



Variation of band gap energy with iron content (mole%) at different temperatures

Degradation rate of Methylene Blue with TF0.25% at different temperatures



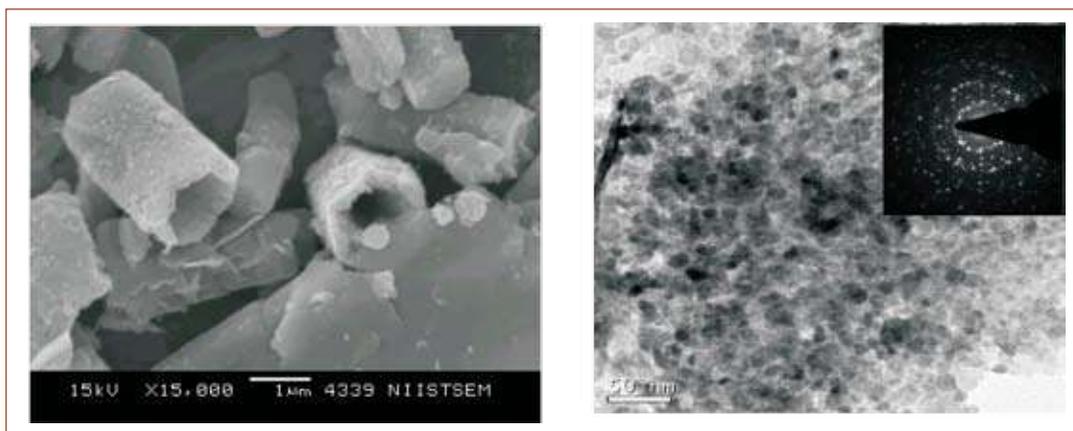
TEM image of TF0.25% calcined at 800°C

Photograph of titania coated flyash tiles

TF 0.25% sample calcined at 800°C showed maximum photoactivity (rate= $7.3 \times 10^{-3} \text{ min}^{-1}$) which is much higher than that obtained on Hombikat titania (rate= $2.1 \times 10^{-3} \text{ min}^{-1}$) and Degussa P-25 (rate= $6.6 \times 10^{-3} \text{ min}^{-1}$). Coated tiles follow the same trend in photoactivity as powders.

Development of high energy composite varistors using rare earth oxides

The project deals with the synthesis of nano composite Zn-Pr-Co-Cr and Zn-Nd-Pr-Co-Cr varistors through wet-chemistry. Nanosize ZnO has been synthesized by hydrothermal and sonochemical routes.

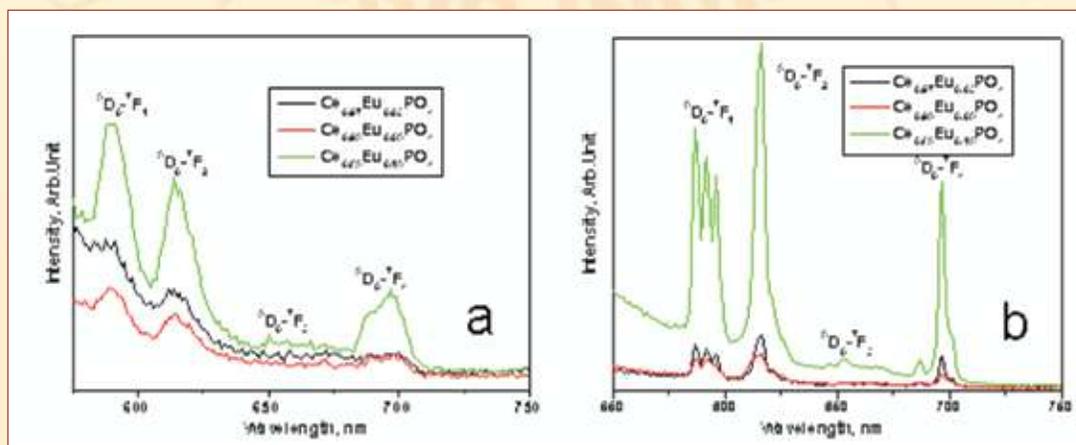


SEM and HRTEM images of ZnO microtube and ultrasonicated nano-ZnO particles

ZnO particle size less than 20 nm was achieved by 'sono-chemical' technique. 0.1 M zinc acetate was subjected to 'aqueous-sono chemical' reaction at various time and pH. The process yielded nanocrystalline ZnO particles at pH 8.5 within one hour sonication. Similarly, ZnO microtube assembly had also been prepared through surfactant and template free thermo-hydrolysis technique. 0.1 M zinc nitrate solution was subjected to hydrolysis reaction at $<100^{\circ}\text{C}$ in presence of Hexamethylenediamine (HMTA) for 4hrs. Such well crystalline ZnO microtube assembly showed enhanced photocatalytic activity compared to other morphologies like rods, whiskers, platelets and spheres. A representative ZnO microtube as well as sonicated nano-ZnO images as observed under SEM and HRTEM are shown in the figure.

Synthesis of europium doped cerium phosphate phosphor through an aqueous sol-gel method

Synthesized various photoluminescent nanosized materials based on rare earth phosphates. Europium doped cerium phosphate and lanthanum phosphate phosphors were synthesised through an aqueous sol-gel technique and were characterized. Nanorods in the size range <75 nm and crystallite size <10 nm of europium doped CePO_4 phosphates were prepared. The rod shaped morphology was retained even after heating at temperature above 600°C . The particles were mesoporous with specific surface area $<50\text{ m}^2\text{g}^{-1}$ and pore size ~ 100 Å.



Emission spectra of $\text{Ce}_{0.97}\text{Eu}_{0.03}\text{PO}_4$, $\text{Ce}_{0.95}\text{Eu}_{0.05}\text{PO}_4$, $\text{Ce}_{0.85}\text{Eu}_{0.15}\text{PO}_4$ a) sol b) powder heated at 1000°C .



Excellent luminescence was obtained for the phosphate composition $Ce_{0.85}Eu_{0.15}PO_4$ in sol form even at room temperature and the sol dried powders heated at $1000^\circ C$ showed strong emission of europium. The sol was coated on glass substrates to a thickness of ~ 50 nm and such coating were also photoluminescent and could be further developed for functional applications.

MATERIALS FOR ELECTRONICS AND COMMUNICATION

Millimeter wave communication

The rapid development in the microelectronic technologies such as wireless LAN, intelligent transport system (ITS) and microwave integrated circuits (MIC) has led to an increase in the utilized frequency from kilometer wave to millimeter wave. In millimeter wave communication, large amount of information need to be transmitted at very high speed. For high frequency applications (>30 GHz), materials with low relative permittivity ($\epsilon_r < 15$) are preferred due to the small size of these materials at high frequencies, minimum cross coupling effect as well as high signal propagation velocity. In addition, a high quality factor (Q_u) to increase the selectivity and a near zero temperature coefficient of resonant frequency ($\tau_f \sim 0$) to ensure frequency stability are needed. A few dielectrics with Q_f up to 100000 GHz were developed. The lithium magnesium silicate had a relative permittivity of 5 and loss tangent of 1×10^{-4} at 8 GHz. The preparation temperatures of these silicates were lowered by the addition of a small amount of low melting glasses.

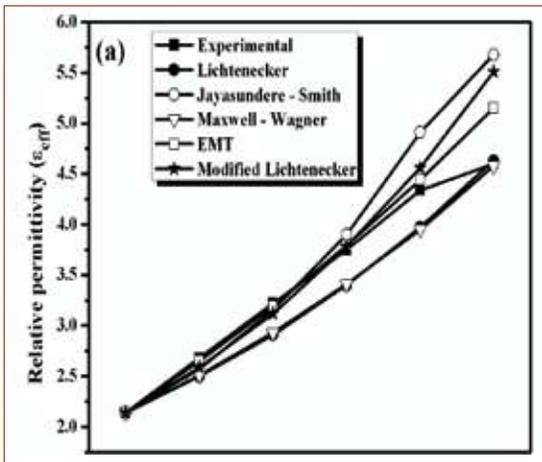
Polymer-ceramic composites of 0-3 connectivity for circuits in electronics

Composite technology, where a novel artificial material is fabricated by combining e.g. ceramic and polymer materials in ordered manner or just by mixing, is earlier widely used for sonar, medical diagnostics and NDT purposes. However, in recent decades large amounts of ceramic polymer composites for telecommunication and microelectronics applications have been introduced. For these purposes, composites of 0-3 connectivity (a three dimensionally connected polymer phase is loaded with isolated ceramic particles) are the most attractive from the application point of view. Composites of 0-3 connectivity enable flexible forms and very different shapes with very inexpensive fabrication methods

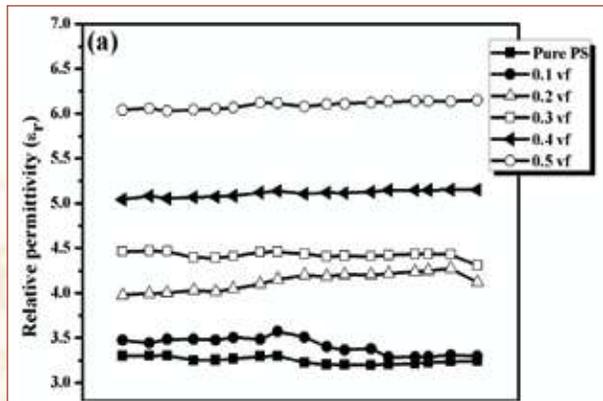
Polymer	Filler	V_f	ϵ_r	$\tan \delta$	Frequency
Polyethylene	$Sm_2Si_2O_7$	0.4	4.81	0.005 5	8 GHz
Polyethylene	$Ca[(Li_{1/3}Nb_{2/3})_{0.8}Ti_{0.2}]O_3$	0.4	7.72	0.004	8 GHz
Polyethylene	Li_2MgSiO_4	0.4	3.54	0.003 2	8 GHz
Polyethylene	$Sr_9Ce_2Ti_{12}O_{36}$	0.4	12.1	0.004	8 GHz
HDPE	$Sr_2Ce_2Ti_5O_{15}$	0.4	11.0	0.006	8 GHz
Polystyrene	Li_2MgSiO_4	0.4	3.84	0.012	8 GHz
Polyestylene	$Sm_2Si_2O_7$	0.4	4.34	0.010 1	8 GHz
Polystyrene	$Sr_2Ce_2Ti_5O_{15}$	0.5	13.6	0.000 4	8 GHz
polystyrene	$Ca[(Li_{1/3}Nb_{2/3})_{0.8}Ti_{0.2}]O_3$	0.4	7.4	0.003	8 GHz
PTFE	CeO_2	0.6	5.0	0.006 4	7 GHz
PTFE	$ZnAl_2O_4-TiO_2$	0.6	4.8	0.008	7 GHz
PTFE	LSCO	0.3	25000	>10	1 MHz
PTFE	$Sr_2Ce_2Ti_5O_{16}$	0.4	7.72	0.08	7 GHz
PTFE	LSCO	0.3	27000	>10	1 MHz
Epoxy	$Sr_9Ce_2Ti_{12}O_{36}$	0.4	14.1	0.022	8 GHz
Epoxy	$Ca(Li,Nb)TiO_3$	0.3	8.0	0.009	1 MHz
Epoxy	$Ca(Li,Nb)TiO_3.Ag$	0.3Ag	81800 0	2.6	1 MHz
Epoxy	$Ca(Li,Nb)TiO_3.Ag$	0.26Ag	72.3	0.065	1 MHz

including simply mixing and molding. These 0-3 ceramic-polymer composites have found applications as microwave substrates, embedded capacitor, inductor or microwave absorbing performances. The table below gives the dielectric properties of polymer-ceramic composites developed by the Institute.

The dielectric properties can be tailored as a function of the filler content. The relative permittivity obtained was compared with different theoretical models. It was found that the EMT model fitted well with the experimental results and these composites showed a nearly temperature independent dielectric properties.



Comparison of theoretical and experimental relative permittivity (a) polystyrene- $\text{Sm}_2\text{Si}_2\text{O}_7$



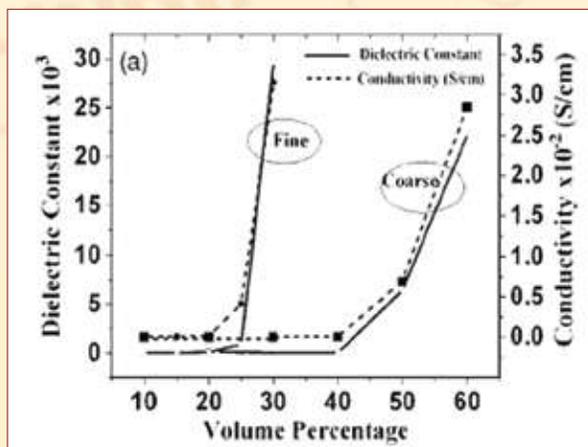
The variation of relative permittivity with temperature for Polystyrene- $\text{Sm}_2\text{Si}_2\text{O}_7$ composites for different volume fractions of the filler ceramic.

Tunable dielectrics

Tunable RF (radio frequency) circuits play an important role in determining the overall quality, sensitivity, size and power consumption of mobile wireless devices and the base stations. Tuned circuits are designed to respond optimally at a specific frequency band and the circuits can be adjusted with a simple voltage adjustment to function optimally as condition change. Development of new dielectric materials having high tunability and low loss is one of the major challenges in the microelectronic industry. The Institute is working on BST and BZT based tunable dielectrics. The BST has a relative permittivity of 2000 and $\text{Ba}(\text{Zr},\text{Ti})\text{O}_3$ about 8000. Thin films of BST and BZT were made by PLD in collaboration with CUSAT. The films had a tunability of about 8 %.

Giant permittivity composite for electrostrictive and embedded capacitor applications

Recently, considerable attention has been paid to high permittivity materials, because of their potential for a wide range of technologically important applications such as electrostrictive materials. High relative permittivity, reasonably low loss and low processing temperature are the basic requirements of these materials for such applications. It is known that enhanced electrostriction is related to the enhanced relative permittivity of the composite near percolation threshold. Addition of conducting phase into dielectric ceramic enhances the relative permittivity to about a few lakhs near the percolation threshold.



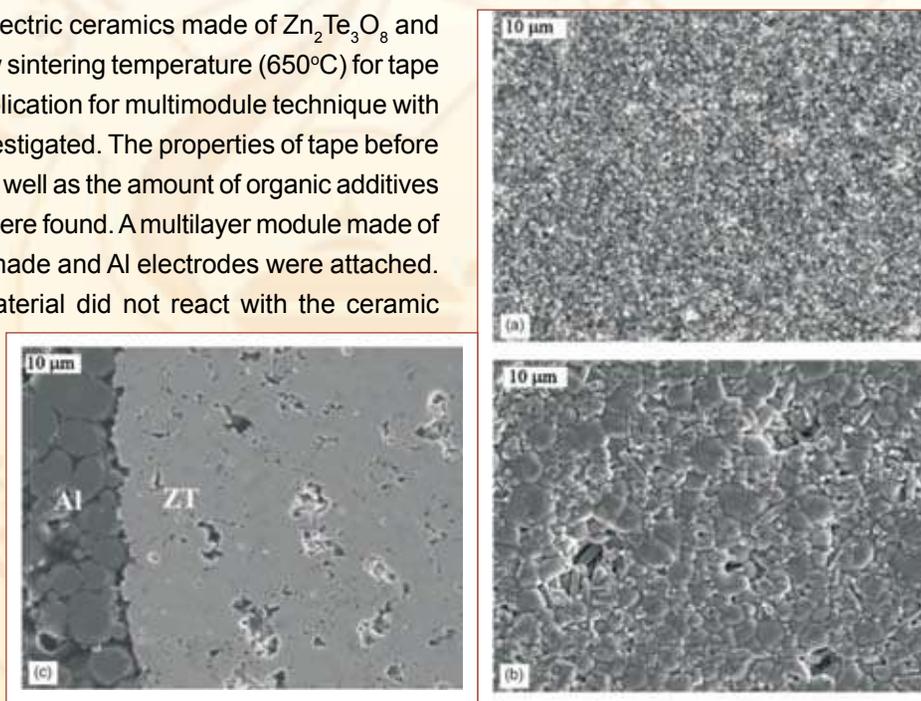
Variation of relative permittivity and conductivity as a function of volume % of filler for fine and coarse filler particles



Embedded capacitor technology is an important emerging technology that will enable significant improvement of the performance and functionality of future electronic devices. One major challenge for implementing this technology is the development of dielectric material that possesses good dielectric and mechanical properties and processabilities. Majority of the electronic component in microelectronic circuits are passive and occupy more than 80% of the printed wired surface area. Integration of embedded passive components into printed circuit board offers a significant reduction in size, better electrical performance, reliability, lower costs and improved design options. The Institute developed PTFE-LSCO, PTFE-Ag, BZN-Ag, PTFE-Ca[(Li,Nb)Ti]O₃-Ag composites with high permittivity suitable for embedded capacitor applications. It was found that the percolation threshold, and the relative permittivity depended on the filler particle size.

Tapecasting and dielectric properties of Zn₂Te₃O₈ based ceramics with an ultralow sintering temperature

Low temperature cofired ceramics have immense applications for cost effective high performance reliable multilayer microwave devices composed of ceramic layers and embedded metal electrodes. The suitability of dielectric ceramics made of Zn₂Te₃O₈ and TiO₂ with an ultra-low sintering temperature (650°C) for tape casting and their application for multimodule technique with Al electrode was investigated. The properties of tape before and after sintering as well as the amount of organic additives for casting process were found. A multilayer module made of stacked tapes was made and Al electrodes were attached. The Al electrode material did not react with the ceramic tape. The stacked and sintered tape showed a permittivity of 17 and tanδ 0.006. The results showed that the composition is well suited for tape process.

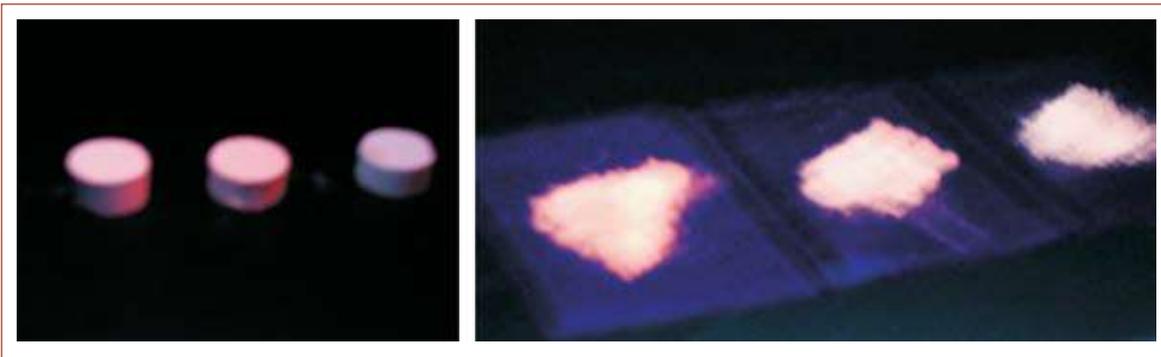


Surface morphology of (a) green Zn₂Te₃O₈+4 wt% TiO₂ tape (b) Tape sintered at 660°C (c) cross sectional view of the interface between Al electrode and the tape sintered at 660°C indicating non-reactivity.

MATERIALS FOR ELECTRICAL AND ELECTRO-OPTIC APPLICATIONS

Development of novel functional ceramic oxides for electrical and electro-optical applications

Novel powellite based red-emitting phosphor material CaLa_{1-x}NbMoO₈:xEu³⁺ was investigated for white light emitting diodes. The photoluminescence investigations indicated that CaLa_{1-x}NbMoO₈:xEu³⁺ emits strong red light at 615 nm originating from ⁵D₀→⁷F₂ (electric dipole transition) under excitation either into the ⁵L₀ state with 394 nm or the ⁵D₂ state with 464 nm, that correspond to the two popular emission lines from near UV and blue LED chips respectively.



CaLa_{1-x}NbMoO₈:xEu³⁺ phosphors when irradiated with UV radiation.

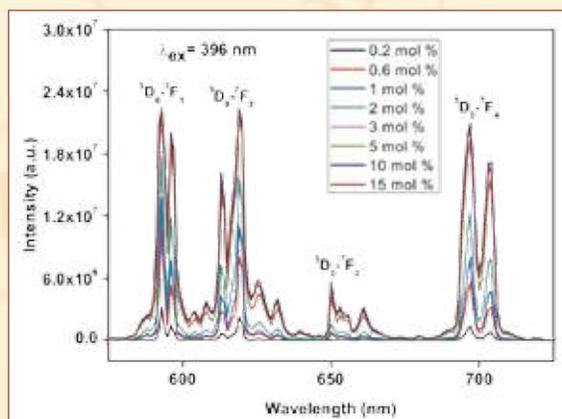
When compared with emission intensity from a CaMoO₄:Eu³⁺, the emission from CaLaNbMoO₈:Eu³⁺ showed greater intensity values under the same excitation wavelength (394 nm). These materials could be promising red phosphors for use in generating white light in phosphor-converted white light emitting diodes (WLEDs).

Electron microscopy & Micro-chemical analysis: The microstructural and microchemical characterization of wide variety of samples to observe at submicron levels has been carried out. About 850 samples have been studied for their morphological characterization, which included aluminium alloys, ceramic sintered pellets, powders, polyaniline nanomaterials, clays and biological samples from NIIST as well as outside agencies such as VSSC, Trivandrum and S.N. College, Kollam.

Multiband orange-red-emitting phosphors, SrY₃SiP₅O₂₀:Eu³⁺ under near-UV irradiation

The photoluminescence properties of a silicon based xenotime type rare earth phosphate as an orange-red emitting phosphor material, SrY₃SiP₅O₂₀:xEu³⁺ is reported for the first time. Photoluminescence spectra of the silicon phosphate indicated the simultaneous occurrence of six predominant orange-red band emissions due to doubly split magnetic-dipole (⁵D₀-⁷F₁), electric-dipole (⁵D₀-⁷F₂), and unusual (⁵D₀-⁷F₄) transitions under a near ultraviolet excitation.

With high Eu³⁺ concentration, the phosphor has strong excitation due to *f-f* transitions appearing around 396 nm that correspond to the popular emission line from near-UV LED chip which is a potential candidate for white light generation by using near-UV LEDs.



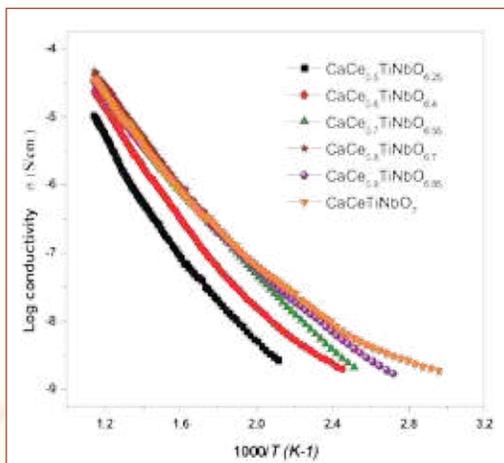
Emission spectra of SrY₃SiP₅O₂₀:xEu³⁺ (0.2, 0.6, 1, 2, 3, 5, 10 and 15 mol %) phosphors.

Semiconducting ceramic oxides for thermistor applications

A series of quaternary non stoichiometric cubic pyrochlores with varying cerium content in Ca-Ce-Ti-Nb-O system were synthesized through solid state route. The electrical conductivity studies proved that all the compounds were semiconducting and the conductivity increased with increase in



Ce content. These materials may find potential applications in photoelectrolysis of water and devices like NTC thermistors.

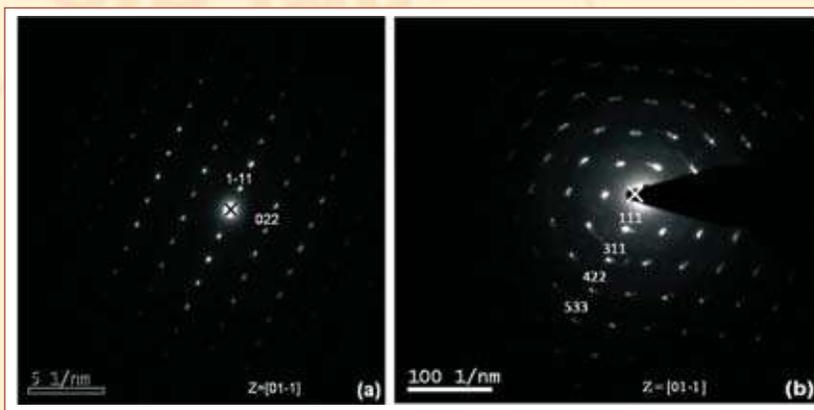


Variation of log conductivity (σ) vs. reciprocal temperature for various compositions.

Liquid Nitrogen Plant: A 10 l/h capacity liquid nitrogen plant was installed and maintained. LN₂ requirements for the up keep of the sophisticated instruments like NMR, TEM, SEM, EDS were met in addition to superconductivity research as well as other R&D requirements of the Institute.

Order-disorder phase transformations in quaternary pyrochlore oxide system

Order-disorder transformations in a quaternary pyrochlore oxide system, CaY₂ZrTaO were studied by powder X-ray diffraction (XRD) method, transmission electron microscope (TEM) and FT-NIR Raman spectroscopic techniques.



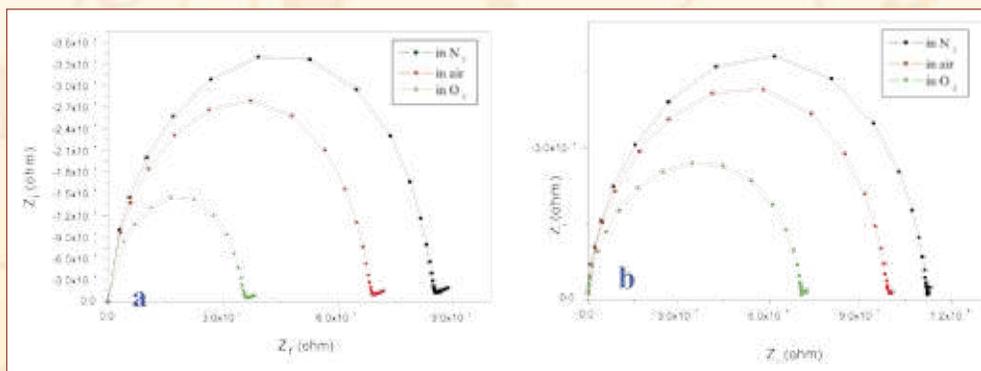
Selected area electron diffraction (SAED) patterns showed highly ordered diffraction maxima with characteristic weak diffraction spots of the pyrochlore structure for (a) Ca_{0.6}Y_{1.33}Zr_{1.33}Ta_{0.33}O₇ (C2YZT2) and bright diffraction maxima arranged in a ring pattern of the fluorite structure for (b) Ca_{0.29}Y_{1.71}Zr_{1.71}Ta_{0.29}O₇ (CY6Z6T).

This structural transformation in the present system is attributed to the lowering of the average cation radius ratio, r_A/r_B as a result of progressive and simultaneous substitution of larger cation Ca^{2+} for Y^{3+} at A sites and smaller cation Ta^{5+} for Zr^{4+} at B sites. Raman spectroscopy and TEM analysis corroborated the XRD results.

X-ray Diffractometer: XRD facilities available in the laboratory were extended to different divisions of the Institute and outside agencies. A new PANalytical X'Pert Pro X-ray diffractometer was installed. Necessary expertise in the analysis and interpretation of the powder diffraction pattern was built up.

Oxide ion conductivity and relaxation in CaREZrNbO_7 (RE= La, Nd, Sm, Gd, and Y) system

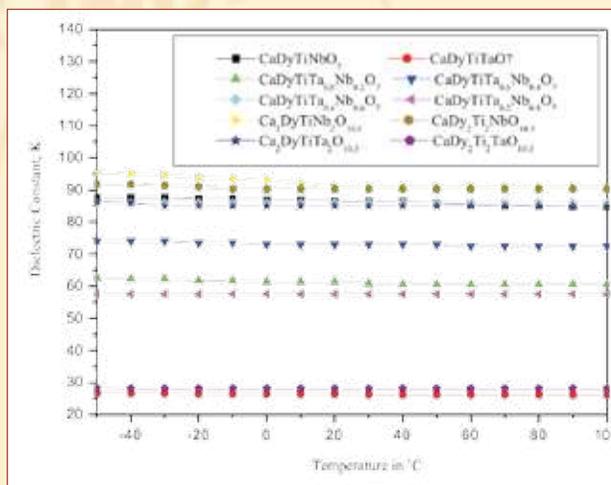
CaREZrNbO_7 (RE = La, Nd, Sm, Gd and Y) system changed from fluorite (F)-type to pyrochlore (P)-type structure when the ionic radius ratios, $r(\text{Ca}^{2+}\text{-RE}^{3+})/r(\text{Zr}^{4+}\text{-Nb}^{5+})_{\text{av}}$ were larger than 1.34. The ionic conductivity of CaREZrNbO_7 (RE = La, Nd, Sm, Gd and Y) system showed the maximum at the boundary between the F- and P-type phases. Among the prepared compounds, CaGdZrNbO_7 showed the highest ionic conductivity of 9.47×10^{-3} S/cm at 750°C which was about twice as high as that observed in $\text{Gd}_2\text{Zr}_2\text{O}_7$ (4.2×10^{-3} S/cm at 800°C).



Typical impedance plots for (a) CaGdZrNbO_7 and (b) CaLaZrNbO_7 in air, O_2 , and N_2 atmospheres at 550°C .

Low temperature coefficient dielectric materials

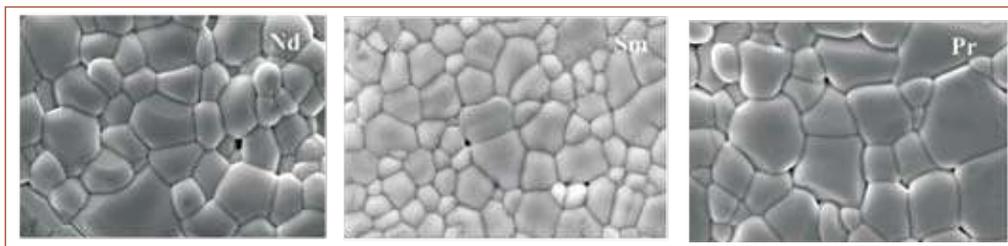
Pyrochlore based Oxides with small temperature coefficient of dielectric constant (TCK) in Ca-RE-Ti-M-O (RE = Sm or Dy; M = Nb or Ta) system were reported. The 1 MHz dielectric constants of these oxides varied from 26 to 102.



Variation of dielectric constant (K) with frequency for various compositions in the Ca-Dy-Ti-Nb-Ta-O system.



The temperature coefficient of dielectric constant (TCK) in the vicinity of room temperature (20°C) dramatically decreased, from more than -200 for CaRETiMO₇ to less than -3 ppm/°C in the solid solutions of CaRETiNbO₇-CaRETiTaO₇ phases.



Typical sintered microstructures of PbRETiTaO₇ ceramics.

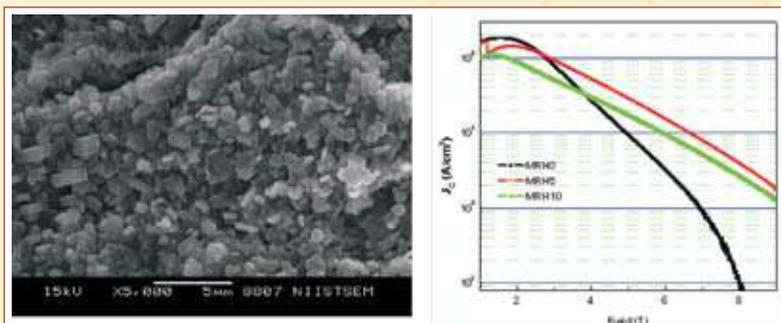
A series of pyrochlore type oxides, PbRETiTaO₇ (RE = Y, La, Nd, Sm, Gd, or Dy) having low temperature coefficient dielectric constant were investigated for the first time. The 1 MHz dielectric constants were in the range 43-99 and the temperature coefficient of dielectric constant over the temperature range 30-100°C was negative and low in the range -72 to -342 ppm/°C. The sintered microstructure showed well formed grains without much porosity.

MATERIALS FOR MAGNETIC & ELECTRICAL APPLICATIONS

Development of long length multifilamentary MgB₂, superconducting wires and tapes for fusion grade magnets and current leads

The recent discovery of superconductivity in MgB₂ with the highest superconducting transition temperature ($T_c = 39$ K) ever reported for an intermetallic compound has drastically changed the applied superconductivity prospects. Besides the high T_c , MgB₂ has transparent grain boundaries, large coherence length, low anisotropy, high J_c ($>10^5$ A/cm² at 4.2 K) and H_{c2} (>30 T at 4.2 K) with a great scope for further improvement in the coming years. MgB₂ is considered to be the most potential superconductor for the next generation high field magnets and a strong competitor for the currently used NbTi and Nb₃Sn and suited for operation around 20 K using cryocoolers with reduced production and operation costs.

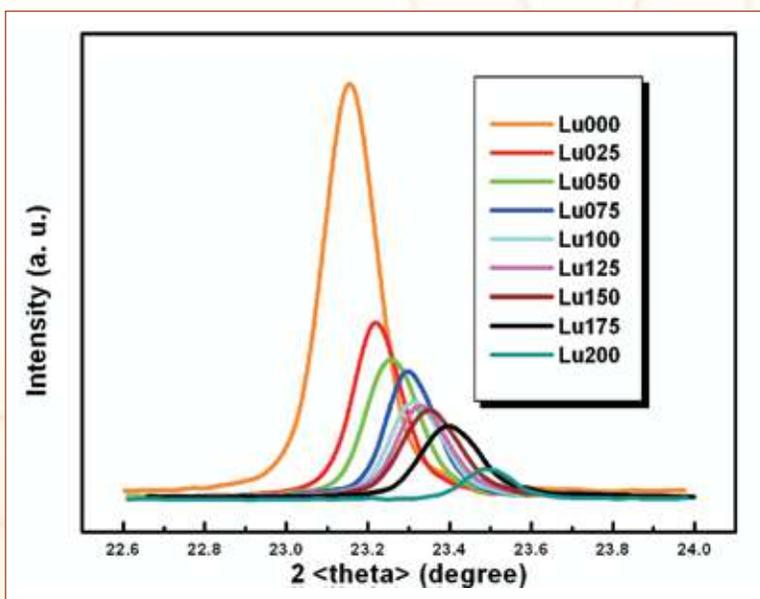
In continuation to the successful feasibility of preparation of MgB₂, the Institute has taken up two major projects funded by BRNS and National Fusion Programme to develop MgB₂ based superconducting wires for different applications. The projects are being implemented in collaboration with RRCAT, Indore, IPR, Gandhinagar and JNCASR, Bangalore. As a part of the targets of the first year, it has been possible to develop MgB₂ based bulk superconductors with properties at par with international standards ($T_c = 38.5$ K, $J_c = 10^6$ A/cm² at 5 K and $H_{irr} = 9$ T).



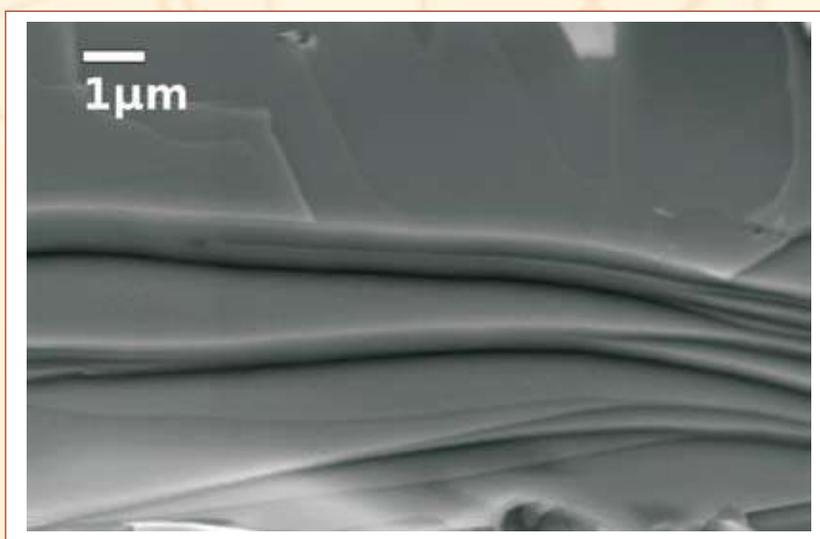
SEM image of pure MgB₂ superconductor showing faceted hexagonal grains (left) and variation of critical current density of pure (MRH0) and burned rice husk doped (MRH5 and MRH10) MgB₂ samples with respect to magnetic field at 5 K. The doped samples exhibit excellent field withstanding capability (right).

Scaling of vortex-liquid resistivity in rare earth modified (Bi, Pb) – 2212 superconductors

The vortex-liquid resistivity close to the vortex-glass to liquid transition region in a series of high T_c superconductors modified by rare earth substitution at different sites has been investigated. The investigation has enabled to find out the influence of the various rare earth atoms on the magneto-resistive transition, glass transition temperature (T_g), magnetic field dependent activation energy $U_o(B)$ and the field and temperature dependent activation energy $U_o(B,T)$ in the superconductor.



Systematic increase in peak position and decrease in peak intensity of an XRD peak (008) of Lu doped (Bi, Pb)-2212 superconductor with respect to Lu content showing a contraction of c-lattice parameter and decrease of texture.



SEM image of clean large flaky grains of Lu doped (Bi, Pb)-2212 superconductor

It has been possible to identify and develop novel superconductors in (Bi, Pb)–2212 system having much higher T_c , J_c , and $J_c(H)$ properties by the substitution La, Dy and Eu.

Carrier induced metal-insulator transition in high T_c superconductors

The high T_c cuprates exhibit a generic phase behaviour as a function of hole density ranging from an antiferromagnetic insulator at zero doping to a metallic Fermi liquid at high doping with the



appearance of superconductivity at intermediate doping levels. The hole doping is achieved by different cationic substitutions at different sites which lead to change in carrier concentration and increase in disorder. In the present work a detailed study on the effects of rare earth (Pr, Y and Sm) substitution at different sites of (Bi, Pb)–2212 superconductor on metal-insulator transition (MIT), crystal structure and transport and superconducting properties were carried out. The results led to the identification of conduction mechanism in several compositions exhibiting MIT.

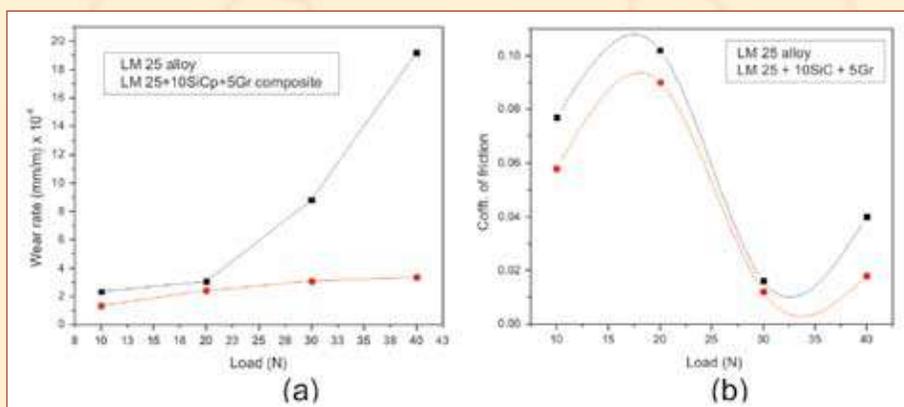
Development of high magneto caloric effect materials for magnetic refrigeration applications

Magnetic Refrigeration is being viewed as one of the most important and exciting applications of magnetic materials today. This technology can be used for cryogenic applications at a very wide range of temperatures. The most crucial ingredient behind a magnetic refrigerator is a magnetic material which possesses large magnetocaloric effect (MCE). For application purposes, one has to use giant MCE materials which show large MCE at moderately low magnetic fields so that this technology becomes economically viable. Though a lot of work has been done on intermetallic systems, recently, there are a few reports available which report considerable MCE in certain magnetic ceramics and nano structured materials. Particularly, the observation of giant magnetoresistance in many such ceramic materials has prompted for an early investigation for MCE also, in these materials. Like magnetoresistance, MCE is also associated with a change in the applied magnetic field. An added advantage with these ceramic materials is the well-established process routes, which allows a fine control of the physical properties. The group has developed the following materials with excellent magneto caloric properties: (i) Garnets [R₃Fe₅O₁₂-based] (ii) Perovskites [RMO₃-based] and (iii) Manganites [LaMnO₃-based], MCE of these materials along with physical and microstructural characterizations were done.

LIGHT METALS ALLOYS & COMPOSITES

Studies on tribological characteristics of Al-SiC-Graphite hybrid metal matrix composites

The wear characteristics of Al-7.5Si-0.3Mg-10%SiC-5%Graphite hybrid composite synthesized by liquid metallurgy technique were studied in detail. The dry sliding wear tests have been carried out using pin-on-disc equipment by varying the nominal applied load and sliding distance. The comparison of wear rates of the base alloy and the composite at different nominal loads showed an increase in wear rate with increase in load.



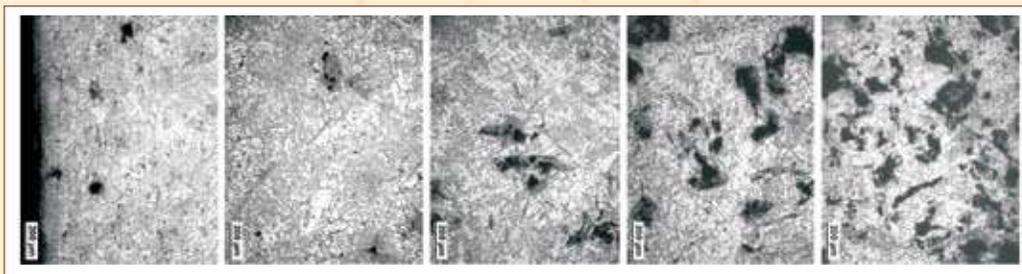
The wear mechanism for the composite remained the same through out for different loads, whereas it changed from mild wear to severe wear for the alloy at an applied load of 20N. The coefficient of friction for alloy and composite did not show any normal pattern, however the composite showed lower coefficient of friction than the base alloy at any applied load. The wear behaviour with respect to sliding distance appeared to be similar for both the alloy and the composite as that observed in the case of varying load.

Development of high strength aluminium alloys and processes for engineering components

The principal reason for use of aluminium in automobiles is to reduce weight as part of the overall goal to improve fuel efficiencies and reduce vehicle emissions. The objective of this project is to develop a high strength cast aluminium alloy for engineering applications and to develop liquid die forging/ squeeze casting process for producing high integrity automobile components such as connecting rod. The specifications fixed for the high strength Al alloy for producing connecting rod are UTS > 400 MPa, elongation: 8% and hardness > 100 BHN. Based on literature survey, an Al-Si-Cu alloy (319) was selected for developing the high strength cast Al alloy. The typical mechanical properties for permanent mould castings of this alloy in T6 condition are UTS: 280 MPa, elongation: 3.0 % and hardness: 95 BHN. Several attempts have been reported to improve the mechanical properties of this alloy including minor alloying additions. Hardening during ageing occurs by a cooperative precipitation of Al_2Cu and Mg_2Si phases in this type of alloys. In Mg containing alloys, considerable enhancement in UTS is observed after heat treatment of the alloys to T6 condition along with a significant decrease in ductility. The ductility is proposed to be increased due to the microstructural refinement that can be obtained by squeeze casting. In order to study the effect of Mg on the mechanical properties of 319 alloy, varying amounts of Mg (0 to 0.45 %) were added to the base alloy, cast in permanent moulds, solution heat treated at 500°C for 8 hours, quenched in water at 80°C and subjected to ageing at 150°C for 5 hours. The Mg free base alloy gave values of UTS: 330-340 MPa and elongation: 6-10 % in the T6 condition, compared to the standard values of UTS: 280 MPa and elongation: 3 % for this alloy. The evaluation of the mechanical properties of the various Mg containing alloys is in progress.

Fabrication and characterization of graphite and primary silicon reinforced hybrid functionally graded aluminium composites

Functionally Graded Materials (FGM) exhibits gradual transitions in the microstructure and/or the composition in a specific direction leading to variation in the functional performance of a engineering component. *Ex-situ* Graphite and *in-situ* primary silicon reinforced hybrid functionally graded Aluminium composites have been synthesised by centrifugal casting using the LM30 matrix alloy and 60 μm graphite particles.



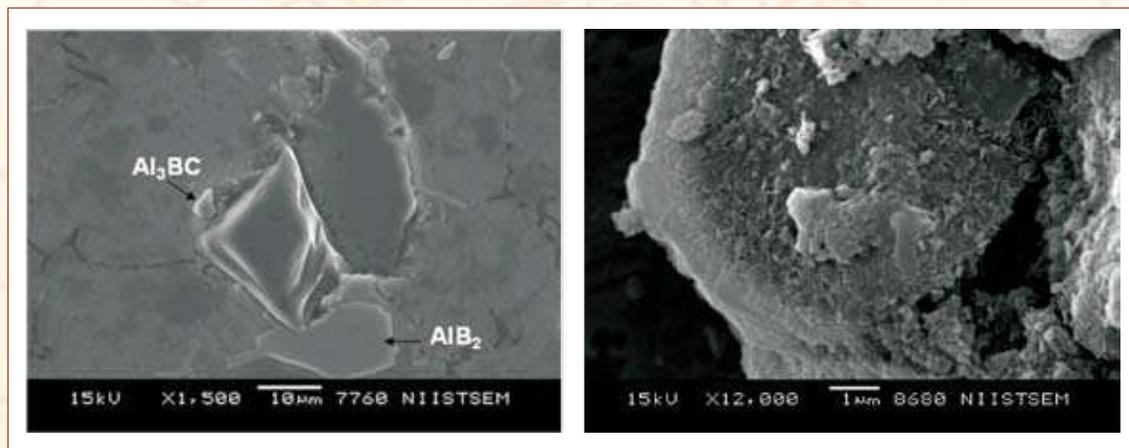
Microstructures of Graphite and primary silicon reinforced hybrid FGM from outer edge of the casting



Both the graphite and primary silicon hybrid particles segregate towards the inner periphery, since both the graphite (2 g/cc) and primary silicon (2.33 g/cc) possess lower density than the alloy. The hard particle reinforcement by primary silicon has improved the strength and abrasive wear resistance and soft particle reinforcement by graphite improved the adhesive wear resistance and acted as solid lubricant.

Interfacial characteristics of boron carbide reinforced aluminium matrix composites

Boron carbide reinforced aluminium matrix composites were synthesised using liquid metal stir casting method. Evaluation of microstructure by SEM and extracted particle by XRD showed the formation of interfacial reaction products such as AlB_2 , Al_4C_3 and small amounts of Al_3BC ternary carbides. During processing of composites by liquid metal stir casting the matrix-reinforcement interface will be in the dynamic condition and the interfacial reaction products are observed both in the matrix and near the interfacial region.



(a) SEM micrographs of (a) Al(6061)-B4C MMC and (b) extracted B4C particle showing interfacial reaction products on the surface.

Processing of ultrafine alumina particle reinforced aluminium matrix composites

The properties of ultrafine particle dispersed metal matrix are better compared to those of micron size particles reinforced composites. However, the challenge is on the dispersion of ultrafine and nanosize particles into the liquid metals. Suitable reinforcement selection, better surface treatment to reinforcement, optimized processing conditions and use of selective secondary processing techniques can resolve this problem. Surface treated ultrafine alumina particles of 360 nm average particle size was dispersed into 6061 aluminium alloy by liquid metal stir casting techniques. The microstructural characteristics showed good distribution of particles and the hardness of the composites were higher than the matrix alloy as well as micron size particle reinforced composite.

Moulding and sand casting of clutch housing and piston using Al-SiC composites for battle tanks

An exploratory project on the 'Development of Housing First Gear and Piston using Aluminum Matrix Composites for battle tank applications' has been initiated. Primary processing of silicon carbide reinforced 356 Aluminium MMC have been carried out using liquid metal stir casting.



(a) Al MMC clutch housing

(b) Al MMC piston

Sand moulds were fabricated using CO_2 moulding technique and the re-melted Al MMC was poured into the preheated moulds. The figures show the raw casting of Al MMC clutch housing and piston. The evaluation of its characteristics and further machining are in progress.

Creep behaviour of AZ91 alloy

AZ91 is one of the commercial alloys used in automobiles. This alloy offers excellent mechanical and foundry properties. However, the major problem is with its high temperature properties. The effect of different alloying additions on the creep behavior of AZ91 alloy was investigated. Si and Sb were added to AZ91 and their effect on the creep properties at 150°C and 200°C and 50 MPa were studied. The results indicated that alloying additions greatly improved the creep performance of AZ91 at 150°C . Even though not much change in the creep rate was observed, significant improvement in the creep life of AZ91 alloy was noticed with the additions. However similar improvement was not observed at 200°C .

Grain refinement studies on AZ91 Magnesium alloy

AZ91 magnesium alloy can effectively be grain refined using carbon inoculation technique in which carbon is incorporated into the melt through different sources. In the present work, different percentages of C_2Cl_6 , charcoal powder and graphite powder were added and its efficiency on the grain refinement of AZ91 alloy was studied. The results indicated that for an optimum amount of different additions, the grain size of AZ91 alloy was reduced from $100\ \mu\text{m}$ to 20, 16, $14\ \mu\text{m}$ with C_2Cl_6 (0.3%), charcoal powder (0.2%) and graphite powder (0.15%) respectively. The grain refinement efficiency of all the additions was similar. Different amount of boron in the form of Al-4B master alloy was added to AZ91 alloy and its grain refinement ability was also studied. A maximum grain refinement of $100\ \mu\text{m}$ to $30\ \mu\text{m}$ was accomplished with 0.032 wt% boron addition. This was attributed to the presence of AlB_2 particles, which act as a heterogeneous nucleation sites for the magnesium grains.

Ageing studies on AZ91 Magnesium alloy

AZ91 magnesium alloy is an age hardenable alloy. During ageing the aluminium in supersaturated matrix precipitates out as $\text{Mg}_{17}\text{Al}_{12}$ in two forms: coarse discontinuous (DP) and fine continuous (CP) precipitates. It is well established that CP is responsible for the age hardening whereas DP is detrimental to mechanical properties. An attempt has been made to suppress the DP formation during ageing of AZ91 alloy through the addition of different elements such as Sb, Si and Sr. The results indicated

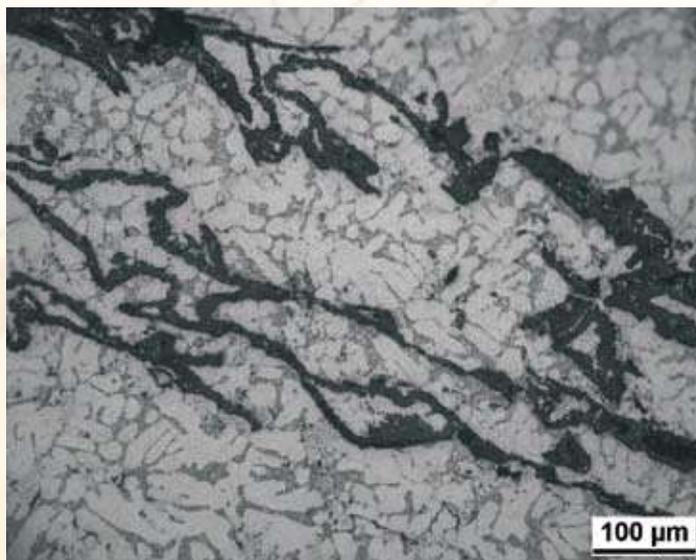


that these additions greatly reduced the DP during ageing at 200°C. It was found that these additions basically introduced thermally stable intermetallics in the microstructure which lead to the formation of high dislocation densities around it due to the difference in co-efficient of thermal expansion between the intermetallics and the matrix. These dislocations acted as a nucleation site for the CP and hence suppressed the formation of DP.

Processing and characterization of in-situ Al-7Si-0.3Mg (356)-4Mg-AlN composite

Al-AlN composites have been synthesized at a constant temperature of 880°C by varying the alloy systems and gas flow rates. Individual micron level particles with a volume fraction of 2% were obtained with pure Al at low reaction time. However, higher gas flow rates and presence of Mg and Si as alloying elements enhanced the nitridation process and a network of agglomerated AlN particles with range of particle sizes (mainly nano size) have been obtained.

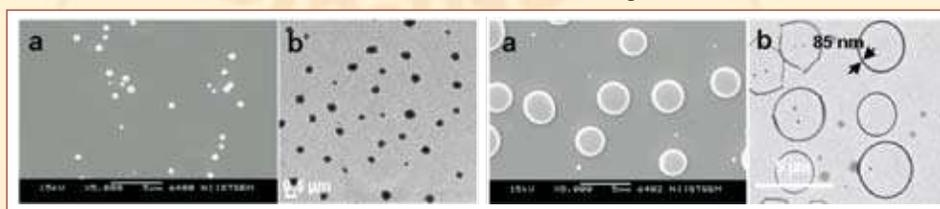
CTE measurement showed good agreement with the reported values in the literature. Further work in obtaining uniformly distributed fine AlN particles and finding the exact mechanism of nitridation with the presence of alloying elements are in progress.



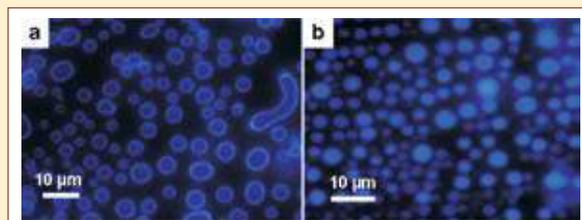
Optical micrograph of the in-situ Al-7Si-0.3Mg (356)-4Mg-AlN composite after 4 hours reaction (gas flow rate: 0.4lpm)

Micro-vesicles from polymer-clay nanocomposite

Polystyrene-clay nanocomposite particles (PCN) exhibiting solvent-assisted self-assembling properties have been synthesized by *in situ* intercalative polymerization using a novel POSS-modified organoclay. A dilute solution of the particle in THF when cast on a glass plate followed by drying of the solvent yielded micro-vesicles of 2.5-3.5 micrometer with average membrane thickness of 85 nanometer.



(a) SEM and (b) TEM images of PCN particles (a) SEM and (b) TEM images of Micro-vesicles



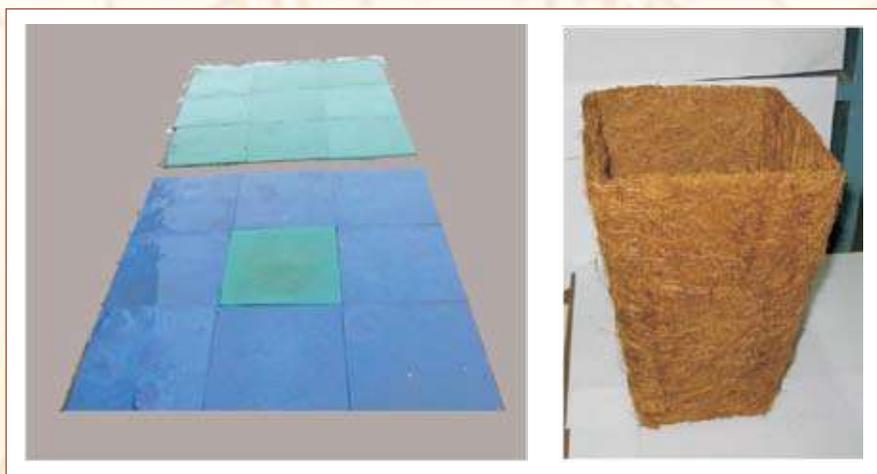
Fluorescent micrographs of guest-encapsulated micro-vesicles
(a) Fluorescent probe ANS and (b) Oil containing ANS



Guest-encapsulated vesicles were obtained by preparing them from solution containing the guest molecule. PCN was thermally stable over 250° C and the vesicle was impermeable to water, permeable to alcohol and unstable in low-dielectric solvents such as toluene. PCN vesicle may find use as micro-storage/reactor system and micro-encapsulation/delivery applications in cosmetics, paints etc.

Development of coir - rubber composite products

The project aims at development of cost-effective 'eco-friendly' products based on renewable natural resources such as coir, natural rubber and cashew nut shell liquid (CNSL) for consumer/industrial applications, based on coir – rubber composites. Pre-formed 'coir sheets' were prepared by bonding short coir fibre with either PCNSL based contact adhesive or natural rubber latex, the technique which was reported last year was scaled up to 20 kg level. Roof tiles made out of such composites were bonded to a concrete base using PCNSL modified rubber based contact adhesive.



Roof tiles based on coir – rubber composites. Garden pot based on coir-sheet

Very good 'weather resistance' was observed for the bonded tiles. Pre-formed coir sheets were also used for preparing 'garden pots' for horticultural applications. These were also found to be eco-friendly and resistant to weather.

MATERIALS FROM BEACH SAND MINERALS

Scientific and technical services rendered to M/s. CMRL, Always, during post technology transfer period

The Institute has transferred a technology for the production of synthetic rutile from ilmenite to Cochin Minerals and Rutile Limited (CMRL). Scientific and technical assistance were rendered to CMRL for executing many of the preliminary requirements for setting up of the commercial plant. Laboratory scale experiments were also carried out to further fine tune process conditions in order to maximize the efficiency and hence economy of the process. These include: investigation on microwave processing of ilmenite and its intermediate products and harness the advantages accrued thereon in the subsequent processing such as metallization, rusting and acid leaching. Preliminary investigations revealed that pre treated ilmenite by microwave heating showed favorable process conditions and better kinetics in subsequent chemical processing. Optimization of the processing conditions is in progress.



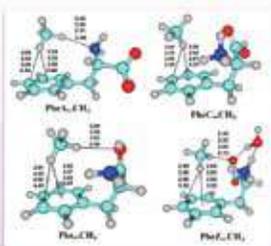
Preparation of Aluminium–Silicon alloys from sillimanite through plasma technology:

Aluminium – Silicon master alloys are extensively used in automobile industries owing to their light weight and excellent castability into required shape. Investigations were carried out for the preparation of aluminium–silicon master alloy directly from sillimanite mineral through plasma assisted reduction. Efforts were continued in the optimization of process parameters such as reduction conditions and fine tuning of plasma variables for the maximum alloy recovery with better consolidation. It was observed that DC plasma in transferred mode in 30-40V and 300-500 A resulted in better consolidation of the alloy in the reduction mixture. Excessive evaporation of silicon and aluminium metal was observed during the reduction experiments carried out at longer duration of plasma heating and at high voltage. Addition of small quantity of granular graphite on the top of the reduction mixture was found required for imparting conductivity of the charge and onset of stable plasma. Addition of aluminium melting flux into the charge showed indication of better alloy separation. The alloy nodules separated from the reduction mass were subjected to chemical analysis and physical characterization such as XRD. XRD data of the alloy samples revealed the presence of aluminum and silicon and traces of carbide impurities. Process conditions, flux characteristics required for the reduction of carbide impurities are being optimized.

Characterization of Nickel powders through surface area analysis:

A few samples nickel powders supplied by Vikram Sarabhai Space Centre, Department of Space, Trivandrum were characterized by surface area analysis. The powder samples were initially heated at 300 °C to drive out moisture and adsorbed gases. After degasification the samples were analysed for their surface area using BET surface area analyzer in 3 point mode.





PROCESS ENGINEERING AND ENVIRONMENTAL TECHNOLOGY

HIGHLIGHTS

- ◆ Anaerobic leach bed based technology for the production of white pepper transferred to six more clients.
- ◆ A full scale zero discharge treatment plant for 200 tpd rice mill designed and installed at Kalady Rice Millers Consortium based on the pilot plant trials.
- ◆ UNIDO supported project aimed towards the implementation of Stockholm Convention on persistent organic pollutants in India launched. Representative samples collected from the south Indian states.
- ◆ Modified reverse flow natural convection drier reduced the moisture content of fresh ground nut to 6-7% from initial 45-46% in 30-36 hours.



This Division strives to achieve generation and application of knowledge by interfacing science and engineering with computational modelling leading to processes, technologies, models, software products, high impact publications, patents and also technology up-gradation for industries and rural applications. The four distinct sections working with very clear objectives are (i) **Environmental Technology Section**, (ii) **Computational Modelling & Simulation Section** (iii) **Chemical and Process Engineering Section**, and (iv) **Dioxin Research Section**.

ENVIRONMENTAL TECHNOLOGY

Anaerobic leach bed technology for treatment of solid wastes

The management of Municipal Solid Wastes (MSW) is the single biggest issue engaging the urban bodies in Kerala and in other parts of India, claiming up to 70% of the expenditure. Most towns merely collect MSW and dispose it in uncontrolled dumps. As a result of public protests, uncontrolled dumping is no longer an acceptable option in Kerala and MSW treatment is planned for most municipalities. "Windrow composting" is usually chosen for the MSW treatment. Windrow composting is an aerobic biological treatment system for stabilizing putrescent wastes. Unfortunately, this method is not successful in Kerala due to high temperature, high moisture and fast degrading material content which results in extreme odour, fly and pest nuisance, terrible occupational health environment.

These limitations can be overcome by using anaerobic digestion for stabilization of putrescible fraction of MSW. The anaerobic leach bed reactor (ALBR) allows digestion of unsorted MSW containing non-degradable materials such as plastic. In the ALBR coarsely shredded MSW is contacted with a leach liquor circulated through a UASB reactor. Volatile fatty acids (VFA) are formed during rapid decay of MSW is removed with the leach liquor and converted to Biogas in a UASB reactor.

Laboratory tests showed that 5 days ALBR retention time is sufficient for complete hydrolysis of putrescibles. The maximum rate of generation of VFA from 1 kg unsorted MSW was found 200 m.moles per day for average MSW containing 25% food waste. If the percentage of food waste increases, 200 mmoles/d increase can be expected for every additional 25% food waste fraction. Total biogas generation was 40 l / kg(wet) unsorted MSW and the maximum rate of gas production is 5 l / day per kg MSW. If food waste is more than 25 %, for each additional food fraction of 25% gives biogas additionally at the rate of 40 l / kg MSW. Alkalinity and pH of the anaerobic reactor effluent was well within the allowable concentration for further leachate generation in ALBR. The same liquor can be re-circulated batch after batch with no toxicity to UASB observed even with exposure to air during leaching. No chemicals are required for pH control. Volume of waste reduced to 50 % after 5 day's leaching. If the quantity of food waste is of 50 %, then the volume reduction will be in the order of 65% after 5 days.

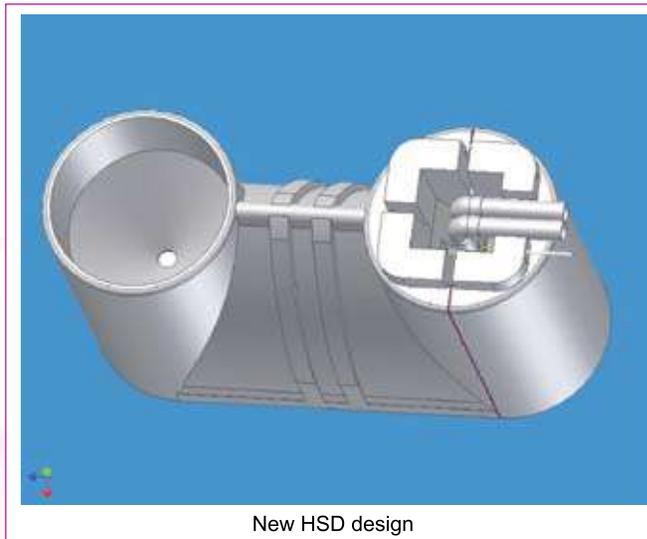
Based on these results at 5 kg level, a 5 tpd MSW leach bed pilot plant was approved by the Ministry for Renewable Energy. A site has been identified by the Corporation of Thiruvananthapuram for installation of the plant. The work on design of the plant is underway. The conceptual design of the ALBR is crucial to the success of the process. Unlike in the laboratory studies, design concepts need to be developed for loading, unloading and movement of MSW within the reactor, which are quite difficult engineering tasks given the heterogeneity and characteristics of MSW.

Household sewage treatment device

The household sewage treatment device (HSD) is an advanced septic tank enabling better treatment of sewage. The device comprises a digester, settler chamber, a biofilm tank containing media for further anaerobic treatment of settler overflow. Gas collection is provided from both digester and tank. The material of construction is polyethylene and is designed for mass production by rotational molding. The first prototype HSD was installed in for the treatment of sewage

from a flat in NIIST Staff Quarters. There was difficulty in start-up and acidification if combined black and grey water were treated in the digester chamber. It was found that better treatment efficiency is obtained by separate black water treatment in digester while grey water is directly sent to biofilm tank. Mathematical modeling studies supported the observation.

The HSD design has been modified. The new design makes it less expensive and easier to manufacture and transport. The design has new features that allow gas collection and storage and a final settling chamber. The new design is scaleable without difficulty to larger sizes.



Zero discharge process for paddy parboiling

The modern hot soak parboiling process requires about 1 tonne of water per tonne of paddy processed and about 0.8 t soak water /t paddy is discharged as effluent. This contains 2500-4000 mg/l COD derived from sugars, amino nitrogen and total phenolic compounds which putrefies quickly. Biological treatment removes sufficient COD but results in coloured effluent by the formation of polyphenolic compounds, which are difficult to degrade.

A zero-discharge process was developed for parboiled rice mills and

pilot plant studies were carried out at Kalady Rice Millers Consortium Pvt Ltd., (KRMC) in Mattoor-Kalady. The pilot plant comprises 2 tonne/batch parboiling tank, heat exchanger and UASB reactor. The specially designed UASB can store treated water without air contact, for reuse. The UASB reactor produces 1.5 m³ biogas per m³ effluent. This corresponds to 3 kg COD removal per litre of effluent, which is sufficient for recycle. The effluent was recycled for parboiling and 12 successive batches of paddy were evaluated. Rice quality (taste, odour, appearance) between the successive batches was





unaffected in blind tests. UASB loading rate up to 8 kg COD/m³ active-volume/d was obtained in the pilot plant trials.

A full scale zero discharge treatment plant for 200 tpd rice mill was designed by the Institute on the basis of pilot plant tests. It has been installed and commissioned by Kalady Rice Millers Consortium Pvt Ltd. The anaerobic reactor is fully functional. Further tests on anaerobic treated effluent have shown that ion-exchange was able to effectively decolourise the effluent. The ion exchange resin can be regenerated using brine.

Fish meal factory odour control

Fish meal is made from low value bony fishes such as sardines and anchovies. In the modern fish meal factory, fish is cooked in continuous cookers, and pressed to extract oil and liquid protein and dried to produce sterilized fish meal. However, the process causes extreme odour emissions. The gas biofilter technology of NIIST was successfully installed now in 2 fish meal factories for complete control of odour.



Fish meal factory odour control biofilter under construction

Zero discharge treatment for clay processing

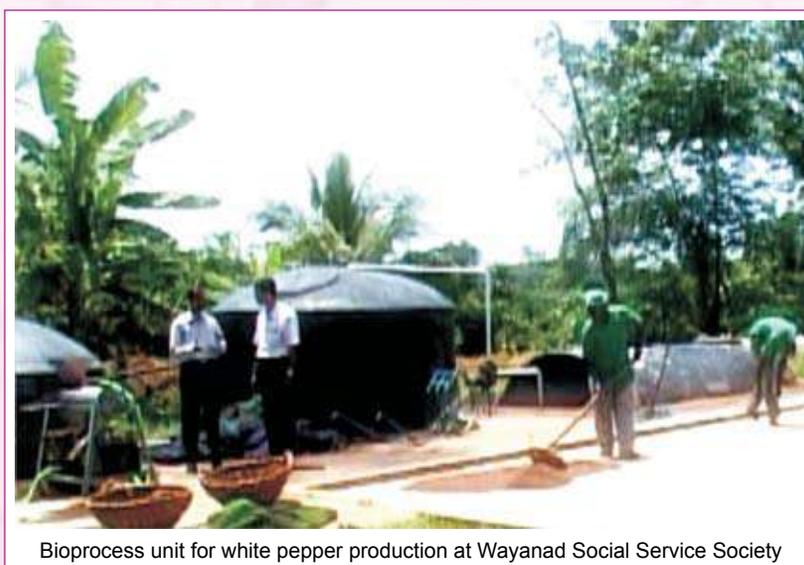
During the recently conducted EIA study on the china clay pilot processing plant to be set up by M/s. Ashapura Minechem Private Limited, Mumbai near KINFRA, Thiruvananthapuram, it was observed that around 3-5m³ wastewater per ton of product is usually discharged from clay processing industries. The run-off sample usually is contaminated with iron in +3 oxidation state which contributes to light yellow - to - pink shade to the kaolin.

A laboratory scale process was designed for the biological treatment of wastewater which involved the conversion of some of its ferrous iron content to ferric iron which could be separated out by post precipitation techniques. The process employs a Reverse Fluidized Loop Reactor (RFLR) and is catalyzed by autoinduced microorganisms grown under suitable media which are fixed on floating carrier-particles. Synthetic water with similar composition to that of clay processing effluent was fed into the reactor under an optimum steady supply of oxygen. pH requirement of the bacteria is around 2.8 and a temperature range 30-32°C. Microbial oxidation employing RFLR gave a maximum conversion of 87% Fe(II) to Fe(III) at a load rate of 6.2 g/day. Further study is in progress.

White pepper production

Decorticated pepper (*Piper nigrum* L.) is known as the white pepper which has a very large international market and fetches higher price. It is produced by removing the outer skin of fresh or dried black pepper. White pepper berries are light yellow grayish in colour; nearly globular in shape; around 5mm or less in diameter, smooth, striated with small protuberance at the base. Current demand of the white pepper is nearly one and a half lakh ton per annum and India contributes very little to this value added pepper. The traditional method followed is retting to loosen the skin which is feasible only with fresh pepper. Fresh pepper is available only during harvest season and hence white pepper production is limited.

The anaerobic leach bed technology developed for coir retting and MSW treatment was efficiently applied for the production of white pepper. This clean bioprocess enables decortication of both black and fresh pepper through enzymatic degradation of pectin layers in the outer mesocarp (middle layers of skin) that cement between the outer skin (epicarp) and pepper kernel. In this process the pectinolytic enzymes are designed to produce in-situ by coupling with a bioreactor which contains anaerobic microorganisms. This clean bioprocess enables production of better quality white pepper in short time and at all scales, and through out the year. The process completes in 2 (fresh pepper) to 4 days (dried black pepper). The degraded metabolites in the bioprocess of skin removal are converted to biogas energy and biomanure (skin waste) concomitantly, and become an environmental friendly method of white pepper production.



Bioprocess unit for white pepper production at Wayanad Social Service Society

This bioprocess could be executed in the industrial system consisting of **pepper soak tanks** and **anaerobic reactor** containing the microbial community, wherein the soak liquor from the pepper soak tank is circulated through the anaerobic reactor. After 2 or 4 days the pepper is removed from the soak tank and passed through a cleaning machine for final washing prior to drying. This process has been licensed to several farmers and industries and is used for commercial production. The clean bioprocess enables production of quality white pepper to any extent.

Biodegradation of environmental pollutants

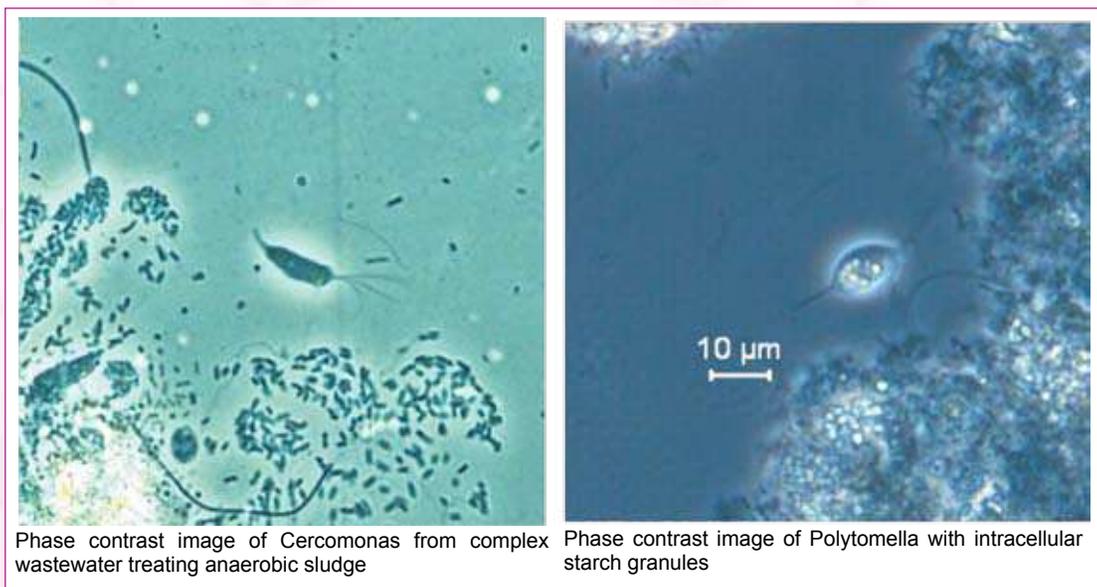
Bacterial degradation of triclosan an antimicrobial compound used in household products under aerobic and anaerobic/anoxic conditions was studied. A number of Triclosan tolerant bacteria have been isolated from environmental samples. Some of the bacteria with high degradation potential were



identified (through 16S rRNA gene sequence analysis) as *Sphingomonas sp.*, *Pseudomonas sp.* and *Nisseria sp.* Phylogenetic analysis of these organisms was also done.

Perchlorate is an environmental pollutant identified in recent times. It is mainly used as a fuel additive in rockets, missiles, explosives and for certain industrial activities. Anaerobic mixed microbial culture developed reduced perchlorate (ClO_4^-) completely to chloride (Cl^-). Batch and fed batch studies were conducted to determine the effect of various environmental variables on perchlorate removal. Surface modified, local and indigenous clay based adsorbent was developed and kinetic studies were completed for perchlorate removal.

Involvement of protozoa in anaerobic degradation process



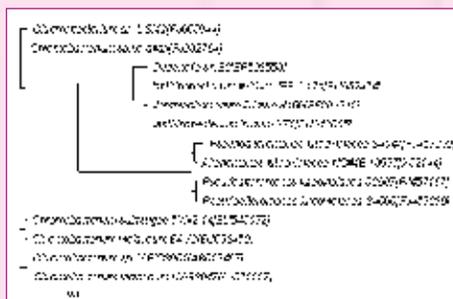
Phase contrast image of *Cercomonas* from complex wastewater treating anaerobic sludge

Phase contrast image of *Polytomella* with intracellular starch granules

The ecology and functional importance of higher trophic organisms such as protozoa in anaerobic systems is a research activity that originated in this laboratory. A number of new protozoa (ciliates and flagellates) were identified first time in wastewater treating bioreactor systems. Some of the ciliates like *Metopus sp.* improved suspended organic matter removal and simultaneously contributed to biogas production. Meanwhile, flagellates like *Polytomella sp.* identified in the perchlorate removing anaerobic sludge consumed acetate and synthesized starch granules intracellular.

Molecular identification and phylogenetic analysis of bacterial species

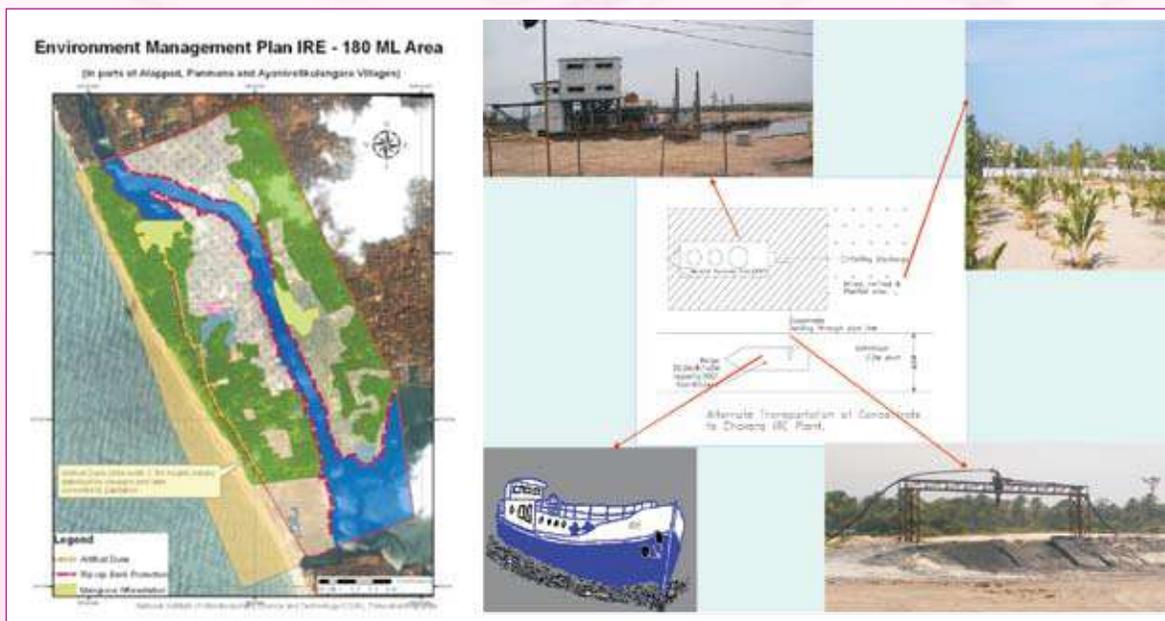
The Institute has developed the capability to carry out 16S rRNA based molecular identification, similarity search in gene bank and phylogenetic analysis of bacteria in engineered biological systems and environmental samples. This is useful in detailed examination of biological treatment systems.



NJ phylogram based on 16S rRNA gene sequences showing the phylogenetic position of a novel bacterium *Chromobacterium sp. keralian* with related organisms

EIA study for the proposed heavy mineral sand mining by Indian Rare Earths Ltd at Alappad, Panmana & Ayanivelikulangara, Kollam district

Impact of the proposed activity was predicted based on the field studies as well as desk research. Quantification of the impacts was carried out applying mathematical models. As dredge mining is a wet process, the significant aspects are emissions due to transportation and connected road congestion. The report looks into the viability of barge economics which appears to be feasible option for transporting mine concentrate using TS canal (NW3 water way) to IRE plant. The distance to IRE plant site is only 6.29 km as compared to 19 kms road distance. Rip Rap protection along the river banks and construction of groynes along the sea coast are recommended to prevent erosion. Another positive outcome of the proposed activity is that the mining out of sand and separation of heavy mineral concentrates eventually contributes to a reduction in the overall level of radiation in the environment which is a relief to the inhabitants in the area. The mined out area shall be suitably subjected to landscaping and formation of sand dunes. The rehabilitation & resettlement schemes were formulated as an outcome of the study. Post project monitoring to ensure that the mitigation measures planned function effectively during the entire period of the mining and reclamation were also highlighted in the draft report.



Regional EIA study in clay mining areas in Thiruvananthapuram district for Directorate of Mining & Geology, Government of Kerala

The objective of the study is to identify the environmental impacts on the area due to the prevalent mining activity for china clay. The study identifies the existing environmental and social conditions of 46 mines, deviation in the approved mine plan/ mine closure norms, determine the extent to which mining has contributed to actual and perceived environmental and social problems and suggest management plan and safeguards for clay mining activity. The major environmental issues in the area are depletion of ground water and dust emissions. These were studied in greater detail.





Field survey & site selection for the proposed berth based on environmental sensitivity of Pawas Bay for M/s Finolex Ltd, Ratnagiri

Marine ecology study was conducted for the proposed extension of jetty facility at Pawas Bay, Ratnagiri, Maharashtra. Detailed survey was conducted to establish the existing status of the marine water in and around the proposed project site. The study included data collection and analysis of physicochemical and biological characteristics of marine water and sediment samples. The outcome of the study helped the client to site the most environment friendly location of Jetty.

Analytical Services

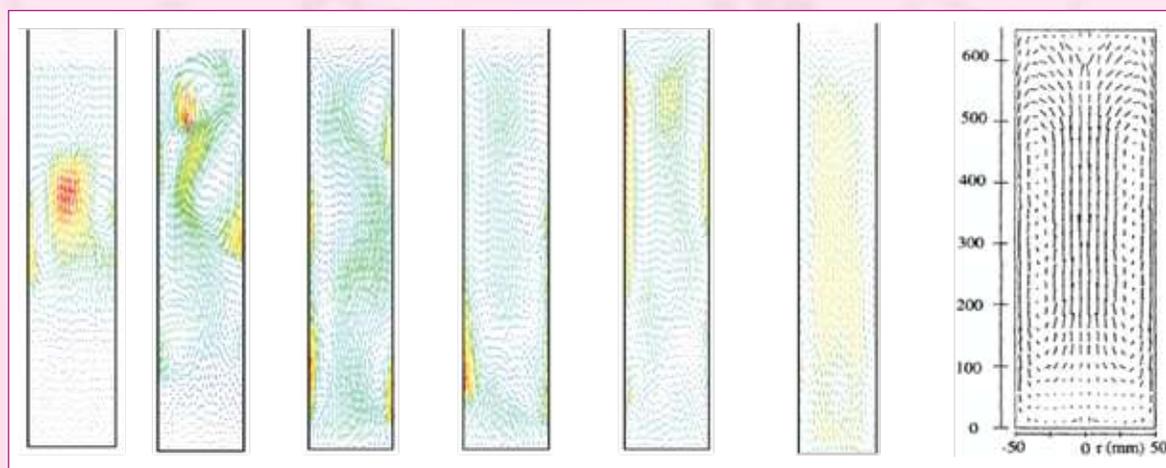
Analytical services for physicochemical and biological characterisation of surface water / ground water/ waste water/ industrial effluents carried out. Major clients were the city Hospitals, POABS readymix concrete, Thiruvananthapuram, Nuclear Power Corporation Ltd., Koodankulam, Tamil Nadu, Ashapura Minechem Ltd., Thiruvananthapuram and private individuals.

COMPUTATIONAL MODELLING AND SIMULATION

CFD simulation of multiphase flow reactors

Multiphase reactors are being widely used in chemical, biochemical, petrochemical, and pharmaceutical industries. The modeling studies were directed towards understanding the complex hydrodynamics of mechanically agitated reactors and fluidised bed reactors using multiphase CFD. The hydrodynamics of two phase (liquid-solid) fluidised bed reactors and mechanically agitated reactors were reported earlier. The present study focused on carrying out three phase (gas-liquid-solid) hydrodynamics in both these reactors. CFD Simulations were carried out using the commercial package ANSYS CFX-10. As a first step, the complex hydrodynamics of gas-liquid-solid fluidized bed and gas-liquid-solid stirred reactors with various types of impellers were simulated and validated with the experimental results reported in literature.

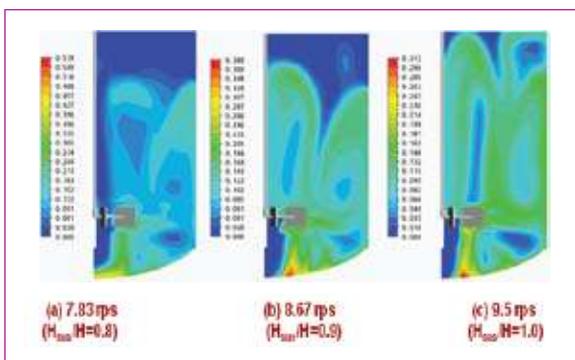
Solid motion in gas-liquid-solid fluidized beds



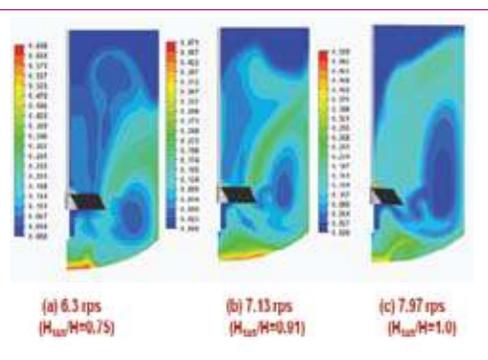
(a) 2S (b) 4S (c) 6S (d) 9S (e) 14S (f) Time average (g) Experiment
Instantaneous snapshots of axial solid velocity vectors for gas superficial velocity of 0.067 m/s and liquid superficial velocity of 0.065 m/s

Solid suspension in gas-liquid-solid stirred reactors

Ruston Turbine impeller



Pitched Blade Turbine



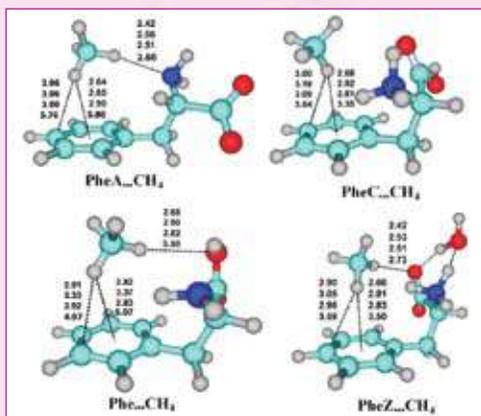
Agent-based simulation of immune system dynamics

An agent-based framework was developed using which one can define and track the behaviour of individual cells over time. This framework was used to implement an agent based model of the immune system. The major types of cells of the innate and adaptive immune system are represented along with parenchymal cells which get infected or become cancerous and activate the immune response. The dynamics of the immune response in different situations can be studied using this model. Using the framework, studies were conducted to elucidate how the immune system is able to eliminate or equilibrate slow growing cancers while fast growing cancers are able to escape the immune system. The strategies by which the Leishmania parasite escapes the immune system and how prolonged exposure to asbestose produces chronic inflammation were also simulated using the model.

Rational design of molecules and reactions

(a) Non-covalent Interactions in Proteins

A systematic theoretical study of $\text{CH}\dots\pi$, $\text{OH}\dots\pi$, $\text{NH}\dots\pi$, and cation $\dots\pi$ interactions has been done using complexes of phenylalanine in its cationic, anionic, neutral and zwitterionic forms with CH_4 , H_2O , NH_3 , and NH_4^+ . All noncovalent interactions were identified by the presence of bond critical points (bcps) of electron density ($\rho(\mathbf{r})$ and $\rho(\mathbf{r})$ showed linear relationship to the binding energies (E_{total}). The estimated E_{total} from supermolecule, fragmentation, and $\rho(\mathbf{r})$ approaches suggested that cation $\dots\pi$ interactions were in the range of 36 to 46 kcal/mol while $\text{OH}\dots\pi$, and $\text{NH}\dots\pi$ interactions have comparable strengths of 6 to 27 kcal/mol and $\text{CH}\dots\pi$ interactions were the weakest (0.62 to 2.55 kcal/mol) (*J. Comput. Chem.* **2009**, *30*, 1392-404).

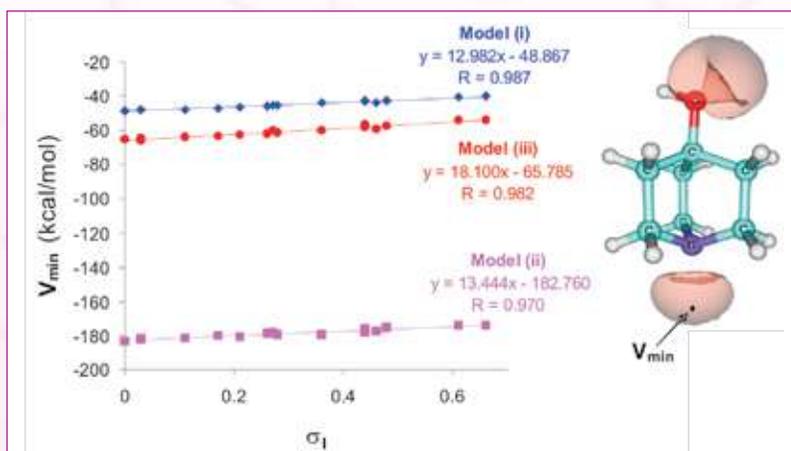


$\text{CH}\dots\pi$ interactions in the anionic (PheA), Cationic (PheC), neutral (Phe) and zwitterionic (PheZ) forms of phenylalanine.



(b) Inductive effect

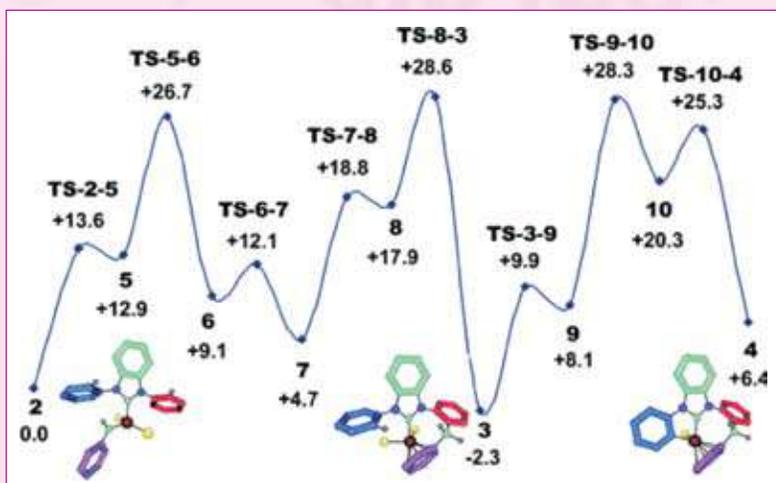
DFT computations were carried out for three type of model compounds, viz. (i) 4-substituted bicyclo[2.2.2]octane carboxylic acids, (ii) anions of 4-substituted bicyclo[2.2.2]octane carboxylic acids and (iii) 4-substituted quinuclidines to study the dependencies between molecular electrostatic potential minimum (V_{\min}) and the inductive substituent constant σ_I . All the three model systems showed excellent linear correlation between V_{\min} and σ_I . Thus V_{\min} offers a simple and efficient computational approach for the evaluation of inductive substituent constant. V_{\min} analysis of multiply substituted systems showed that the inductive effect follow an additivity rule. (*Phys. Chem. Chem. Phys.* **2008**, *10*, 6492 – 99)



Correlations of V_{\min} from model (i), (ii) and (iii) with inductive substituent constant σ_I .

(c) Homogeneous catalysis

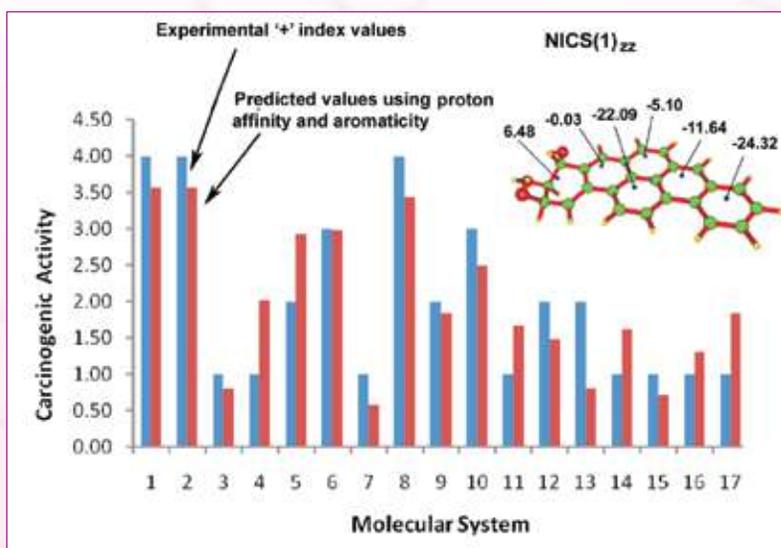
A mechanistic study was carried out to explore the structural and energetic features leading to the decomposition pathways of a Grubbs second-generation olefin metathesis catalyst using DFT. The theoretical results strongly suggest that the deactivation pathway initiates with the C-H activation rather than pericyclic cyclization suggested for the related Grubbs-Hoveyda catalyst system by Blechert *et al.* The flexibility of all three phenyl rings through their single bond connectivity plays a major role in the deactivation process, as it leads to C-H agostic interactions with the ruthenium center. Therefore, more efficient catalyst can be designed by controlling the deactivation pathway through the designing of NHCs with rigid substituents (*Organometallics*, **2008**, *27*, 4666–70).



Mechanism for the deactivation of Grubbs olefin metathesis catalyst. 2 is the active form of the catalyst.

(d) Computational study of the carcinogenic activity of polycyclic aromatic hydrocarbons

A comparative QSAR study was conducted for bay (bDE) and non-bay diol epoxides (nbDE) of polycyclic aromatic hydrocarbons (PAH) to understand the factors responsible for the increased carcinogenic activity of bay-region derivatives by mainly focusing on their molecular electrostatic potential (MESP) features, aromaticity, and proton affinity values. A QSAR approach using a multiple linear regression analysis of aromaticity and proton affinity strongly suggested that these quantities can be used as decisive descriptors for evaluating the carcinogenic activity of diol epoxide derivatives of PAH systems (*Org. Biomol. Chem.* **2008**, 6, 4384-90).



QSAR approach to predict carcinogenic activity from aromaticity and proton affinity

CHEMICAL AND PROCESS ENGINEERING

Value addition of 'Indian china clay' and optimum utilisation of 'channel waste'

Continuing the activities from the previous year, size classification was progressively done on M/s KCCPL's 'Indian clay' using 1 inch hydrocyclone which showed that the fraction below 2 micron increased to 65% (from a feed value of 26.9%). This was followed by two-stage wet high intensity magnetic separation (WHIMS) by which brightness increased to 64.5% ISO (from a feed value of 61%). Again, by reduction bleaching brightness enhanced to 66.8%. These values are below to the specifications for paper and paint industries, hence the final product is considered only for ceramic applications. The final product (i.e., product of WHIMS II) was subjected to validation tests at CGCRI, Kolkata for ceramic applications. Results showed that most of the properties of the final product was matching with the specifications for Gr.II ceramic use (IS 2840 : 2002). A few properties which do not satisfy the specifications can be overcome by blending this final product with other china clays. Based on the studies, a commercial process flow sheet was designed which included operations such as blunging, screening, 3-stage hydrocycloning and two-stage magnetic separation.

Preliminary studies using the channel wastes of 'Lilite' and 'Hindustan' clays showed that both the materials cannot be upgraded for any ceramic for filler applications.



Value addition of GMDC (Gujarat Mineral Development Corporation) ball clays for ceramic applications

The objective of this study is to upgrade ball clay samples (two) for possible use in ceramic applications. Raw Ball clay sample I was blunged, screened, size-classified using 2 inch stub cyclone and was subjected to wet high intensity magnetic separation (WHIMS) in order to remove iron containing contaminant mineral impurities. While iron could be reduced to 1.5% from a raw clay value of 2.53% and that of titania reduced to 0.17% from a feed value of 2.05%. Thus the clay could be upgraded to the level of Type 1, Grade 1 ceramic clay (IS 4589: 2002) as far as particle size and chemical analysis are concerned. About 25 Kgs. of product clay sent to CGCRI, Kolkata for validation studies for ceramic applications. The processing work on other GMDC ball clay sample is in progress.

Development of reverse flow natural convection driers and cottage level processing for rural development

Based on the successful and wide spread use of RRL-T NC Driers for the drying of various rural agricultural products such as coconuts (for making copra), rubber sheets, spices, various fruits etc., efforts are being made for expanding and popularising the use of such driers for more materials such as ground nuts, cardamom, reisisins, mango bar, pappad, fish etc. Different designs were tested in the laboratory to develop a drier and process for drying field fresh ground nut to a marketable material having reduced moisture content. A cylindrical chamber configuration was selected with a rectangular outer body having an approximate volume of 825. Mixing of the ground nut during drying was achieved by regular timed rotation of the cylindrical chamber using a hand-operated wheel. A detachable furnace unit was also designed and integrated to the drier. Several batch drying experiments (using 100-125 Kg. nuts) showed that the moisture content of the fresh ground nut could be reduced to 6-7% from an initial content of 45-46% (in the nut) within a duration of 30-36 hours depending upon the type of fuel and interval of firing. A fuel mix consisting of firewood, coconut husk and coconut shells was used for generating hot air for the reverse flow heating and drying. Based on the data generated, efforts are being made to scale up and fabricate a drier for drying at least about 300 Kgs. of ground per batch.



Outer body of ground nut drier



Inner cylindrical chamber of ground nut drier

Development of faster methods of making ball copra and scale up of natural convection driers with reverse air flow

The studies for the production of ball copra using a pilot model drier were continued with partial load (1800 nuts) and full load (3000 nuts). Results showed that good quality ball copra could be obtained within about 105 days (3.5 months) with a pre-fixed firing schedule using a fuel mix consisting of firewood, coconut husk and coconut shells. The time required by conventional method of ball copra making is about 10-12 months. Occasional bacterial growth was observed while storing the ball copra under humid conditions which could be prevented by intermittent smoking. Action is being taken to shift the drier to the location identified by Coconut Development Board for actual field trials for further scale up of the drier capacity to 10,000 nuts per batch.

Trial runs were also carried for the production of cup copra with scaled up version drier. The moisture level was reduced from about 45-46% to 6-7% with in 2.5-3 days using a fuel mix consisting of coconut husk, coconut shell and fire wood. The conventional drying in sunlight takes normally seven days to achieve this moisture level.



Figure Ball copra drier

Figure Cup copra drier



Microbial-mediated removal of iron mineral impurities from kaolin for value addition

After carrying out growth studies, shake flask experiments were carried out using pellets, metabolites and cultures of bacteria such as *acidithiobacillus ferroxidans* (Tf), *Leptospirillum ferroxidans* (Lf) and *acidithiobasillus thioxidans* (Tt) in order to leach out iron impurities from raw Koraput clay. While, Tf and Lf showed limited or adverse effect, Tt was found to be highly favourable for the removal of iron from the clay. Using the metabolite of Tt, 64% iron could be removed by continuous leaching for about 15 days. Cascade leaching was more effective than continuous leaching. Optimisation of leaching conditions is in progress so as to carry out bench scale tests in the next phase of work.

DIOXIN RESEARCH

UNIDO funded project on Dioxins

As first step towards the implementation of Stockholm Convention in India with the objective of protecting human health and environment from Persistent Organic Pollutants (POPs), the country is required to develop the National Implementation Plan (NIP). Under this component, the Institute has been entrusted with the responsibility of the preparation of inventory on industrial and non industrial sources that releases dioxins and furans to various compartments of the atmosphere across South Indian States. The project has been launched in June 2008.

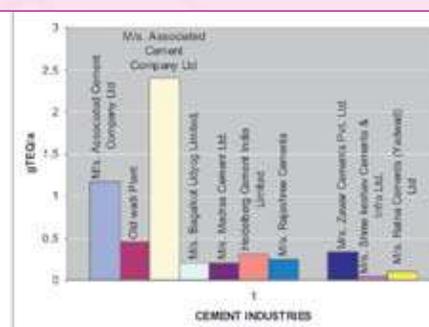
Brainstorming session on dioxins

An Inception workshop & brainstorming session on “Measures in Relation to Unintentionally Produced POPs - Development of National Implementation Plan in India as First Step to Implement the Stockholm Convention on Persistent Organic Pollutants was organised with an objective to create awareness among researchers, officials and public on the impact of dioxins and furans during November 21, 2008.



Dioxin monitoring in industrial emissions

Representative samples of flue gas, soils/sediment, residues and products were collected from various categories/ sub-categories across the south Indian states. The figure shows the sampling conducted at Bhrahmapuram Power Plant, Cochin, Kerala. Annual dioxin emission estimated



for the Karnataka based cement industries is illustrated by the graph with a total amount of 5g TEQ-I per year. Dioxin control measures will be formulated in the next phase of the project.



RESEARCH PLANNING AND BUSINESS DEVELOPMENT

Agreements/MoUs signed during 2008-09

Technology Licensing and Transfer Agreements:

1. Agreement for technology transfer and licensing of knowhow for setting up a semi commercial pilot plant in the premises of M/s Travancore titanium products Ltd., Thiruvananthapuram for making nanotitania.
2. Agreement for licensing of know-how for a process for making white pepper from dried pepper (black) and matured green pepper with Shri. Kurian Abraham, Kottayam.
3. Agreement for licensing of know-how for a process for making white pepper from dried pepper (black) and matured green pepper with Shri. P.J. Chackochan, Organic Wayanad, Wayanad.
4. Agreement for licensing of know-how for a process for making white pepper from dried pepper (black) and matured green pepper with Shri. C.A. Nandakumar Somana, Bangalore.
5. Agreement for licensing of know-how for a process for making white pepper from dried pepper (black) and matured green pepper with Kerala Agro Industries Corporation, Thiruvananthapuram.
6. Agreement for licensing of know-how for a process for making white pepper from dried pepper (black) and matured green pepper with Shri. Reji Varghese, Thiruvalla.
7. Agreement for licensing of know-how for the process for making white pepper from dried pepper (black) and matured green pepper with Shri. K. Mohammed Arif, Mangalore.
8. Agreement for licensing the knowhow of flux bonding technology for producing high volume fly ash building components with Champ Infrastructure Private Limited, Chennai.



Agreements signed for taking up R&D/Consultancy work:

9. Non-disclosure agreement for a project on “Aluminum alloy and Metal Matrix Composite cylinder liner” with WABCO-TVS (India) Ltd.
10. Agreement for engineering consultancy for setting up ginger processing plant for making ginger oil, cleaned waxed ginger and / or ginger powder with Horticulture and Cash Crop Development Department, Government of Sikkim, Gangtok
11. MoU for studies on development of coir-rubber composite products with National Coir Research and Management Institute (NCRMI), Govt. of Kerala, Thiruvananthapuram.
12. MoU for Academic/Research collaboration with **Annamalai University**, Tamil Nadu
13. Secrecy agreement for evaluating a process for the preparation of pressure sensitive adhesives with M/s Bharathy Clays & Industries, Thiruvananthapuram.
14. MoU for setting up solid wastes treatment facility for Trivandrum Municipal Corporation (beneficiary) as part of grant-in-aid R&D project entitled “anaerobic technology for biogas recovery and stabilization of unsorted municipal wastes” sponsored by Ministry of New and Renewable Energy, Government of India.
15. Confidential disclosure agreement with Marico Limited, Mumbai.



**Contract Research Programmes****AGRO PROCESSING DIVISION**

Client	Project Title	Project Leader
STCL	Setting up chilli processing plant in Karnataka	Mr. M.M. Sreekumar
CSIR(Ayush)	Standardisation of plants, plant products and formulations in terms of phytochemical and chemical markers, chemical characteristics of bhasmas	Dr. Sunderesan
CSIR	Development of continuous process for essential oil/oleoresin and active ingredient isolation from fresh/dry spices and botanicals based on Swing Technology	Mr. M.M. Sreekumar
TMOP	Establishment of 2.5 ton FFB/hr palm oil mill in the State of Orissa	Dr. Sunderesan

BIOTECHNOLOGY DIVISION

Client	Project Title	Project Leader
DBT	Scale up studies on the production of galactosidases	Dr. P. Prema
INDOF-RENCH	Mannolipids and mannose metabolism in <i>Mycobacterium tuberculosis</i>	Dr. K. Madhavan Nam-pootheri
DBT	Development of efficient probiotic to combat vitamin B12 folic acid and iron deficiency	Dr. K. Madhavan Nam-pootheri
MOEF	Utilization of brown coir waste pith for lignin degrading enzymes production and development of value added products from fermented waste pith	Dr. P. Prema
DST	Microbial mediated removal of iron mineral impurities from kaolin for value addition	Dr. Sathy Chandrashekar/ Dr. P. Prema
DBT	Production, characterization and application of microbial alpha galactosidase- A therapeutical enzyme for flatulence	Dr. P. Prema
DBT	Construction and screening of environmental DNA libraries for novel beta-lactamase inhibitors and lipases	Dr. Ashok Pandey
DST	Isolation and cloning of glucose tolerant Beta-glucosidase from fungal isolate BTCF-5 and the CBH1 control elements from <i>Trichoderma reesei</i> and studies on the properties of the enzyme	Dr. Rajeev K Sukumaran
DBT	Development of thermostable and low pH tolerant phytase from <i>Aspergillus niger</i> using site directed mutagenesis	Dr. Ashok Pandey
CSIR	Bioethanol from lignocellulosic biomass	Dr. Ashok Pandey



DBT	Construction and analysis of recombinant pentose utilising <i>Corynebacterium glutamicum</i> strains for amino acid production from hemicellulose containing agro-waste materials	Dr. K. Madhavan Nam-pootheri
TIFAC	Centre for biofuels	Dr. Ashok Pandey
DBT	Development of a bioprocess for the production of polyhydroxy butyrate from biodiesel industry generated glycerol	Dr. Ashok Pandey
DBT	Cost effective production of lactic acid for poly lactide (PLA) synthesis and studies on PLA application and biodegradation	Dr. K. Madhavan Nam-pootheri
DBT	Molecular characterisation of petide deformylase and methionine amino peptidase involved in the peptide deformylase of <i>M. tuberculosis</i>	Dr. K. Madhavan Nam-pootheri

CHEMICAL SCIENCES & TECHNOLOGY DIVISION

Client	Project Title	Project Leader
BRNS	Recovery of uranium from sea water via solid phase extraction using tailored ion imprinted polymer materials	Dr. T. Prasada Rao
DST	Design, synthesis and biological studies of neo glyco conjugates	Dr. K.V. Rahakrishnan
DST	Calixpyrroles, novel anion and neutral substrate receptors	Dr. A. Srinivasan
TIRUPATHI	Development of efficient luminescent molecular devices based on lanthanide complexes	Dr. M.L.P. Reddy
MOEF	Development of novel solid waste remediation process through resource recovery and its reintegration as value added state of art products in titanium minerals processing industry	Dr. M.L.P. Reddy
DRDO	Biomimetic sensors for detection of chemical warfare agents	Dr. T. Prasada Rao
KSCSTE	Design and development of polymeric material for organic pollutants in natural waters	Dr. T. Prasada Rao
NMITLI	Design and development of environmentally secure RE based colorants for surface coating applications	Dr. M.L.P. Reddy
KSCSTE	Design and development of novel hydrogen bonding resins for UV curable applications	Dr. Asha Kannan
DMSRDE	Synthesis of spinnable grade PBO	Dr. Asha Kannan
DST	Establishment of high resolution TEM at RRL Tvm	Director



VSSC	Development of EMI shielding/static charge dissipating materials from electrically conducting PANICNs for space applications.	Dr. J.D. Sudha
STEC, GOK	Chemical prospecting and <i>in vitro</i> activity evaluation of the bioactive compounds of <i>Njavara</i>	Dr. A. Jayalekshmi
DBT	Investigations on immobilized enzyme nano particles(ENCP) for novel catalytic applications	Dr. Emilia Abraham
IRE	Design & development of environmentally secure rare earth based colorants	Dr. M.L.P. Reddy
DST	Ramanna fellowship	Dr. A. Ajayghosh
DST	Metal-coordinated imprinted polymers for drug delivery applications	Dr. T. Prasada Rao
DST	Functional nanomaterials of pi-conjugated molecules	Dr. A. Ajayghosh
KSCSTE	Microanalytical investigations of urinary stones: FTIR spectroscopy vs SEM-EDAX	Dr..R.Luxmi Verma
IFCPAR	Functional hybrid nanomaterials of polymeric gels and Pi conjugated self assemblies	Dr. A. Ajayghosh
DST	Engaging N-Heterocycles and N-Heterocyclic carbenes as organocatalysts for Novel carbon-carbon and carbon-Heteroatom bond forming reactions	Dr. G. Vijay Nair
BRNS	Study of photo induced electron transfer in cyclodextrin based supra molecular systems	Dr. K.R. Gopidas
DST	Development of sensitizers based on NIR dyes	Dr. D. Ramaiah

MATERIALS AND MINERALS DIVISION

Client	Project Title	Project Leader
DRDO/CU-SAT	Thermal, elastic and dielectric properties of new microwave substrate materials	Dr. M.T. Sebastian
DRDO	Fatigue characteristics of low Pr. cast AZ91 MG alloy	Dr. U.T.S. Pillai
DST	Development of Mg based alloys for high temperature applications(Coll. with NML Jamshedpur)	Dr. U.T.S. Pillai
Coconut Development Board	Developing of coconut climbing bike	Dr. V. John
ICDD	Preparation of new ceramic oxides and generation of their XRPD patterns	Dr. Jose James
KSCSTE	Low loss ceramic polymer composites for micro electronic packaging application	Dr. C. Pavithran
KSCSTE	Development of pressure sensitive adhesives	Dr. A.R.R. Menon



KSCSTE	Studies on novel rare earth based phosphates for phosphor and dielectric applications	Dr. Peter Koshy
DST	Studies on novel oxide semiconductors $A_3 B_5 C_5 O_{30}$ and $CA_3 B_7 C_2 O_{26.5}$ (A=Ba, Sr; B=Ti, Zr and C=V, Nb, Ta) and their thermal cycling for possible applications in NTC thermistors	Dr. Peter Koshy
IRELTDC	Pilot scale production facility for nano size rare earth phosphates and development of industrially potential application areas	Dr. K.G.K. Warriar
DST	Nano structured dielectric LTCC composite tapes for modern high speed communication integrated circuits	Dr. Manoj Rama Varma
DST	Pilot scale demonstration and technical feasibility of nano size photo catalytic titanium oxide for anti algal, anti bacterial and anti soiling coating on terracotta, glazed ceramic surfaces	Dr. K.G.K. Warriar
BRNS	Ceramic-metal and polymer-metal composites for electromechanical applications	Dr. Jose James
DRDO	Development of ceramics-based nano structured magnetic refrigerators	Dr. Manoj Rama Varma
IRE, Mumbai	Investigations on the production of aluminum-silicon master alloys from sillimanite through plasma processing	Mr. H. K. Bhat
DST	Tunable microwave materials and devices	Dr. Jose James
BRNS	Development of boron carbide reinforced aluminum matrix composites for nuclear applications	Dr. T. P. D. Rajan
BMTPC	Development and evaluation of techno economics through pilot scale demonstration of value added building materials from high volume flux bonded fly ash	Dr. K.G.K. Warriar
BRNS	Investigation on the reactivity and wetting behaviour of molten metals with nano size lanthanum phosphate sintered ceramic and coatings	Dr. K.G.K. Warriar
ICDD	Generation of powder X-ray diffraction patterns for new ceramic oxide compounds	Dr. Prabhakar Rao
ISRO	Development of ultrafine grain aluminium alloy and composite through equal channel angular pressing for space applications	Dr. T.P. D. Rajan
IRE, Kollam	Development of high field composite varistor based on rare earth oxides	Dr. Ananthakumar
M/s. Areva T & D lightning Ltd	Development of high energy varistors through nano precursors	Dr. Ananthakumar
BHEL, Bangalore	Development and demonstration of multifunctional ultra filtration ceramic membrane for industrial applications	Dr. K.G.K. Warriar
CMRL, Alwaye	Rendering scientific and technical support to M/s. CMRL synthetic rutile commercial plant.	Mr. H. K. Bhat



ICDD	Generation of powder X-ray diffraction patterns for new generation ceramic oxide compounds	Dr. Prabhakar Rao
Institute of Plasma Research	Development of long filamentary MgB ₂ superconducting wires and tapes for fusion grade magnets and current leads	Dr.U. Syamprasad
NCRMI, Trivandrum	Studies on development of coir-rubber composites products	Dr. A.R.R. Menon
BRNS, MUMBAI	Development of MgB ₂ superconducting wires and coils for application in high field magnets	Dr.U. Syamprasad
DST	Optimization of aging parameters and alloy composition for improved age hardening response of AZ91 magnesium alloy.	Dr.A.Sreenivasan
DRDO	Development of mono and hybrid discontinuously reinforced magnesium metal matrix composites for engineering applications	Dr.U.T.S. Pillai
DST	Silicate based dielectrics for electronic packaging applications	Dr.M.T.Sebastian

PROCESS ENGINEERING AND ENVIRONMENTAL TECHNOLOGY DIVISION

Client	Project Title	Project Leader
DBT	Anaerobic degradation of perchlorate and development of a bioprocess for removing perchlorate in aqueous phase	Dr. B. Krishna Kumar
IFS	Biodegradation of triclosan under aerobic and anaerobic conditions	Dr. B. Krishna Kumar
DRDO	Prediction of solid morphology in mushy alloys	Dr. Roschen Sasikumar
DST	Quantum chemical and QSAR studies on carcinogenic activities of polycyclic aromatic hydrocarbons and their epoxide derivatives	Dr. K. P. Vijayalakshmi
DST	Rational discovery of novel photo responsive molecules and materials: molecular modeling simulations and synthesis	Dr. C. H. Suresh
DST	Development of a molecular aggregation model for the co-precipitation synthesis of Ba(Mg ^{1/3} Ta ^{2/3})O ₃ dielectric ceramic nano particles	Dr. S. Savithri
GMDC	Value addition of GMDC Ball clays for ceramic applications	Mr. P. Raghavan
M/s. General Motors Ltd.	Nucleation, movement and growth of gas bubbles in aluminium castings	Dr. Roschen Sasikumar
KCCPL	Value addition of Indian China clay and optimum utilization of channel waste for M/s. Kerala Clays & Ceramic products, Kannur	Mr.P. Raghavan
Dept of Information Technology	An agent runtime environment for biological simulations	Dr.Elizabeth Jacob



DST	Investigations on layer by layer vapour phase coating on oxide microparticles in a fluidized bed	Mrs. Ani K. John
MOEF	Pilot plant for eco friendly coir retting and waste water treatment under the scheme for assistance of abatement of pollution	Dr. V. B. Manilal
UNIDO	Development of national implementation plan in India as first step to implement the Stockholm convention on persistent organic pollutants	Dr.M. Anbu
MNRE	Development of a household wastes & sanitation device with biogas recovery	Dr. V. B. Manilal

CONSULTANCY PROGRAMMES

Client	Project Title	Project Leader
M/s Terra Tile Consortium	Consultancy & technical support to M/s Terra Tile Consortium Ltd.	Dr. K.G.K. Warriar
IRE	Engineering consultancy to the setting up of a pilot scale production for nano sized rare earth phosphates for M/s IRE Ltd.	Dr. K.G.K Warriar
NTPC, M/s. Ramagundam	General consultancy project on suitability of fly ash from NTPC Ramagundam power plant for the flux building technology of NIIST.	Dr. K.G.K Warriar
M/s. Std. Brick & Tile Co.Pvt.Ltd, Bangalore	Consultancy & Technical support to set up a quality control lab.in M/s. Std & brick and Tile company, Bangalore	Dr. K.G.K Warriar
M/s. Hitech Biosciences India Ltd, Pune	Isolation and evaluation of Microbial strains for the production of nitrilase, reductase and hydantoinase	Dr. Ashok Pandey
Colgate Palmolive, USA	Literature survey on the production of amino acids, especially glutamic acid, arginine and citrulline	Dr. Ashok Pandey
Colgate Palmolive , USA	Production of arginine by fermentation and its purification	Dr. Ashok Pandey
Hindustan Insecticides Ltd, Udyogamandal	Requirement study: Zero discharge ETP	Mr. Ajit Haridas
NPM Aquatic fish Links(P) Ltd., Thrissur	Fish meal factory odour control biofilter	Mr. Ajith Haridas



Miracle Polymers India Ltd, Coimbatore	Reclaim rubber factory odour control	Mr. Ajith Haridas
DIR. of Mining and Geology	EIA study in clay mining areas of Mangalapuram	Mr. J. Ansari
IRE	EIA study for IRE	Mr. J. Ansari
M/s. Thermax Ltd	In situ CO ₂ separation in energy recovery by chemical looping computer aided process modeling	Dr. S. Savithri
M/s. Mechwell Industries Ltd.	Coal combustion model for low NO _x burners for wall fired and cornered fired coal boilers	Dr. S. Savithri
ISRO, Trivandrum	Microstructural analysis of metallic samples	Dr. Peter Koshy
S. N. College, Kollam	Microstructural analysis Genus <i>Jasminum Linn</i>	Dr. Peter Koshy
STCL	Consultancy for chilli processing plant in Karnataka	Sri. M.M. Sreekumar
Hort. & Cash Crop Dev. Department, Govt of Sikkim	Consultancy for spice processing unit at Sikkim	Sri. M.M. Sreekumar
M/S Lakshmi Balaji Oils Pvt Ltd.	Consultancy on establishment of palm oil mills at Orissa	Dr. A. Sunderesan
M/s. Kaladi Rice Millers Consortium, Kaladi	Consultancy for the establishment of rice bran oil refinery plant for for M/s Rice Millers Consortium, Kerala.	Dr. A. Sunderesan
Astra Zeneca	Consultancy for XRD studies on polymorphic drugs	Dr. Syamaprasad
BHEL	Development of gel casting direct coagulation method for the fabrication of SiC filter	Dr. C. Pavithran
DRDO	Consultancy and report generation for the development of housing first gear and Piston using aluminium matrix composites	Dr. T.P.D. Rajan
IISER, Trivandrum	Providing guidelines for setting up a modern fully automated Library at IISER, Trivandrum	Mrs. Mini S.
VSSC	Surface area analysis of Nickel powders	Mr. K. Harikrishna Bhat



PATENTS

Patents filed (India)

Application No.	Date	Title	Inventors
1239DEL2008	19/05/2008	PROCESS FOR PREPARING A BIOACTIVE FRACTION FROM RED ONION	C Arumghan, VMV Venugopalan, MM Sreekumar, NM Soumya, and SD Sreevidya
2830DEL2008	15/12/2008	A TRANSPARENT CHITAM GEL AND A PROCESS FOR THE PREPARATION THEREOF	T Emilia Abraham and Simi

Patents filed (Foreign)

Application No.	Date	Title	Inventors
0807427.0 (GB)	23/04/2008	METHOD FOR CONTINUOUS PRODUCTION OF MGB2 BASED SUPERCONDUCTORS	Syamaprasad Upendran, Abhilash Kumar Raveendran Nair Girirajkumari Amma, Vinod Krishnan Kutty, Aloysius Rajappan Padmavathy, Sarun Pallian Murikoli, Thennavarajan Subramanian Guruswamy Perumal
112005003756.8 (DE)	15/05/2008	A MELT TRANSURETHANE PROCESS FOR THE PREPARATION OF POLYURETHANES	Manickam Jayakannan, Deepa Puthaparambil
0185NF2005 /DE	21/05/2008	METHOD FOR CONTINUOUS PRODUCTION OF MGB2 BASED SUPERCONDUCTORS	Syamaprasad Upendran, Abhilash Kumar Raveendran Nair Girirajkumari Amma, Vinod Krishnan Kutty, Aloysius Rajappan Padmavathy, Sarun Pallian Murikoli, Thennavarajan Subramanian Guruswamy Perumal



0185NF2005/JP	26/05/2008	METHOD FOR CONTINUOUS PRODUCTION OF MGB2 BASED SUPERCONDUCTORS	Syamaprasad Upendran, Abhilash Kumar Raveendran Nair Girirajkumari Amma, Vinod Krishnan Kutty, Aloysius Rajappan Padmavathy, Sarun Pallian Murikoli, Thennavarajan Subramanian Guruswamy Perumal
0411NF2004/JP	12/06/2008	MULTIFUNCTIONAL ALCOHOLS FROM CARDANOL, ITS MULTIFUNCTIONAL ACRYLIC CROSS-LINKER AND HIGHLY PENDANT PHOSPHORUS FLAME RETARDANT DERIVATIVES	Vadakkethonipurathu Sivankutty Nair Prasad, Chennakkattu Krishna Sadasivan Pillai
12/097354 (US)	13/06/2008	MULTIFUNCTIONAL ALCOHOLS FROM CARDANOL, ITS MULTIFUNCTIONAL ACRYLIC CROSS-LINKER AND HIGHLY PENDANT PHOSPHORUS FLAME RETARDANT DERIVATIVES	Vadakkethonipurathu Sivankutty Nair Prasad, Chennakkattu Krishna Sadasivan Pillai
12/097489 (US)	13/06/2008	AMPHIPHILIC SQUARINE DYES, A PROCESS FOR THE PREPARATION THEREOF AND THEIR USE AS NEAR INFRARED FLUORESCENCE PROBES FOR BIOLOGICAL BIOCHEMICAL AND INDUSTRIAL APPLICATIONS	Danaboyina Ramaiah, Kalliat Thazhathveetil Arun, Jyotish Kuthanapillil
12/097478 (US)	13/06/2008	A PROCESS FOR THE SYNTHESIS OF TELECHELIC URETHANE ACRYLATE UV CURBLE PRE POLYMER MATERIALS FROM RENEWABLE RESOURCES	Syamakumari Asha, Chennakkattu Krishna Sadasivan Pillai
PCT/IN08/00374 (WO)	13/06/2008	PYRROLE END-CAPPED BIPYRIDINE ASSAY POWDER FOR SELECTIVE DETECTION OF ZINC IONS AND PROCESS THEREOF	Ayyappanpillai Ajayaghosh, Sivaramapanicker Sreejith
PCT/IN08/00372 (WO)	13/06/2008	WHITE LIGHT EMITTING ORGANOGEL AND PROCESS THEREOF	Ayyappanpillai Ayajaghosh, Chakkooth Vijayakumar, Vakayil K Praveen
05856287.7 (EP)	18/06/2008	AMPHIPHILIC SQUARINE DYES, A PROCESS FOR THE PREPARATION THEREOF AND THEIR USE AS NEAR INFRARED FLUORESCENCE PROBES FOR BIOLOGICAL BIOCHEMICAL AND INDUSTRIAL APPLICATIONS	Danaboyina Ramaiah, Kalliat Thazhathveetil Arun, Jyotish Kuthanapillil



07700012.3 (EP)	18/06/2008	QUINALDINE BASED SEMISQUARAINES AND SQUARAIN DYES, A PROCESS FOR THE PREPARATION THEREOF AND THEIR USE AS SENSITIZERS FOR PHOTODUNAMIC THERAPEUTICAL AND INDUSTRIAL APPLICATIONS	Danaboyina Ramaiah, Jyothish Kuthanapillil, Kalliat Thazhathveetil Arun
0811272.4 (GB)	19/06/2008	MULTIFUNCTUINAL ALCOHOLS FROM CARDANOL, ITS MULTIFUNCTIONAL ACRYLIC CROSS-LINKER AND HIGHLY PENDANT PHOSPHORUS FLAME RETARDANT DERIVATIVES	Vadakkethonipurathu Sivankutty Nair Prasad, Chennakkattu Krishna Sadasivan Pillai
200580052408.2 (CN)	24/06/2008	AMPHIPHILIC SQUARAIN DYES, A PROCESS FOR THE PREPARATION THEREOF AND THEIR USE AS NEAR INFRARED FLUORESCENCE PROBES FOR BIOLOGICAL BIOCHEMICAL AND INDUSTRIAL APPLICATIONS	Danaboyina Ramaiah, Kalliat Thazhathveetil Arun, Jyotish Kuthanapillil
12/164643 (US)	30/06/2008	FUNCTIONALISED DOPENTS/ CONDUCTING POLYANILINE MATERIALS FROM RENEWABLE RESOURCES, THEIR BLENDS AND A PROCESS THEREOF	Manickam Jayakannan, Chennakkattu Sadasivan Pillai, Sundeep Kumar Dhawan, Dinesh Chandra Trivedi, Subramaniam Radhakrishnan
0149NF2005/CN (CN)	07/07/2008	QUINALDINE BASED SEMISQUARAINES AND SQUARAIN DYES, A PROCESS FOR THE PREPARATION THEREOF AND THEIR USE AS SENSITIZERS FOR PHOTODUNAMIC THERAPEUTICAL AND INDUSTRIAL APPLICATIONS	Danaboyina Ramaiah, Jyothish Kuthanapillil, Kalliat Thazhathveetil Arun
2008-548081 (JP)	13/08/2008	FUNCTIONALISED DOPENTS/ CONDUCTING POLYANILINE MATERIALS FROM RENEWABLE RESOURCES, THEIR BLENDS AND A PROCESS THEREOF	Manickam Jayakannan, Chennakkattu Sadasivan Pillai, Sundeep Kumar Dhawan, Dinesh Chandra Trivedi, Subramaniam Radhakrishnan
2008-548077 (JP)	13/08/2008	A PROCESS FOR THE SYNTHESIS OF TELECHELIC URETHANE ACRYLATE UV CURBLE PRE POLYMER MATERIALS FROM RENEWABLE RESOURCES	Syamakumari Asha, Chennakkattu Krishna Sadasivan Pillai
PCT/IN08/00538 (WO)	26/08/2008	PROCESS FOR THE DEVELOPMENT OF SUPERHYDROPHOBIC CARBON NANOTUBES COATINGS	Ayyappanpillai Ajayaghosh, Sampath Srinivasan, Vakayil K Pravin



08075815.4 (EP)	10/10/2008	A PROCESS FOR THE PRODUCTION OF PEROXIDASE FROM PLANT CELL AND CALLUS CULTURES	Tholath Emilia Abraham, Nisha Rani Devaki, Thomson Kuruvilla, Jegan Roy Joseph
33/2009 (BD)	04/02/2009	A METHOD FOR ANAEROBIC PROCESS COUPLED SEPERATION AND REFINING OF PLANT MATERIALS	Vattackatt Balakrishnan Manilal, Ajit Hardas
PCT/ IN2009/000075 (WO)	04/02/2009	A METHOD FOR ANAEROBIC PROCESS COUPLED SEPERATION AND REFINING OF PLANT MATERIALS	Vattackatt Balakrishnan Manilal, Ajit Hardas

Patents granted (India)

Patent No.	Date	Title	Inventors
220189	16/05/2008	A PROCESS FOR THE PREPARATION MELT PROCESSABLE LIQUID CRYSTALLINE POLY (4-PHENYLENE TEREPHTHALATE - CO-OXYPHENYL ACETATE PROPIONATES, POLY (4,4'-BIPHENYLENE TEREPHTHALATE -CO-OXYPHENYL ACETATE/PROPIONATE) S AND POLY (2,6-NAPHTHALENE TERIPHT	Vadakkethonipurathu SivankuttyNair Prasad, Chennakkattu Krishna Sadasivan Pillai, Marayil Ravindranathan
220910	10/06/2008	COCONUT PITH BIOFILTER FOR THE REMOVAL OF ODOURNOUS AND TOXIC VAPOURS FROM CONTAMINATED AIR	Haridas Ajit ; Majumdar Swachchha
223945	24/09/2008	PROCESS AND REVERSE FLUIDISED LOOP REACTOR FOR WASTEWATER PURIFICATION	Ajit Haridas, Swachchha Majumdar
225516	18/11/2008	A NOVEL PROCESS FOR THE PRODUCTION OF OLEORESIN FROM FRESH GREEN CHILLI	M A Sumathykutty, A Nirmala Menon, B Sankarikutty Amma, K P Padmakumari Amma, M M Sreekumar, C Arumughan
226259	16/12/2008	A METHOD FOR THE PREPARATION OF MODIFIED BIOADSORBENT PARTICLES FOR THE REMOVAL OF TOXIC METALS AND OTHER COMPOUNDS FROM WATER	Sudhabai, TE Abraham



226526	17/12/2008	AN IMPROVED NATURAL CONVECTION DRIER USEFUL FOR PROCESSING AGRICULTURAL PRODUCTS	Pokkattu Pathrose Thomas, Thiruthanathil Pathrose Poulouse, Pillai Rajeshree Rajan, Thonduparampil Varghese Philipose
227580	14/01/2009	AN ANTIOXIDANT EXTRACT FROM SESAME SEEDS/CAKES	Ananthasankaran Jayalekshmy, Chami Arumughan, Kizhiyedath Polachira Suja

Patents granted (Foreign)

Patent No.	Date	Title	Inventors
7390641 (US)	24/06/2008	PRODUCTION OF PEROXIDASE FROM PLANT CELL AND CALLUS CULTURES	Abraham; Tholath Emilia, Devaki; Nisha Rani, Kuruvilla; Thomson, Joseph; Jegan Roy
7396554 (US)	08/07/2008	ANTIOXIDANT SESAME EXTRACT	Jayalekshmy; Ananthasankaran, Arumughan; Chami, Suja; Kizhiyedathu Polachira
2003304660 (AU)	17/07/2008	A NOVEL LOW TEMPERATURE PROCESS FOR THE SYNTHESIS OF ULTRA-FINE RUTILE PHASE TITANIUM DIOXIDE PARTICLES THROUGH VAPOR PHASE HYDROLYSIS OF TITANIUM TETRACHLORIDE	Gerald Devasagayam Surender, Ani Kariumpanoor John, Kumara Pillai Rajendra Prasad, Sivaraman Savithri
2004317862 (AU)	31/07/2008	A NOVEL IN-EXPENSIVE AND EFFICIENT PROCESS FOR ISOLATION FOR IMPERATORIN, A POTENT INDUCIBLE NITRIC OXIDE SYNTHASE INHIBITOR AND ANTI-INFLAMMATORY DRUG CANDIDATE FROM AEGLE MARMELOS CORREA	Ponnappalli Mangala Gowri, Maheshwari Muralidharan Jeeja, Velupparambu Madam Vadirajan Venugopalan, Chami Arumughan
7413726 (US)	19/08/2008	SYNTHESIS OF ULTRAFINE RUTILE PHASE TITANIUM DIOXIDE PARTICLES	Surender; Gerald D., John; Ani K. , Prasad; Kumara P. Rajendra, Sivaraman; Savithri



7456134 (US)	25/11/2008	PROCESS FOR THE CONTINUOUS PRODUCTION OF MAGNESIUM DIBORIDE BASED SUPERCONDUCTORS	Upendran; Syamaprasad, Amma; Abhilash Kumar Raveendran Nair Girijakumari, Kutty; Vinod Krishnan , Padmavathy; Aloysius Rajappan, Murikoli; Sarun Pallian, Subramanian; Thennavarajan, Perumal; Guruswamy
1758992 (EP)	24/12/2008	A PROCESS FOR THE PRODUCTION OF PEROXIDASE FROM PLANT CELL AND CALLUS CULTURES	Tholath Emilia Abraham, Nisha Rani Devaki, Thomson Kuruvilla, Jegan Roy Joseph



KNOWLEDGE RESOURCE CENTRE

The Knowledge Resource Centre (KRC) acts as a nodal point for the published information resources and network based services to the institute and the S&T Community. The section made significant progress in creating and further strengthening the infrastructure, resources and rendering services. Highlights of the achievements include:

Information Resource Management

Collection Strength

The total collection has gone up to 41,000 plus documents which include 12,510 books, 10947 standards and 8715 bound volumes of periodicals. The total number of the print versions of periodicals received during the year was 186 Titles (Subscribed: Foreign - 86, Indian – 82 & Gratis -18)

Databases and Database Searches

Updated the in-house databases of books, periodicals, reports/reprints, PhD theses, publications of NIIST scientists, etc. The last two databases are linked to the Lab's Website as well as Intranet. The centre also conducted regular and extensive CD-ROM and Online database searches including those of Standards and Patents.

e-Resources Access Facility under the CSIR Consortia Programme.

Trial access followed by regular access to the e-resources under the CSIR e-Journals Consortia Programme was facilitated through the desktops of all scientists, research students and other functionaries across the Lab in IP-enabled mode. The list of access facilities/ publishers whose e-journals full text databases are accessible is furnished below (* indicates new additions during the year of reporting) :

- American Chemical Society
- Blackwell
- Cambridge University Press
- Elsevier (Science Direct) (Access up to March 2008 issues)
- Emerald
- IEEE
- JCCC@INSTIRC*
- Nature
- Oxford University Press
- Royal Society of Chemistry
- Sage
- Springer/ Kluwer
- Taylor & Francis
- Wiley Interscience
- Indian Jls.com of Divan Enterprises





Bibliographic & Citation Databases	- Web of Science – Science Citation Index Expanded
Patent Databases	- Delphion & Derwent Innovations Index
Standards	- ASTM and BIS online

This was in addition to the Trial access of ASME, CSIRO, Engineering Collection of Maney , METADEX- Proquest CSA, Micropatent Databases, NRC Press Journals & Science Direct e-Books.

e- Resource Access facilities arranged under the Lab Funds :

SCOPUS of Elsevier : The usage of e-resources has been overwhelming particularly those of ACS and Elsevier (Science Direct and SCOPUS). The regular monitoring of usage and various promotional programmes have enhanced the level of usage.

e-Resources promotional activities undertaken to enhance usage

- Broadcasted regular messages of new facilities/ services initiated and hosted the same in the intranet with search links to each item
- Initiation of new members to the various services of KRC
- In addition, our resource facilities and services were extended to external users, primarily from research, industrial and academic sectors.

Analysis of Publications

Carried out bibliometric/scientometric/impact factor analysis of NIIST publications using Journal Citation Report, Web of Science - Science Citation Index Expanded and SCOPUS. Provided support service for publishing in journals with high Impact Factor. The total number of SCI Papers (2008) has gone up to 233 with an average IF value of 2.67.

KRC Automation & Web OPAC

Majority of the KRC in-house activities and services including the circulation system have been automated using Libsuite - Integrated Library Software. Completed bar-coding of library documents. New bar-coded membership cards introduced.

Institutional Repository

Steps have already been initiated to create an Institutional Repository of NIIST Publications, Annual Reports, Thesis, Audio and Video Clippings of major programmes and conferences held at the lab, news paper clippings etc.

Physical Verification & Binding

Completed physical verification of library books & periodicals. Binding of back volumes of periodicals and books is in progress.



IT-Enabled Systems and Services

- staff and students through LAN/WAN segments of the 24x7 network system facility
- 2 Mbps leased line of BSNL
- Proposed bandwidth increase from 2 Mbps to 8Mbps
- E-mail & messaging system
- Wi-Fi system facility
- Up gradation of PCs and Servers
- MIS first phase implemented
- Video conferencing facility
- New website for NIIST (Development in progress)
- Information Communication Technology (ICT) programme implementation
- Cyber security
- Storage devices implemented





LIST OF PUBLICATIONS: 2008

- 1 **ABHILASH (N P), SURESH (C H) and VIJAY NAIR (G)**
Pyridine-catalyzed stereoselective addition of acyclic 1,2-diones to acetylenic esters:
Synthetic and theoretical studies of an unprecedented rearrangement
Chemistry - A European Journal
14(19):5851-5860;27 Jun 2008
- 2 **ABHILASH (N P), SURESH (E) and VIJAY NAIR (G)**
A novel synthesis of highly substituted but-2-enoic acid esters by the reaction of
DMAP-methyl phenylpropiolate zwitterion and diaryl 1,2-diones
Synthesis - Stuttgart
(1):29-31;03 Jan 2008
- 3 **AHMED (S U), SINGH (S K), PANDEY (A), KANJILAL (S) and PRASAD (R B N)**
Fatty Acid profiling during Microbial Lipid Production under varying pO_2 and Impeller Tip
Speeds
Applied Biochemistry and Biotechnology
151(2-3):599-609;Dec 2008
- 4 **AJAYAGHOSH (A), CHITHRA (P), REJI VARGHESE and DIVYA (K P)**
Controlled self-assembly of squaraines to ID supramolecular architectures with high molar
absorptivity
Chemical Communications
(8):969-971;2008
- 5 **AJAYAGHOSH (A), PRAVEEN (V K) and VIJAYAKUMAR (C)**
Organogels as scaffolds for excitation energy transfer and light harvesting
Chemical Society Reviews
37(1):109-122;2008
- 6 **AJAIKUMAR (B K), ICHIKAWA (H), PREETHA ANAND, MOHANKUMAR (C J),
HEMA (P S), MANGALAM S NAIR and AGGARWAL (B B)**
Coronarin D, a labdane diterpene, inhibits both constitutive and inducible nuclear factor-kB
pathway activation, leading to potentiation of apoptosis, inhibition of invasion, and
suppression of osteoclastogenesis
Molecular Cancer Therapeutics
7(10):3306-3317;Oct 2008
- 7 **AJAYAKUMAR (G) and GOPIDAS (K R)**
Long-lived photoinduced charge separation in new $Ru(bipyridine)_3^{2+}$ - phenothiazine dyads
Photochemical & Photobiological Sciences
7(7):826-833;2008
- 8 **AKHILA RAJAN and EMILIA ABRAHAM (T)**
Studies on crystallization and cross-linking of lipase for biocatalysis
Bioprocess and Biosystems Engineering
31(2):87-94;Feb 2008



- 9 **AKHILA RAJAN, SUDHA (J D) and EMILIA ABRAHAM (T)**
Enzymatic modification of cassava starch by fungal lipase
Industrial Crops and Products
27(1):50-59;Jan 2008
- 10 **AMBILI RAJ (D B), BIJU (S) and REDDY (M L P)**
One-, Two-, and Three-dimensional arrays of Eu^{3+} -4,4,5,5,5-pentafluoro-1-(naphthalen-2-yl) pentane-1,3-dione complexes: Synthesis, crystal structure and photophysical properties
Inorganic Chemistry
47(18):8091-8100;2008
- 11 **AMRUTHA (S R) and JAYAKANNAN (M)**
Probing the π -stacking induced molecular aggregation in π -Conjugated Polymers, Oligomers, and their blends of *p*-Phenylenevinylenes
Journal of Physical Chemistry B
112(4):1119-1129;31 Jan 2008
- 12 **ANAS (S), SAJISHA (V S), JUBI JOHN, NAYANA (J), SHOLLY (C G) and RADHAKRISHNAN (K V)**
Facile synthesis alkylidene cyclopentenes via palladium catalyzed ring opening of fulvene derived bicyclic hydrazines
Tetrahedron
64(41):9689-9697;06 Oct 2008
- 13 **ANAS (S), SARIKA (C), RANI (R) and RADHAKRISHNAN (K V)**
A facile synthesis of novel triazabicyclic molecules as potential bicyclic templates for Pharmaceutical ligands by the ring opening metathesis-cross metathesis of triazatricyclo [3.2.1.0^{2,6}]dec-8-ene-3,5-diones
Indian Journal of Chemistry Section B- Organic Chemistry including Medicinal Chemistry
47B(7):1063-1070;July 2008
- 14 **ANILKUMAR (P) and JAYAKANNAN (M)**
Divergent Nanostructures from identical ingredients: Unique Amphiphilic Micelle Template for Polyaniline Nanofibers, Tubes, Rods, and Spheres
Macromolecules
41(20):7706-7715;28 Oct 2008
- 15 **ANILKUMAR (P) and JAYAKANNAN (M)**
Hydroxyl-functionalized Polyaniline Nanospheres: Tracing Molecular Interactions at the Nanosurface via Vitamin C sensing
Langmuir
24(17):9754-9762;Sep 2008
- 16 **ANISH CYRIAC, AMRUTHA (S R) and JAYAKANNAN (M)**
Renewable resource-based Poly (*m*-phenylenevinylene)s and their statistical copolymers: Synthesis, characterization, and probing of molecular aggregation and Forster energy transfer processes
Journal of Polymer Science: Part A: Polymer Chemistry
46(10):3241-3256;15 May 2008



- 17 **ANISHA (G S) and PREMA (P)**
Reduction of non-digestible oligosaccharides in horse gram and green gram flours using crude α - galactosidase from *streptomyces griseoloalbus*
Food Chemistry
106(3):1175-1179;01 Feb 2008
- 18 **ANISHA (G S) and PREMA (P)**
Cell immobilization technique for the enhanced production of α -galactosidase by *Streptomyces griseoloalbus*
Bioresource Technology
99(9):3325-3330;Jun 2008
- 19 **ANISHA (G S), ROJAN P JOHN, NICEMOL (J), NILADEVI (K N) and PREMA (P)**
Production and characterization of partially purified thermostable α -galactosidases from *Streptomyces griseoloalbus* for food industrial applications
Food Chemistry
111(3):631-635;01 Dec 2008
- 20 **ANISHA (G S), SUKUMARAN (R K) and PREMA (P)**
Evaluation of α -galactosidase biosynthesis by *Streptomyces griseoloalbus* in solid-state fermentation using response surface methodology
Letters in Applied Microbiology
46(3):338-343;Mar 2008
- 21 **ANISHA (G S), SUKUMARAN (R K) and PREMA (P)**
Statistical optimization of α -galactosidase production in submerged fermentation by *Streptomyces griseoloalbus* using response surface methodology
Food Technology and Biotechnology
46(2):171-177;Apr-Jun 2008
- 22 **ANJANA (P S) and SEBASTIAN (M T)**
Microwave dielectric properties and low-temperature sintering of $(1-x)\text{CeO}_2\text{-}x\text{BaTi}_4\text{O}_9$ ceramics
International Journal of Applied Ceramic Technology
5(1):84-93;Jan 2008
- 23 **ANJANA (P S), SEBASTIAN (M T), SUMA (M N) and MOHANAN (P)**
Low dielectric loss PTFE/ CeO_2 ceramic composites for microwave substrate applications
International Journal of Applied Ceramic Technology
5(4):325-333;Jul 2008
- 24 **ANJANA (P S), SHERIN THOMAS, SEBASTIAN (M T) and JOSE JAMES**
Synthetic Minerals for Electronic Applications
Earth Science India
1(1):36-52;Jan 2008
- 25 **ANJU (K S), RAMAKRISHNAN (S), THOMAS (A P), SURESH (E) and SRINIVASAN (A)**
9, 10, 19, 20-Tetraarylporphycenes
Organic Letters
10(24):5545-5548;18 Dec 2008



- 26 **ANOOP KRISHNAN (K) and AJIT HARIDAS**
Removal of phosphate from aqueous solutions and sewage using natural and surface modified coir pith.
Journal of Hazardous Materials
152(2):527-535;01 Apr 2008
- 27 **ANUPAMA (V N), AMRUTHA (P N), CHITRA (G S) and KRISHNAKUMAR (B)**
Phosphatase activity in anaerobic bioreactors for wastewater treatment
Water Research
42(10-11):2796-2802;May 2008
- 28 **ARAVIND (P R), SHAJESH (P), MUKUNDAN (P), KRISHNA PILLAI (P) and WARRIER (K G K)**
Non-supercritically dried silica-silica composite aerogel and its possible application for confining simulated nuclear wastes
Journal of Sol-Gel Science & Technology
46(2):146-151;May 2008
- 29 **ARAVIND (P R), SHAJESH (P), SMITHA (S), MUKUNDAN (P) and WARRIER (K G K)**
Nonsupercritically dried silica-alumina aerogels - Effect of gelation pH
Journal of the American Ceramic Society
91(4):1326-1328;Apr 2008
- 30 **ARAVIND (S G), RANJITH ARIMBOOR., MEENA RANGAN, SOUMYA (N M) and ARUMUGHAN (C)**
Semi-preparative HPLC preparation and HPTLC quantification of tetrahydroamentoflavone as marker in *Semecarpus anacardium* and its polyherbal formulations
Journal of Pharmaceutical and Biomedical Analysis
48(3):808-813;04 Nov 2008
- 31 **ASHA (A S), SEBASTIAN (M T) and JAYARAJ (M K)**
Structural and electrical properties of $\text{La}_{0.5}\text{Sr}_{0.5}\text{CoO}_3$ thin films prepared by rf magnetron sputtering
Journal of Alloys and Compounds
449(1-2):68-72;31 Jan 2008
- 32 **ASWATHY (R G), BINDHUMOL (I), ROJAN P JOHN and NAMPOOTHIRI (K M)**
Evaluation of the Probiotic Characteristics of newly isolated Lactic Acid Bacteria
Applied Biochemistry and Biotechnology
151(2-3):244-255;Dec 2008
- 33 **BABITHA (S), CARVAHLO (J C), SOCCOL (C R) and PANDEY (A)**
Effect of light on growth, pigment production and culture morphology of *Monascus purpureus* in solid-state fermentation
World Journal of Microbiology & Biotechnology
24(11):2671-2675;Nov 2008
- 34 **BABU (S S), PRAVEEN (V K) and AJAYAGHOSH (A)**
Noncovalent Macromolecular Architectures of Oligo(*p*-phenylenevinylene)s(OPVs): Role of End Functional Groups on the gelation of organic solvents
Macromolecular Symposia
273(1):25-32;Nov 2008



- 35 **BABU (S S), PRAVEEN (V K), PRASANTHKUMAR (S) and AJAYAGHOSH (A)**
Self-Assembly of Oligo (*para*-phenylenevinylene)s through Arene- Perfluoroarene Interactions: π Gels with longitudinally controlled fiber growth and supramolecular exciplex-mediated enhanced emission
Chemistry - A European Journal
14(31):9577-9584;29 Oct 2008
- 36 **BAIJU (K V), SHUKLA (S), SANDHYA (K S), JOSE JAMES and WARRIER (K G K)**
Role of surface-purity in photocatalytic activity of nanocrystalline anatase-titania processed via polymer-modified sol-gel
Journal of Sol-Gel Science and Technology
45(2):165-178;Feb 2008
- 37 **BAKARE (I O), PAVITHRAN (C), OKIEIMEN (F E) and PILLAI (C K S)**
Synthesis and characterization of rubber-seed-oil-based polyurethanes
Journal of Applied Polymer Science
109(5):3292-3301;05 Sep 2008
- 38 **BALACHANDRAN (C), MAYAMOL (P N), SHINY (T), DIVYA (S), SUNDARESAN (A) and ARUMUGHAN (C)**
An ecofriendly approach to process rice bran for high quality rice bran oil using supercritical carbon dioxide for nutraceutical applications
Bioresource Technology
99(8):2905-2912;May 2008
- 39 **BALASUBRAMANI (N), PILLAI (U T S) and PAI (B C)**
Effect of Zn concentration on the microstructure and phase formation of Mg-5Gd alloy
Journal of Alloys and Compounds
460(1-2):L6-L10;28 Jul 2008
- 40 **BALASUBRAMANI (N), PILLAI (U T S) and PAI (B C)**
Optimization of heat treatment parameters in ZA84 magnesium alloy
Journal of Alloys and Compounds
457(1-2):118-123;12 Jun 2008
- 41 **BALASUBRAMANI (N), SRINIVASAN (A), PILLAI (U T S), RAGHUKANDAN (K) and PAI (B C)**
Effect of antimony addition on the microstructure and mechanical properties of ZA84 magnesium alloy
Journal of Alloys and Compounds
455(1-2):168-173;08 May 2008
- 42 **BEENA JOY**
Separation and characterization techniques of biologically active molecules from natural products
Chemical Industry Digest
21(9):92-95;Sep 2008
- 43 **BEENA JOY, OMANAKUTTY (M) and MOLLEY MATHEW**
Antibacterial effects and chemical composition of the essential oil of *Hyptis suaveolens* poit leaves.
Journal of Essential Oil Bearing Plants (Jeobp)
11(4):384-390;2008



- 44 **BENHERLAL (P S) and ARUMUGHAN (C)**
Studies on modulation of DNA integrity in Fenton's system by phytochemicals
Mutation Research-Fundamental and Molecular Mechanisms of Mutagenesis
648(1-2):1-8;15 Dec 2008
- 45 **BIJU (A), SARUN (P M), ALOYSIUS (R P) and SYAMAPRASAD (U)**
Flux pinning properties of Yb substituted (Bi,Pb)-2212 superconductor
Journal of Alloys and Compounds
454(1-2):46-51;24 Apr 2008
- 46 **CHACKO (S), PHILIP (N S), GOPCHANDRAN (K G), PETER KOSHY and VAIDYAN (V K)**
Nanostructural and surface morphological evolution of chemically sprayed SnO₂ thin films
Applied Surface Science
254(7):2179-2186;30 Jan 2008
- 47 **CHITHRA (P), REJI VARGHESE, DIVYA (K P) and AJAYAGHOSH (A)**
Solvent-Induced aggregation and Cation-controlled self-assembly of Tripodal Squaraine
Dyes: Optical, Chiroptical and Morphological properties
Chemistry - An Asian Journal
3(8-9):1365-1373;2008
- 48 **CIDADE (M T), MENON (A R R), LEAL (C R) and PILLAI (C K S)**
Experimental results for the rheological and rheo-optical behavior of poly(ethylene
terephthalate) / liquid-crystalline polymer blends
Journal of Applied Polymer Science
107(2):1280-1287;15 Jan 2008
- 49 **ORAL (J), KARP (S G), VANDENBERGHE (L P de Souza), PARADA (J L), PANDEY (A)
and SOCCOL (C R)**
Batch fermentation model of Propionic acid production by *propionibacterium acidipropionici* in
different carbon sources
Applied Biochemistry and Biotechnology
151(2-3):333-341;Dec 2008
- 50 **COSTAS (L), BOSIO (V E), PANDEY (A) and CASTRO (G R)**
Effects of Organic Solvents on Immobilized lipase in Pectin Microspheres
Applied Biochemistry and Biotechnology
151(2-3):578-586;Dec 2008
- 51 **DEEPA (P) and JAYAKANNAN (M)**
Polyurethane-Oligo(phenylenevinylene) random copolymers: π-Conjugated pores, vesicles,
and nanospheres via solvent-induced self-organization
Journal of Polymer Science: Part A Polymer Chemistry
46(17):5897-5915;01 Sep 2008
- 52 **DEEPA (P) and JAYAKANNAN (M)**
Solvent-Free and Nonisocyanate Melt Transurethane Reaction for Aliphatic Polyurethanes
and Mechanistic aspects
Journal of Polymer Science: Part A :Polymer Chemistry
46(7):2445-2458;01 Apr 2008



- 53 **DEEPAK (V D) and ASHA (S K)**
Random and AB diblock copolymers of tricyclodecanemethanol urethane methacrylate with styrene: Synthesis and morphology characterization
Journal of Polymer Science: Part A: Polymer Chemistry
46(4):1278-1288;15 Feb 2008
- 54 **DEEPTHI (N R), RAVINDRAN NAIR (K), PRABHAKAR RAO (P), SIBI (K S), PETER KOSHY and VAIDYAN (V K)**
New perovskite type oxides: NaATiMO₆ (A=Ca or Sr; M=Nb or Ta) and their electrical properties
Materials Letters
62(4-5):623-628;29 Feb 2008
- 55 **DEEPTHI (N R), RAVINDRAN NAIR (K), PRABHAKAR RAO (P), SIBI (K S), PETER KOSHY and VAIDYAN (V K)**
Ionic conductivity in new perovskite type oxides: NaAZrMO₆ (A = Ca or Sr; M = Nb or Ta)
Materials Chemistry and Physics
109(2-3);189-193;15 Jun 2008
- 56 **DHANYA (D), SWETHA (S), NAMPOOTHIRI (K M), RAJEEV K SUKUMARAN and PANDEY (A)**
Response surface methodology for the optimization of alpha amylase production by *Bacillus amyloliquefaciens*
Bioresource Technology
99(11):4597-4602;Jul 2008
- 57 **DIAS (A), ABDUL KHALAM (L), SEBASTIAN (M T), LAGE (M M), MATINAGA (F M) and MOREIRA (R L)**
Raman scattering and Infrared spectroscopy of chemically substituted Sr₂LnTaO₆ (Ln = Lanthanides, Y, and In) double perovskites
Chemistry of Materials
20(16):5253-5259;22 Jul 2008
- 58 **DIAS (A), SUBODH (G), SEBASTIAN (M T), LAGE (M M) and MOREIRA (R L)**
Vibrational studies and microwave dielectric properties of A-site-substituted tellurium-based double perovskites
Chemistry of Materials
20(13):4347-4355;08 Jul 2008
- 59 **DIVYA (S), RANJITH (A) and ARUMUGHAN (C)**
HPTLC fingerprinting and quantification of lignans as markers in sesame oil and its polyherbal formulations
Journal of Pharmaceutical and Biomedical Analysis
47(4-5):795-801;05 Aug 2008
- 60 **ELIZABETH KURUVILLA, NANDAJAN (P C), SCHUSTER (Gary B) and RAMAIAH (D)**
Acridine-Viologen Dyads: Selective recognition of Single-Strand DNA through fluorescence enhancement
Organic Letters
10(19):4295-4298;02 Oct 2008
- 61 **EMILIA ABRAHAM (T) and SANGEETHA (K)**
Stabilization of industrial proteases for novel applications in chemical industry
Chemical Industry Digest
21(3):69-77;Mar 2008



- 62 **GANGA (V B), SURESH (E) and LUXMI VARMA (R)**
Novel 1,3-dipolar cycloaddition reactions of calix[4]bis(spirodienones): Synthesis of isoxazolidine derived macrocycles.
Tetrahedron Letters
49(11):1750-1752;10 Mar 2008
- 63 **GANGA (V B), SURESH (E), SURESH (C H) and LUXMI VARMA (R)**
Synthesis of novel heterocyclic calixarenes via the Diels-Alder reaction of calix[4]bis(spirodienones)
Indian Journal of Chemistry Section B- Organic Chemistry including Medicinal Chemistry
47(7):1071-1079;Jul 2008
- 64 **GAYATHRI DEVI (D), CIBIN (T R), RAMAIAH (D) and ANNIE (A)**
Bis(3,5-diiodo-2,4,6-trihydroxyphenyl) squaraine: A novel candidate in photodynamic therapy for skin cancer models in vivo
Journal of Photochemistry and Photobiology B: Biology
92(3):153-159;18 Sept 2008
- 65 **GIABLE GEORGE, SANDHYA KUMARI (L), VISHNU (V S), ANANTHAKUMAR (S) and REDDY (M L P)**
Synthesis and characterization of environmentally benign calcium-doped Pr₂Mo₂O₉ pigments: Applications in coloring of plastics
Journal of Solid State Chemistry
181(3):487-492;Mar 2008
- 66 **GOKULNATH (S) and CHANDRASHEKAR (T K)**
One-Pot Synthesis of Core-Modified meso-Aryl Calix[5]phyrin and N-Fused [24]Pentaphyrin
Organic Letters
10(4):637-640;21 Feb 2008
- 67 **GOKULNATH (S) and CHANDRASHEKAR (T K)**
Expanded porphyrins as third order non-linear optical materials: Some structure-function correlations
Journal of Chemical Sciences
120(1):137-142;Jan 2008
- 68 **GUHA (D), BISWAS (S), JOSEPH (T) and SEBASTIAN (M T)**
Defected ground structure to reduce mutual coupling between cylindrical dielectric resonator antennas
Electronics Letters
44(14):836-837;03 Jul 2008
- 69 **JACOB (N), NILADEVI (K N), ANISHA (G S) and PREMA (P)**
Hydrolysis of pectin: An enzymatic approach and its application in banana fiber processing
Microbiological Research
163(5):538-544;01 Sep 2008
- 70 **JAMES (D), MARY GLADIS (J), PANDEY (A K), NAIDU (G R K) and PRASADA RAO (T)**
Design of two-dimensional biomimetic uranyl optrode and its application to the analysis of natural waters
Talanta
74(5):1420-1427;15 Feb 2008



- 71 **JANCY (B) and ASHA (S K)**
Hydrogen-Bonding-Induced Conformational Change from J to H aggregate in Novel Highly Fluorescent Liquid-Crystalline Perylenebisimides
Chemistry of Materials
20(1):169-181;08 Jan 2008
- 72 **JAYASANKAR (M), ANANTHAKUMAR (S), MUKUNDAN (P), WUNDERLICH (W) and WARRIER (K G K)**
 $\text{Al}_2\text{O}_3 @ \text{TiO}_2$ —A simple sol-gel strategy to the synthesis of low temperature sintered alumina-aluminium titanate composites through a core-shell approach
Journal of Solid State Chemistry
181(10):2748-2754;Oct 2008
- 73 **JOSE (S), THOMAS (S), BIJU (P K), PETERKOSHY and KARGER-KOCSIS (J)**
Thermal degradation and crystallisation studies of reactively compatibilised polymer blends
Polymer Degradation and Stability
93(6):1176-1187;Jun 2008
- 74 **JOSEPH (J T), KUMAR (H P), MANOJ RAAMA VARMA, THOMAS (J K) and SOLOMON (S)**
Effect of Nb_2O_5 substitution on the dielectric characteristics of DyTiTaO_6 microwave ceramics
Materials Letters
62(6-7):1064-1066;15 Mar 2008
- 75 **JOSEPH (S), SREEKALA (M S), PETER KOSHY and THOMAS (S)**
Mechanical Properties and water sorption behavior of phenol-formaldehyde hybrid composites reinforced with banana fiber and glass fiber
Journal of Applied Polymer Science
109(3):1439-1446;05 Aug 2008
- 76 **KANT (R), SINGHAL (K), SHUKLA (S K), CHANDRASHEKAR (K), SAXENA (A K), RANJAN (A) and RAJ (P)**
Synthesis and biological activity of a novel compound: $(\text{C}_6\text{F}_5)_2\text{SbPh}$
Phosphorus, Sulfur, and Silicon and the Related Elements
183(8):2029-2039;2008
- 77 **KOUTINAS (A A) and PANDEY (A)**
Special Issue: Selected papers presented at the ICBF-2006 in Patras, Greece, June 18-21, 2006 - Preface
Food Technology and Biotechnology
46(2):123;Apr-Jun 2008
- 78 **KRISHNAKUMAR (B), ANUPAMA (V N), MANILAL (V B) and AJIT HARIDAS**
Dynamics of sustainable grazing fauna and effect on performance of gas biofilter
Journal of Bioscience & Bioengineering
105(3):192-197;Mar 2008
- 79 **KUMAR (H P), JOSEPH (S), SOLOMON (S), MANOJ RAAMA VARMA and THOMAS (J K)**
Synthesis, Structure analysis, and microwave dielectric properties of $\text{LnTiSb}_x\text{Ta}_{1-x}\text{O}_6$ (Ln=Ce,Pr, and Nd) ceramics
International Journal of Applied Ceramic Technology
5(4):347-352;2008



- 80 **KUMAR (N S S), SHINTO VARGHESE, RATH (N P) and SURESH DAS**
Solid state optical properties of 4-alkoxy-pyridine butadiene derivatives: Reversible thermal switching of luminescence
Journal of Physical Chemistry C
112(22):8429-8437;05 Jun 2008
- 81 **LIMA (L F O), HABU (S), GERN (J C), NASCIMENTO (B M), PARADA (J L), NOSEDA (M D), GONSALVES (A G), NISHA (V R), PANDEY (A), SOCCOL (V T) and SOCCOL (C R)**
Production and characterization of the Exopolysaccharides produced by *Agaricus brasiliensis* in submerged fermentation
Applied Biochemistry and Biotechnology
151(2-3):283-294;Dec 2008
- 82 **MACIEL (G M), VANDENBERGHE (L P D), HAMINIUK (C W I), FENDRICH (R C), DELLA BIANCA (B E), BRANDALIZE (T Q D), PANDEY (A) and SOCCOL (C R)**
Xylanase production by *Aspergillus niger* LPB 326 in solid-state fermentation using statistical experimental designs
Food Technology and Biotechnology
46(2):183-189;Apr-Jun 2008
- 83 **MAHADEVAN (K), RAGHUKANDAN (K), PAI (B C) and PILLAI (U T S)**
Influence of precipitation hardening parameters on the fatigue strength of AA 6061-SiC_p composite
Journal of Materials Processing Technology
198(1-3):241-247;03 Mar 2008
- 84 **MANGALARAJA (R V), LEE (S T), RAMAM (K V S), ANANTHAKUMAR (S) and MANOHAR (P)**
Mechanical characterization of Ni_{1-x}Zn_xFe₂O₄ prepared by non-conventional methods
Materials Science and Engineering A - Structural Materials Properties Microstructure and Processing
480(1-2):266-270;15 May 2008
- 85 **MANGALARAJA (R V), LEE (S T), ANANTHAKUMAR (S), MANOHAR (P) and CAMURRI (C P)**
Effect of composition on initial permeability of Ni_{1-x}Zn_xFe₂O₄ prepared by flash combustion technique
Materials Science and Engineering A - Structural Materials Properties Microstructure and Processing
476(1-2):234-239;15 Mar 2008
- 86 **MANILAL (V B)**
New hopes for pepper sector: A successful technology for white pepper production
Spice India
21(1):31-32;Jan 2008
- 87 **MANOJ (M) and ELIZABETH JACOB**
Information retrieval on Internet using meta-search engines: A review
Journal of Scientific & Industrial Research
67(10):739-746;Oct 2008
- 88 **MANOJ RAAMA VARMA, NISHA (P) and RAJATH VARMA (P C)**
Sinterability studies and microwave dielectric properties of sol-gel synthesized Ba(Zn_{1/3}Ta_{2/3})O₃ nanoparticles
Journal of Alloys and Compounds
457(1-2):422-428;12 Jun 2008



- 89 **MATHEW (G M), RAJEEV K SUKUMARAN, SINGHANIA (R R) and PANDEY (A)**
Progress in research on fungal cellulases for lignocellulose degradation
Journal of Scientific & Industrial Research
67(11):898-907;Nov 2008
- 90 **MATHEW (J), KOGA (N) and SURESH (C H)**
C-H bond activation through σ -bond metathesis and agostic interactions:Deactivation pathway of a Grubbs second-generation catalyst
Organometallics
27(18):4666-4670;22 Sep 2008
- 91 **MATSUNAGA (Y), TAKECHI (K), AKASAKA (T), RAMESH (A R), JAMES (P V), GEORGE THOMAS (K) and KAMAT (P V)**
Excited-State and Photoelectrochemical behavior of Pyrene-Linked Phenyleneethynylene Oligomer
Journal of Physical Chemistry B
112(46):14539-14547;20 Nov 2008
- 92 **MAYAMOL (P N), SHINY (T), DIVYA (S), BALACHANDRAN (C), SARITHA (S S), SUNDARESAN (A) and ARUMUGHAN (C)**
Process for zero-trans shortening using palm oil, sunflower oil and soybean oil through interesterification
Journal of Food Science and Technology - Mysore
45(4):305-311;Jul-Aug 2008
- 93 **MEENAKSHI (S), SAIRAM SUNDARAM (C) and RUGMINI SUKUMAR**
Enhanced fluoride sorption by mechanochemically activated kaolinites
Journal of Hazardous Materials
153(1-2):164-172;01 May 2008
- 94 **MEKALA (N K), SINGHANIA (R R), RAJEEV K SUKUMARAN and PANDEY (A)**
Cellulase production under solid-state fermentation by *Trichoderma reesei* RUT C30: Statistical optimization of process parameters
Applied Biochemistry and Biotechnology
151(2-3):122-131;Dec 2008
- 95 **MELEDANDRI (Carla J), STOLARCZYK (Jacek K), SWAPANKUMAR GHOSH and BROUGHAM (Dermot F)**
Nonaqueous magnetic nanoparticle suspensions with controlled particle size and nuclear magnetic resonance properties
Langmuir
24(24):14159-14165;16 Dec 2008
- 96 **MISRA (R) and CHANDRASHEKAR (T K)**
Structural diversity in expanded Porphyrins
Accounts of Chemical Research
41(2):265-279;Feb 2008
- 97 **MOLLY MATHEW and BEENA JOY**
Evaluation of the Protective Effect of Ethanol Extract of *Acalypha indica* Leaf Against Paracetamol-induced liver dysfunction
Asian Journal of Chemistry
20(1):705-710;Jan 2008



- 98 **MONDAL (B), KUNDU (S), LOHAR (A K) and PAI (B C)**
 Net-shape manufacturing of intricate components of A356/SiC_p composite through rapid-prototyping-integrated investment casting Materials Science and Engineering A - Structural Materials Properties
Microstructure and Processing
498(1-2)Sp.iss.S1:37-41;20 Dec 2008
- 99 **MUNUSAMY (U), VIKINESWARY (S), MUNIANDY (S), ABDULLAH (N), PANDEY (A) and JONES (E B G)**
 Characterisation of laccase from *pycnoporos sanguineus* KUM 60953 and KUM 60954
Journal of Biological Sciences
8(5):866-873;2008
- 100 **MUNUSAMY (U), VIKINESWARY (S), MUNIANDY (S), ABDULLAH (N), PANDEY (A) and JONES (E B G)**
 Biodegradation of Polycyclic Aromatic Hydrocarbons by Laccase of *Pycnoporus sanguineus* and toxicity evaluation of treated PAH
Biotechnology
7(4):669-677;2008
- 101 **NAGY (V), NAMPOOTHIRI (K M), PANDEY (A), RAHULAN (R) and SZAKACS (G)**
 Production of L-leucine aminopeptidase by selected *Streptomyces* isolates
Journal of Applied Microbiology
104(2):380-387;Feb 2008
- 102 **NAIR (K R), PRABHAKAR RAO (P), SAMEERA (S), VINITHA S MOHAN CHANDRAN (M R) and PETER KOSHY**
 New powellite type oxides in Ca-R-Nb-Mo-O system (R=y, La, Nd, Sm or Bi) - Their synthesis, structure and dielectric properties
Materials Letters
62(17-18):2868-2871;30 Jun 2008
- 103 **NAMPOOTHIRI (K M), RUBEX (R), PATEL (A K), NARAYANAN (S S), KRISHNA (S), DAS (S M) and PANDEY (A)**
 Molecular cloning, overexpression and biochemical characterization of hypothetical β -lactamases of *Mycobacterium tuberculosis* H37Rv
Journal of Applied Microbiology
105(1):59-67;Jul 2008
- 104 **NARAYANAN (S S), AJEENA RAMANUJAN, KRISHNA (S) and NAMPOOTHIRI (K M)**
 Purification and Biochemical characterization of Methionine Aminopeptidase (MetAP) from *Mycobacterium smegmatis* mc²155
Applied Biochemistry and Biotechnology
151(2-3):512-521;Dec 2008
- 105 **NEETHU (S), SURESH (C H), THRESIA (T), THOMAS (T J) and PILLAI (C K S)**
 Liquid crystalline phase behavior of high molecular weight DNA: A comparative study of the influence of metal ions of different size, charge and binding mode
Biomacromolecules
9(7):1860-1869;Jul 2008
- 106 **NICEMOL (J), ASHA POORNA (C) and PREMA (P)**
 Purification and partial characterization of polygalacturonase from *Streptomyces lydicus*
Bioresource Technology
99(14):6697-6701;Sep 2008



- 107 **NICEMOL (J) and PREMA (P)**
Novel process for the simultaneous extraction and degumming of banana fibers under solid-state cultivation
Brazilian Journal of Microbiology
39(1):115-121;Jan-Mar 2008
- 108 **NICEMOL (J), RAJEEV K SUKUMARAN and PREMA (P)**
Optimisation of Enzymatic Clarification of Sapodilla juice: A Statistical perspective
Applied Biochemistry and Biotechnology
151(2-3):353-363;Dec 2008
- 109 **NILADEVI (K N) and PREMA (P)**
Immobilization of laccase from *Streptomyces psammoticus* and its application in phenol removal using packed bed reactor
World Journal of Microbiology & Biotechnology
24(7):1215-1222;Jul 2008
- 110 **NILADEVI (K N) and PREMA (P)**
Effect of inducers and process parameters on laccase production by *Streptomyces psammoticus* and its application in dye decolorization
Bioresource Technology
99(11):4583-4589;Jul 2008
- 111 **NILADEVI (K N), NICEMOL (J) and PREMA (P)**
Evidence for a halotolerant-alkaline laccase in *Streptomyces psammoticus*: Purification and characterization
Process Biochemistry
43(6):654-660;Jun 2008
- 112 **NILADEVI (K N), SHEEJADEVI (P S) and PREMA (P)**
Strategies for enhancing Laccase yield from *Streptomyces psammoticus* and its role in Mediator-based decolorization of Azo Dyes
Applied Biochemistry and Biotechnology
151(1):9-19;Oct 2008
- 113 **PADMA KUMAR (H), THOMAS (J K), MANOJ RAAMA VARMA and SAM SOLOMON**
Synthesis and characterization of thermally stable, high Q, $\text{Nd}_x\text{Y}_{1-x}\text{TiTaO}_6$ dielectric resonators
Journal of Alloys and Compounds
455(1-2):475-479;08 May 2008
- 114 **PANDEY (A) and SINGHANIA (R R)**
Production and application of Industrial Enzymes
Chemical Industry Digest
21(9):82-91;Sep 2008
- 115 **PANICKER (S J), PHILIPOSE (M C) and AJIT HARIDAS**
Buoyant Filter Bio-Reactor (BFBR)-a novel anaerobic wastewater treatment unit
Water Science and Technology
58(2):373-377;2008
- 116 **PANNEERSELVAM (R), SAVITHRI (S) and SURENDER (G D)**
CFD modelling of gas-liquid-solid mechanically agitated contactor
Chemical Engineering Research & Design
86(12A):1331-1344;2008



- 117 **PERIYAT (P), BAIJU (K V), MUKUNDAN (P), PILLAI (P K) and WARRIER (K G K)**
High temperature stable mesoporous anatase TiO₂ photocatalyst achieved by silica addition
Applied Catalysis A - General
349(1-2):13-19;31 Oct 2008
- 118 **PRABHAKAR RAO (P), RAVINDRAN NAIR (K), SIBI (K S) and PETER KOSHY**
Pyrochlore-based oxides with small temperature coefficient of dielectric constant
Applied Physics Letters
92(25):Article No. 252906;23 Jun 2008
- 119 **PRADO (F C), PARADA (J L), PANDEY (A) and SOCCOL (C R)**
Trends in non-dairy probiotic beverages - Review
Food Research International
41(2):111-123;2008
- 120 **PRAKASH (P N) and RAMAIAH (D)**
DNA-assisted long-lived excimer formation in a Cyclophane
Angewandte Chemie International Ed
47(44):8407-8411;20 Oct 2008
- 121 **PRAMOD (P) and GEORGE THOMAS (K)**
Plasmon Coupling in Dimers of Au Nanorods
Advanced Materials
20(22):4300-4305;2008
- 122 **PRASADA RAO (T) and KALA (R)**
Potentiometric transducer based biomimetic sensors for priority envirototoxic markers - An overview
Talanta
76(3):485-496;30 Jul 2008
- 123 **PRAVEEN (V K), BABU (S S), VIJAYAKUMAR (C), REJI VARGHESE and AJAYAGHOSH (A)**
Helical Supramolecular Architectures of Self-Assembled Linear π -Systems
Bulletin of the Chemical Society of Japan
81(10):1196-1211;10 Oct 2008
- 124 **PRIYA (M), AJIT HARIDAS and MANILAL (V B)**
Anaerobic protozoa and their growth in biomethanation systems
Biodegradation
19(2):179-185;Apr 2008
- 125 **PRIYA RANI (B R) and SEBASTIAN (M T)**
The effect of glass addition on the dielectric properties of barium strontium titanate
Journal of Materials Science: Materials in Electronics
19(1):39-44;Jan 2008
- 126 **PURUSHOTHAMAN (J), SURYAKUMAR (G), SHUKLA (D), MALHOTRA (A S)
KASIGANESAN (H) KUMAR (R), SAWHNEY (R C) and ARUMUGHAN (C)**
Modulatory effects of seabuckthorn (*Hippophae rhamnoides* L.) in hypobaric hypoxia induced cerebral vascular injury
Brain Research Bulletin
77(5):246-252;25 Nov 2008



- 127 **RAGHAVAN (P), SATHY CHANDRASEKHAR, VOGT (V), GOCK (E) and SURESH (N)**
Additional investigation on the separation of titaniferous impurities from kaolin by high shear pre-treatment and froth flotation – Part II
Applied Clay Science
42(1-2):50-56;Dec 2008
- 128 **RAJAN (T P D), PILLAI (R M) and PAI (B C)**
Centrifugal casting of functionally graded aluminium matrix composite components.
International Journal of Cast Metals Research
21(1-4):214-218;Aug 2008
- 129 **RAJAN (T P D), PILLAI (R M) and PAI (B C)**
Functionally graded Al-Al₃ Ni in situ intermetallic composites: Fabrication and microstructural characterization (Letter)
Journal of Alloys and Compounds
453(1-2):L4-L7;03 Apr 2008
- 130 **RAJESH (K), BAIJU (K V), JAYASANKAR (M) and WARRIER (K G K)**
A Facile Aqueous Sol-Gel Process for the synthesis of Alumina-Lanthanum Phosphate Nanocomposite
Journal of the American Ceramic Society
91(7):2415-2418;Jul 2008
- 131 **RAJESH (K), SHAJESH (P), PULLITHADATHIL (B) and WARRIER (K G K)**
High surface area mesoporous nanocrystalline lanthanum phosphate nanorod through a sol-gel process – Effect of alcohol washing on a non-oxide gel
Microporous and Mesoporous Materials
116(1-3):693-697;Dec 2008
- 132 **RANJITH (A), SARIN KUMAR (K) and ARUMUGHAN (C)**
Simultaneous estimation of phenolic acids in sea buckthorn (*Hippophae rhamnoides*) using with DAD
Journal of Pharmaceutical and Biomedical Analysis
47(1):31-38;12 May 2008
- 133 **RATHEESH (K V), SHIBU ABRAHAM, AKIYAMA (H), FURUMI (S),TAMAOKI (N) and SURESH DAS**
Photoresponsive Glass-Forming Butadiene-based Chiral Liquid Crystals with circularly polarized photoluminescence
Advanced Functional Materials
18(17):2510-2517;10 Sep 2008
- 134 **RAVI (K R), PILLAI (R M), AMARANATHAN (K R), PAI (B C) and CHAKRABORTY (M)**
Fluidity of aluminum alloys and composites: A review
Journal of Alloys and Compounds
456(1-2):201-210;29 May 2008
- 135 **RAVI (K R), SARAVANAN (M), PILLAI (R M), MANDAL (A), MURTY (B S), CHAKRABORTY (M) and PAI (B C)**
Equal channel angular pressing of Al-5 wt% TiB₂ in situ composite
Journal of Alloys and Compounds
459(1-2):239-243;14 Jul 2008
- 136 **REDDY (J S) and ANAND (V G)**
Planar Meso Pentafluorophenyl Core Modified Isophlorins
Journal of the American Chemical Society
130(12):3718--3719;26 Mar 2008



- 137 **REDDY (J S) and ANAND (V G)**
 π -Conjugated macrocycles from thiophenes and benzenes
Chemical Communications
(11):1326-1328;21 Mar 2008
- 138 **REJINI (R), SUBODH (G) and SEBASTIAN (M T)**
 $\text{Ca}_4\text{La}_2\text{Ti}_5\text{O}_{17}$: A novel low loss dielectric ceramics in the $\text{CaO-La}_2\text{O}_3\text{-TiO}_2$ system
Journal of Materials Science: Materials in Electronics
19(12):1153-1155;Dec 2008
- 139 **REKHA (N) and ASHA (S K)**
Synthesis and FTIR spectroscopic investigation of the UV curing kinetics of Telechelic Urethane Methacrylate Crosslinkers based on the Renewable Resource-Cardanol
Journal of Applied Polymer Science
109(5):2781-2790;05 Sep 2008
- 140 **REKHA (R A), JYOTHISH (K) and RAMAIAH (D)**
Infrared absorbing croconaine dyes: Synthesis and metal ion binding properties
Journal of Organic Chemistry
73(1):274-279;04 Jan 2008
- 141 **REMYA (P N), BIJU (S), REDDY (M L P), COWLEY (A H) and FINDLATER (M)**
1D molecular ladder of the ionic complex of Terbium-4-sebacoylbis(1-phenyl-3-methyl-5-pyrazolone) and sodium dibenzo-18-crown-6: Synthesis, crystal structure, and photophysical properties
Inorganic Chemistry
47(16):7396-7404;2008
- 142 **RENUKA DEVI (R), JAYALEKSHMY (A) and ARUMUGHAN (C)**
Antioxidant efficacy of phytochemical extracts from defatted rice bran in in-vitro model emulsions
International Journal of Food Science and Technology
43(5):878-885;May 2008
- 143 **RESHMA (M V), SARITHA (S S), BALACHANDRAN (C) and ARUMUGHAN (C)**
Lipase catalyzed interesterification of palm stearin and rice bran oil blends for preparation of zero trans shortening with bioactive phytochemicals
Bioresource Technology
99(11):5011-5019;Jul 2008
- 144 **RIJU DAVIS, SALEESH KUMAR (N S), SHIBU ABRAHAM, SURESH (C H), RATH (N P), TAMAOKI (N) and SURESH DAS**
Molecular packing and solid-state fluorescence of Alkoxy-Cyano substituted Diphenylbutadienes: Structure of the luminescent aggregates
Journal of Physical Chemistry C
112(6):2137-2146;14 Feb 2008
- 145 **RIYAS (S), KRISHNAN (G) and MOHAN DAS (P N)**
Liquid Phase Photooxidation of Toluene in the Presence of Transition Metal Oxide doped Titania
Journal of the Brazilian Chemical Society
19(5):1023-1032;2008
- 146 **ROJAN P JOHN and NAMPOOTHIRI (K M)**
Strain improvement of *Lactobacillus delbrueckii* using nitrous acid mutation for L-lactic acid production
World Journal of Microbiology & Biotechnology
24(12):3105-3109;Dec 2008



- 147 **ROJAN P JOHN, GANGADHARAN (D) and NAMPOOTHIRI (K M)**
Genome shuffling of *Lactobacillus delbrueckii* mutant and *Bacillus amyloliquefaciens* through protoplasmic fusion for L-lactic acid production from starchy wastes
Bioresource Technology
99(17):8008-8015;Nov 2008
- 148 **ROJAN P JOHN, NAMPOOTHIRI (K M) and PANDEY (A)**
L(+)- Lactic Acid recovery from Cassava Bagasse based fermented medium using Anion Exchange Resins
Brazilian Archives of Biology and Technology
51(6):1241-1248;Nov-Dec 2008
- 149 **ROSCHEN SASIKUMAR, WALKER (M J), SAVITHRI (S) and SUNDARRAJ (S)**
Initiation of microporosity from pre-existing bubbles: A computational study.
Modelling and Simulation in Materials Science and Engineering
16(3):Article No.035009(14pp);Apr 2008
- 150 **RUGMINI SUKUMAR and MENON (A R R)**
Organomodified kaolin as a reinforcing filler for natural rubber
Journal of Applied Polymer Science
107(6):3476-3483;15 Mar 2008
- 151 **SAJAN (D G), AJI (A A), WARRIER (P R S), WARRIER (K G K), RADHAKRISHNAN (P), NAMPOORI (V P N) and VALLABHAN (C P G)**
Photoacoustic thermal characterization of Al_2O_3 -Ag ceramic nanocomposites
Materials Chemistry and Physics
111(1):38-41;15 Sep 2008
- 152 **SANDHYA KUMARI (L), GIABLE GEORGE, PRABHAKAR RAO (P) and REDDY (M L P)**
The synthesis and characterization of environmentally benign praseodymium-doped $TiCeO_4$ pigments
Dyes and Pigments
77(2):427-431;2008
- 153 **SANDHYA KUMARI (L), PRABHAKAR RAO (P) and REDDY (M L P)**
Environment-friendly red pigments from CeO_2 - Fe_2O_3 - Pr_6O_{11} solid solutions
Journal of Alloys and Compounds
461(1-2):509-515;11 Aug 2008
- 154 **SANGEETHA (K) and EMILIA ABRAHAM (T)**
Preparation and characterization of cross-linked enzyme aggregates (CLEA) of subtilisin for controlled release applications
International Journal of Biological Macromolecules
43(3):314-319;01 Oct 2008
- 155 **SANGEETHA (K) and EMILIA ABRAHAM (T)**
Investigation on the development of sturdy Bioactive Hydrogel Beads
Journal of Applied Polymer Science
107(5):2899-2908;05 Mar 2008
- 156 **SANGEETHA (K), MORRIS (V B) and EMILIA ABRAHAM (T)**
Stability and catalytic properties of encapsulated subtilisin in xerogels of alkoxisilanes
Applied Catalysis A - General
341(1-2):168-173;15 Jun 2008



- 157 SANTHA (N I)**
Effect of Bismuth Borate/LiF on the sintering, thermal, and microwave dielectric properties of $Ba_{6-3x}Sm_{8+2x}Ti_{18}O_{54}$ ($x=2/3$) solid solution
International Journal of Applied Ceramic Technology
5(4):334-340;2008
- 158 SANTHA (N) and SEBASTIAN (M T)**
Low temperature sintering and microwave dielectric properties of $Ba_4Sm_{9.33}Ti_{18}O_{54}$ ceramics
Materials Research Bulletin
43(8-9):2278-2284;4 Aug-4 Sep 2008
- 159 SANTHOSH (K), BEJOY THOMAS, LUXMI VARMA, SANDHYAMANY (S), KESAVADAS (C), APPUKUTTAN (P S), SRINIVAS (G), GUPTA (A K), KAPILAMOORTHY (T R) and UNNIKRISHNAN (M)**
Metabolite signature of developmental Foregut Cyst on In Vivo and In Vitro 1H MR Spectroscopy
Journal of Magnetic Resonance Imaging
28(2):493-496;Aug 2008
- 160 SARUN (P M), VINU (S), SHABNA (R), BIJU (A) and SYAMAPRASAD (U)**
Highly enhanced superconducting properties of Eu-doped (Bi, Pb)-2212
Materials Letters
62(17-18):2725-2728;30 Jun 2008
- 161 SASIKALA (T S), SUMA (M N), MOHANAN (P), PAVITHRAN (C) and SEBASTIAN (M T)**
Forsterite-based ceramic-glass composites for substrate applications in microwave and millimeter wave communications
Journal of Alloys and Compounds
461(1-2):555-559;11 Aug 2008
- 162 SATHY CHANDRASEKHAR and PRAMADA (P N)**
Microwave assisted synthesis of zeolite A from metakaolin
Microporous and Mesoporous Materials
108(1-3):152-161; 01 Feb 2008
- 163 SCOTT (J D), MANOS (S), COVENEY (P V), ROSSINY (J C H), FEARN (S), KILNER (J A), PULLAR (R C), ALFORD (N Mc N), AXELSSON (A K), ZHANG (Y), CHEN (L), YANG (S), EVANS (J R G) and SEBASTIAN (M T)**
Functional ceramic materials database: An online resource for Materials Research
Journal of Chemical Information and Modeling
48(2):449-455;Feb 2008
- 164 SEBASTIAN (M T) and JANTUNEN (H)**
Low loss dielectric materials for LTCC applications: A review
International Materials Reviews
53(2):57-90;Mar 2008
- 165 SELLA (S R B R), DLUGOKENSKI (R E F), GUIZELINI (B P), VANDENBERGHE (L P S), MEDEIROS (A B P), PANDEY (A) and SOCCOL (C R)**
Selection and optimization of *Bacillus atrophaeus* Inoculum medium and its effect on spore yield and Thermal Resistance.
Applied Biochemistry and Biotechnology
151(2-3):380-392;Dec 2008



- 166 SHABNA (R), SARUN (P M), VINU (S), BIJU (A), GURUSWAMY (P) and SYAMAPRASAD (U)**
Metal-insulator transition and conduction mechanism in dysprosium doped $\text{Bi}_{1.7}\text{Pb}_{0.4}\text{Sr}_2\text{Ca}_{1.1}\text{Cu}_{2.1}\text{O}_{8+\delta}$ system
Journal of Applied Physics
104(1):013919(6pp);01 Jul 2008
- 167 SHALIGRAM (N S), SINGH (S K), SINGHAL (R S), SZAKACS (G) and PANDEY (A)**
Compactin production in solid-state fermentation using orthogonal array method by *P. brevicompactum*
Biochemical Engineering Journal
41(3):295-300;01 Oct 2008
- 168 SHANMUGAM (P) and VAITHIYANATHAN (V)**
Stereoselective synthesis of 3-spiro- α -methylene- γ -butyrolactone oxindoles from Morita-Baylis-Hillman
Tetrahedron
64(15):3322-3330;07 Apr 2008
- 169 SHANMUGAM (P), VAITHIYANATHAN (V) and SELVAKUMAR (K)**
A mild and efficient CAN mediated oxidation of Morita-Balyis-Hillman adducts of 5-methyl-*N*-alkylisatin to 5-formyl-*N*-alkylisatin
Tetrahedron Letters
49(13):2119-2123;24 Mar 2008
- 170 SHANMUGAM (P), BABY VISWAMBHARAN, SELVAKUMAR (K) and SUCHITHRA (M)**
A facile and efficient synthesis of highly functionalised 3,3' - dispiropyrrolidine- and 3,3' - dispiropyrrrolizidine bisoxindoles via [3+2] cycloaddition
Tetrahedron Letters
49(16):2611-2615;14 Apr 2008
- 171 SHANMUGAM (P), SUCHITHRA (M), BABY VISWAMBHARAN and VAITHIYANATHAN (V)**
Synthesis of highly functionalised linear pentacyclic compounds from Baylis-Hillman adduct of heteroaldehydes with azomethine ylides via [3+2] cycloaddition
Indian Journal of Chemistry
47B(7):1113-1116;July 2008
- 172 SHANMUGAM (P) and BABY VISWAMBHARAN**
A Short and efficient synthesis of 3-Spiro- α -methylene- γ -butyrolactone Oxindolones from isomerised Bromo Derivatives of Morita-Baylis-Hillman Adducts
Synlett
(18):2763-2768;14 Nov 2008
- 173 SHERIN THOMAS and SEBASTIAN (M T)**
Effect of B_2O_3 - Bi_2O_3 - SiO_2 -ZnO glass on the sintering and microwave dielectric properties of $0.83\text{ZnAl}_2\text{O}_4$ - 0.17TiO_2
Materials Research Bulletin
43(4):843-851;01 Apr 2008
- 174 SHERIN THOMAS, DEEPU (V N), MOHANAN (P) and SEBASTIAN (M T)**
Effect of filler content on the dielectric properties of PTFE/ ZnAl_2O_4 - TiO_2 composites
Journal of the American Ceramic Society
91(6):1971-1975;Jun 2008
- 175 SHYNI (R), REDDY (M L P), COWLEY (A H) and FINDLATER (M)**
2-Thiopheneacetato-based one-dimensional coordination polymer of Tb^{3+} : Enhancement of Terbium-centered luminescence in the presence of Bidentate nitrogen donor ligands
European Journal of Inorganic Chemistry
(28):4387-4394;Oct 2008



- 176 SHUKLA (S), ZHANG (P), CHO (H J), LUDWIG (L) and SEAL (S)**
Significance of electrode-spacing in hydrogen detection for tin oxide-based MEMS sensor
International Journal of Hydrogen Energy
33(1):470-475;Jan 2008
- 177 SIMI (C K) and EMILIA ABRAHAM (T)**
Physicochemical, rheological and thermal properties of Njavara Rice (*Oryza sativa*) starch
Journal of Agricultural and Food Chemistry
56(24):12105-12113;24 Dec 2008
- 178 SINDHU MATHEW and EMILIA ABRAHAM (T)**
Characterization of ferulic acid incorporated starch-chitosan blend films
Food Hydrolysis
22(5):826-835;Jul 2008
- 179 SIQUEIRA (P F), KARP (S G), CARVALHO (J C), STURM (W), RODRIGUEZ-LEON (J A), THOLOZAN (Jean- Luc), SINGHANIA (R R), PANDEY (A) and SOCCOL (C R)**
Production of bio-ethanol from soybean molasses by *Saccharomyces cerevisiae* at laboratory, l scales
Bioresource Technology
99(17):8156-8163;Nov 2008
- 180 SMITHA (S), SHAJESH (P), MUKUNDAN (P) and WARRIER (K G K)**
Sol-gel synthesis of biocompatible silica-chitosan hybrids and hydrophobic coatings
Journal of Materials Research
23(8):2053-2060;Aug 2008
- 181 SMITHA (S), SHAJESH (P), MUKUNDAN (P) and WARRIER (K G K)**
Synthesis of mesoporous hydrophobic silica microspheres through a modified sol-emulsion-gel process
Journal of Sol-Gel Science and Technology
48(3):356-361;Dec 2008
- 182 SOLOMON (S), KUMAR (H P), LOVELY JACOB, THOMAS (J K) and MANOJ RAAMA VARMA**
 $\text{Ln}(\text{Zr}_{1/3}\text{Ti}_{2/3})\text{TaO}_6$ (Ln=Ce,Pr,Nd and Eu): A novel group of microwave ceramics
Journal of Alloys and Compounds
461(1-2):675-677;11 Aug 2008
- 183 SPIER (M R), GREINER (R), RODRIGUEZ-LEON (J A), WOICIECHOWSKI (A L), PANDEY (A), SOCCOL (V T) and SOCCOL (C R)**
Phytase production using citric pulp and other residues of the agro industry in SSF by fungal isolates
Food Technology and Biotechnology
46(2):178-182;Apr-Jun 2008
- 184 SREEJA KUMARI (S S), PILLAI (R M) and PAI (B C)**
A study on the structural, age hardening and mechanical characteristics of Mn and Ca added Al-7Si-0.3Mg-0.6Fe alloy
Journal of Alloys and Compounds
453(1-2):167-173;03 Apr 2008
- 185 SREEJA KUMARI (S S), PILLAI (R M) and PAI (B C)**
Calcium in aluminium alloys - beneficial roles
Indian Foundry Journal
54(2):37-42;Feb 2008



- 186 SREEJA KUMARI (S S), PILLAI (R M) and PAI (B C)**
Structure and properties of Calcium and Strontium treated Al-7Si-0.3Mg alloy: A comparison
Journal of Alloys and Compounds
460(1-2):472-477;28 Jul 2008
- 187 SREEJITH (S), DIVYA (K P) and AJAYAGHOSH (A)**
Detection of zinc ions under aqueous conditions using chirality assisted solid-state fluorescence of a bipyridyl based fluorophore
Chemical Communications
(25):2903-2905;2008
- 188 SREEJITH (S), DIVYA (K P) and AJAYAGHOSH (A)**
A near-infrared squaraine dye as a latent ratiometric fluorophore for the detection of Aminothiol content in blood plasma
Angewandte Chemie International ed
47(41):7883-7887;29 Sep 2008
- 189 SREEJITH (S), PRIYA CAROL, CHITHRA (P) and AJAYAGHOSH (A)**
Squaraine dyes: A mine of molecular materials
Journal of Materials Chemistry
18(3):264-274;2008
- 190 SREEKUMAR (V M), PILLAI (R M), PAI (B C) and CHAKRABORTY (M)**
Evolution of $MgAl_2O_4$ crystals in Al-Mg-SiO₂ composites
Applied Physics A :Materials Science & Processing
90(4):745-752;Mar 2008
- 191 SREEKUMAR (V M), PILLAI (R M), PAI (B C) and CHAKRABORTY (M)**
Microstructural development in Al/Mg Al₂ O₄ *in situ* metal matrix composite using value-added silica sources
Science and Technology of Advanced Materials
9(1):Article No.015004;Jan-Mar 2008
- 192 SREEKUMAR (V M), PILLAI (R M), PAI (B C) and CHAKRABORTY (M)**
A study on the formation of $MgAl_2O_4$ and MgO crystals in Al-Mg/quartz composite by differential thermal analysis
Journal of Alloys and Compounds
461(1-2):501-508;11 Aug 2008
- 193 SREEKUMAR (V M), RAVI (K R), PILLAI (R M), PAI (B C) and CHAKRABORTY (M)**
Thermodynamics and kinetics of the formation of $Al_2O_3/MgAl_2O_4/MgO$ in al-silica metal matrix composite
Metallurgical and Materials Transactions A - Physical Metallurgy and Materials Science
39A(4):919-933;Apr 2008
- 194 SREENATH (K), SUNEESH (C V), RATHEESHKUMAR (V K) and GOPIDAS (K R)**
Cu(II)-Mediated generation of Triarylamine Radical Cations and their Dimerization. An Easy Route to Tetraarylbenzidines
Journal of Organic Chemistry
73(8):3245-3251;18 Apr 2008



- 195 SRINIVASAN (A), SWAMINATHAN (J), PILLAI (U T S), GUGULOTH (K) and PAI (B C)**
Effect of combined addition of Si and Sb on the microstructure and creep properties of AZ91 magnesium alloy.
Materials Science and Engineering A - Structural Materials Properties Microstructure and Processing
485(1-2):86-91;25 Jun 2008
- 196 SRINIVASAN (S), BABU (S S), PRAVEEN (V K) and AJAYAGHOSH (A)**
Carbon nanotube triggered self-assembly of Oligo (*p*-phenylene vinylene)s to stable hybrid π gels
Angewandte Chemie International Ed
47(31):5746-5749;21 Jul 2008
- 197 SRINIVASAN (S), PRAVEEN (V K), ROBERT PHILIP and AJAYAGHOSH (A)**
Bioinspired superhydrophobic coatings of carbon nanotubes and linear π systems based on the "Bottom-up" self-assembly approach
Angewandte Chemie International Ed
47(31):5750-5754;21 Jul 2008
- 198 SUBODH (G) and SEBASTIAN (M T)**
Microwave dielectric properties of ATe_3O_8 (A=Sn,Zr) ceramics
Japanese Journal of Applied Physics
47(10):7943-7946;2008
- 199 SUBODH (G), MANJUSHA (M V), PHILIP (J) and SEBASTIAN (M T)**
Thermal properties of Polytetrafluoroethylene/ $Sr_2Ce_2Ti_5O_{16}$ polymer/ceramic composites
Journal of Applied Polymer Science
108(3):1716-1721;05 May 2008
- 200 SUBODH (G), RATHEESH (R), JACOB (M V) and SEBASTIAN (M T)**
Microwave dielectric properties and vibrational spectroscopic analysis of $MgTe_2O_5$ ceramics
Journal of Materials Research
23(6):1551-1556;Jun 2008
- 201 SUKUMARAN (K), RAVIKUMAR (K K), PILLAI (S G K), RAJAN (T P D), RAVI (M), PILLAI (R M) and PAI (B C)**
Studies on squeeze casting of A1 2124 alloy and 2124-10% SiCp metal matrix composite
Materials Science and Engineering A - Structural Materials Properties Microstructure and Processing
490(1-2):235-241;25 Aug 2008
- 202 SUMAN MARIAM THOMAS, PRABHAKAR RAO (P), RAVINDRAN NAIR (K) and PETER KOSHY**
New red- and Green-emitting phosphors, $AYP_2O_{7.5}:RE^{3+}$ (A=Ca and Sr;RE = Eu and Tb) under near-UV irradiation
Journal of the American Ceramic Society
91(2):473-477;Feb 2008
- 203 SUMANTHA (A), FONTANILLE (P), LARROCHE (C) and PANDEY (A)**
Exploration of fungal spores as a possible storehouse of proteolytic biocatalysts
World Journal of Microbiology & Biotechnology
24(12):2897-2901;Dec 2008



- 204 SUMESH GEORGE and SEBASTIAN (M T)**
Effect of sintering temperature on the percolation threshold and the dielectric properties of $\text{Ca}[(\text{Li Nb}_{2/3})_{1-x} \text{Ti}_x] \text{O}_3$ - δ -Ag composite
Composites Science and Technology
68(12):2461-2467; Sep 2008
- 205 SUMI (V S), KALA (R), PRAVEEN (R S) and PRASADA RAO (T)**
Imprinted polymers as drug delivery vehicles for metal-based anti-inflammatory drug
International Journal of Pharmaceutics
349(1-2):30-37; 12 Feb 2008
- 206 SUMI MITRA and PILLAI (C K S)**
Semiflexible Random Thermotropic Copolymers from 8-(3-Hydroxy phenyl) Octanoic Acid and 3-chloro-4-hydroxy Benzoic Acid/3,5-Dibromo-4-Hydroxy Benzoic Acid
Journal of Applied Polymer Science
107(2):778-783; 15 Jan 2008
- 207 SUMITRA (R), FONTANILLE (P), PANDEY (A) and LARROCHE (C)**
Fed-batch production of Gluconic Acid by Terpene-treated *Aspergillus niger* Spores
Applied Biochemistry and Biotechnology
151(2-3):413-423; Dec 2008
- 208 SUMITRA (R), FONTANILLE (P), PANDEY (A) and LARROCHE (C)**
Stability of glucose oxidase activity of *Aspergillus niger* spores produced by solid-state fermentation and their role as biocatalysts in bioconversion reaction.
Food Technology and Biotechnology
46(2):190-194; Apr-Jun 2008
- 209 SUMITRA (R), FONTANILLE (P), PANDEY (A) and LARROCHE (C)**
Permeabilization and inhibition of the germination of spores of *Aspergillus niger* for gluconic acid production from glucose
Bioresource Technology
99(11):4559-4565; Jul 2008
- 210 SURESH (C H), ALEXANDER (P), VIJAYALAKSHMI (K P), SAJITH (P K) and GADRE (S R)**
Use of molecular electrostatic potential for quantitative assessment of inductive effect
Physical Chemistry Chemical Physics
10(43):6492-6499; 2008
- 211 SURESH (C H), VARGHEESE (A M), VIJAYALAKSHMI (K P), MOHAN (N) and KOGA (N)**
Role of structural water molecule in HIV Protease-Inhibitor complexes: A QM/MM Study
Journal of Computational Chemistry
29(11):1840-1849; Aug 2008
- 212 SURESH DAS, NARAYANAN (G), SHIBU ABRAHAM, JAYARAMAN (N), SINGH (M K), KRISHNA PRASAD (S) and SHANKAR RAO (D S)**
Manifestation of a chiral smectic C phase in Diphenylbutadiene-cored Bolaamphiphilic sugars
Advanced Functional Materials
18(11):1632-1640; 11 Jun 2008



- 213 **SYAM KRISHNAN (K), JINESH (M K), JUBI JOHN, SURESH (C H), SURESH (E) and RADHAKRISHNAN (K V)**
Stereocontrolled synthesis of novel spirocyclic oxa-bridged cyclooctanoids through sequential transformations of pentafulvenes
Synthesis - Stuttgart
(13):2134-2140;01 Jul 2008
- 214 **SYAM KRISHNAN (K), RANI (R) and RADHAKRISHNAN (K V)**
Periselectivity in the cycloaddition reactions of pentafulvenes with 3-oxidopyrylium betaines: Effect of substituent on the C-6 carbon
Synthesis - Stuttgart
(12):1955-1959;17 Jun 2008
- 215 **TAKECHI (K), KAMAT (P V), REKHA (R A), JYOTHISH (K) and RAMAIAH (D)**
Harvesting infrared photons with croconate dyes
Chemistry of Materials
20(1):265-272;08 Jan 2008
- 216 **THOMAS (S), SARITHA K NAIR, JAMAL (E M A), AI-HARTHI (S H), MANOJ RAAMA VARMA and ANANTHARAMAN (M R)**
Size-dependent surface plasmon resonance in silver silica nanocomposites
Nanotechnology
19(7):Article No. 075710;20 Feb 2008
- 217 **TORRES (S), BAIGORI (M D), PANDEY (A) and CASTRO (G R)**
Production and Purification of a Solvent-Resistant Esterase from *Bacillus licheniformis* S-86.
Applied Biochemistry and Biotechnology
151(2-3):221-232;Dec 2008
- 218 **TRIPATHI (R P), VARMA (H C), SATHY CHANDRASEKHAR and RAMASWAMY (S)**
Mossbauer spectroscopic study of China clay samples collected from different Indian sites
Hyperfine Interactions
186(1-3):153-160;Sep 2008
- 219 **UBIC (R), SUBODH (G), SEBASTIAN (M T), GOUT (D) and PROFFEN (T)**
Structure of compounds in the $\text{Sr}_{1-3x/2}\text{Ce}_x\text{TiO}_3$ homologous series
Chemistry of Materials
20(9):3127-3133;13 May 2008
- 220 **VARMA (P C R), MANNA (R S), BANERJEE (D), MANOJ RAAMA VARMA, SURESH (K G) and NIGAM (A K)**
Magnetic properties of CoFe_2O_4 synthesized by solid state, citrate precursor and polymerized complex methods: A comparative study
Journal of Alloys and Compounds
453(1-2):298-303;03 Apr 2008
- 221 **VIJAY NAIR (G) and ABHILASH (K G)**
[8+2] Cycloaddition reactions in organic synthesis
Synlett
(3):301-312;12 Feb 2008
- 222 **VIJAY NAIR (G), BENEESH (P B), SREEKUMAR (V) and SURESH (E)**
Stereoselective synthesis of spirocyclopentanones via *N*-heterocyclic carbene-catalyzed reactions of enals and dienones
Chemical Communications
(6):747-749;2008



- 223 VIJAY NAIR (G), BIJU (A T), SMITHA C MATHEW and BABU (B P)**
Carbon-nitrogen bond forming reactions of diakyl azodicarboxylate: A promising synthetic strategy
Chemistry - An Asian Journal
3(5):810-820;2008
- 224 VIJAY NAIR (G), DEVIPRIYA (S) and SURESH (E)**
A novel three-component reaction involving quinoline, dimethyl acetylenedicarboxylate, and C-H acids leading to the synthesis of pyrroloquinoline derivatives
Synthesis - Stuttgart
(7):1065-1068;01 Apr 2008
- 225 VIJAY NAIR (G), DEVIPRIYA (S) and SURESH (E)**
Construction of heterocycles via 1,4-dipolar cycloaddition of quinoline-DMAD zwitterion with various dipolarophiles
Tetrahedron
64(16):3567-3577;14 Apr 2008
- 226 VIJAY NAIR (G), SMITHA C MATHEW, BIJU (A T) and SURESH (E)**
Reaction of Huisgen zwitterion with diaryl ketones leading to the facile synthesis of mono- and bis (alkoxycarbonyl) hydrazones
Synthesis - Stuttgart
(7):1078-1084;01 Apr 2008
- 227 VIJAY NAIR (G), SMITHA C MATHEW, SREEKUMAR (V), ABHILASH (N P) and SURESH (E)**
An efficient three-component reaction involving triazolylidene carbene, DMAD, and aldehydes for the synthesis of furanone derivatives
Synthesis - Stuttgart
(4):551-554;15 Feb 2008
- 228 VIJAY NAIR (G), SREEKUMAR (V) and BABU (B P)**
Recent advances in carbon-carbon bond-forming reactions involving homoenolates generated by NHC catalysis
Chemical Society Reviews
37(12):2691-2698;Dec 2008
- 229 VIJAY NAIR (G), VIDYA (N), ABHILASH (K G) and SURESH (E)**
An efficient synthesis of indolo[3,2-a] carbazoles via the novel acid catalyzed reaction of indoles and diaryl-1,2-diones
Organic & Biomolecular Chemistry
6(10):1738-1742;2008
- 230 VIJAYALAKSHMI (K P) and SURESH (C H)**
Theoretical studies on the carcinogenic activity of diol epoxide derivatives of PAH: proton affinity and aromaticity as decisive descriptors
Organic & Biomolecular Chemistry
6(23):4384-4390;2008
- 231 VIJAYALAKSHMI (K P) and SURESH (C H)**
Theoretical studies on the Carcinogenicity of Polycyclic Aromatic Hydrocarbons
Journal of Computational Chemistry
29(11):1808-1817;Aug 2008



- 232 VINOD (K), NESON VARGHESE, ABHILASH KUMAR (R G), SYAMAPRASAD (U) and ROY (S B)**
Influence of Mg particle size on the reactivity and superconducting properties of *in situ* MgB₂
Journal of Alloys and Compounds
464(1-2):33-37;22 Sep 2008
- 233 VINOD (K), NESON VARGHESE, SYAMAPRASAD (U), SHIPRA and SUNDARESAN (A)**
Structural and superconducting properties of bulk MgB₂ with added nano Tb₄O₇
Superconductor Science and Technology
21(2):Article No.025003(5pp);Feb 2008
- 234 VINU (S), SARUN (P M), BIJU (A), SHABNA (R), GURUSWAMY (P) and SYAMAPRASAD (U)**
The effect of substitution of EU on the critical current density and flux pinning properties of (Bi, Pb)- 2212 superconductor
Superconductor Science and Technology
21(4):045001 (4pp);Apr 2008
- 235 VINU (S), SARUN (P M), SHABNA (R), BIJU (A) and SYAMAPRASAD (U)**
The influence of sintering temperature on the microstructure and superconducting properties of Bi_{1.7}Pb_{0.4}Sr_{1.8}Nd_{0.2}Ca_{1.1}Cu_{2.1}O_{8+δ} superconductor
Superconductor Science and Technology
21(8):Article No.085010(5pp);Aug 2008
- 236 VINU (S), SARUN (P M), SHABNA (R), BIJU (A) and SYAMAPRASAD (U)**
Enhancement of critical current density and flux pinning properties of Gd-doped (Bi, Pb)-2212 superconductor
Journal of Applied Physics
104(4):043905(5pp);20 Aug 2008
- 237 VINU (S), SARUN (P M), SHABNA (R), BIJU (A) and SYAMAPRASAD (U)**
Improved microstructure and flux pinning properties of GD-substituted (Bi,Pb)- 2212 superconductor sintered between 846 and 860°C
Materials Letters
62(29):4421-4424;30 Nov 2008
- 238 VINU (S), SARUN (P M), SHABNA (R), BIJU (A), GURUSWAMY (P) and SYAMAPRASAD (U)**
Effect of Dy substitution at the Sr Site on the critical current density and flux-pinning properties of (Bi, Pb)-2212 superconductor
Journal of the American Ceramic Society
91(11):3585-3589;Nov 2008
- 239 VIOLA (B M), EMILIA ABRAHAM (T), ARATHI (D S), SREEKUMAR (E), PILLAI (M R), THOMAS (T J) and PILLAI (C K S)**
Synthesis and characterization of novel water-soluble polyamide based on spermine and aspartic acid as a potential gene delivery vehicle
Express Polymer Letters
2(5):330-338;2008
- 240 VISHNUVARDHAN (V), KALA (R) and PRASADA RAO (T)**
Chemical switch based reusable dual optoelectronic sensor for nitrite
Analytica Chimica Acta
623(1):53-58;08 Aug 2008



- 241 YADAV (P), MOHAN (H), MAITY (D K), SURESH (C H) and RAO (B S M)**
Oxidation of cinnamic acid derivatives: A pulse radiolysis and theoretical study
Chemical Physics
351(1-3):57-64;03 Jul 2008
- 242 YAGAI (S), MAHESH (S), KIKKAWA (Y), UNOIKE (K), KARATSU (T), KITAMURA (A) and AJAYAGHOSH (A)**
Toroidal Nanoobjects from Rosette Assemblies of Melamine-Linked Oligo (*p*-phenyleneethynylene)s and Cyanurates
Angewandte Chemie International Ed
47(25):4691-4694;09 Jun 2008
- 243 YOON (Min-Chul), MISRA (R), YOON (Z S), KIM (K S), LIM (J M), CHANDRASHEKAR (T K) and KIM (D)**
Photophysical Properties of Core-Modified expanded Porphyrins: Nature of aromaticity and enhancement of Ring Planarity
Journal of Physical Chemistry B
112(23):6900-6905;12 Jun 2008
- 244 ZACHARIAH (A), BAIJU (K V), SHUKLA (S), DEEPA (K S), JOSE JAMES and WARRIER (K G K)**
Synergistic effect in photocatalysis as observed for mixed-phase nanocrystalline titania processed via Sol-Gel solvent mixing and calcination
Journal of Physical Chemistry C
112(30):11345-11356;31 Jul 2008

NB: Titles at SI nos. 24, 34, 42, 43, 61, 86, 99, 100, 114, 185 & 239 are Non-SCI publications



GENERAL INFORMATION

VISITS ABROAD

Scientist Name	Country	Purpose	From	To
Dr. A. Ajayag-hosh	France	Indo-French Collaborative programme	12-05-2008	25-07-2008
	China	Fifth Asian Photochemistry Conference	01-11-2008	12-11-2008
	Japan	NIMS Collaborative programme	12-12-2008	21-12-2008
	France	Indo-French collaborative project	25-03-2009	09-04-2009
Dr. S. Anant-hakumar	France	Post-doctoral Fellowship	01-04-2008	31-03-2009
Dr. Ashok Pandey	Korea	International Conference	08-04-2008	09-04-2008
	France/ Australia	Blaise Pascal Univ. Fellowship and Conference in Australia	02-06-2008	17-07-2008
	South Korea	World Green Energy Forum 2008	08-10-2008	11-10-2008
	Switzerland	Guest Lecturer at Ecole Polytechnique Federale de Lausanne	01-12-2008	19-12-2008
	France	IEA Workshop	09-02-2009	10-02-2009
	Korea	International Mini-Symposium on Biotechnology	23-02-2009	26-02-2009
	Greece	International Scientific Workshop at University of Patras	29-03-2009	30-03-2009
Dr. K. George Thomas	Italy	DST-Italian Collaborative project	15-06-2008	25-06-2008
	Australia	International Conference at Sydney	26-07-2008	02-08-2008
	Italy	Italian Trade Commission Meeting	16-09-2008	20-09-2008
Dr. K. Madhavan Nam-poothiri	Germany	University of Westfalische	02-03-2009	14-03-2009
Dr. Manoj Raama Varma	Germany	CSIR-DAAD Scientist Exchange Programme 2008	01-04-2008	30-06-2008
Dr. M. T. Sebastian	China	International Conference on Microwave Materials	01-11-2008	04-11-2008
Dr. Rajeev K Sukumaran	South Korea	Renewable Energy 2008 Conference	13-10-2008	17-10-2008
Dr. Roschen Sasikumar	Germany	University of Leipzig	28-02-2009	15-03-2009
Dr. S. Savithri	Canada	International Symposium	16-08-2008	22-08-2008
Dr. Suresh Das	China	Fifth Asian Photochemistry Conference	31-10-2008	05-11-2008
	Japan / Hong Kong	Asian Academic Seminar 2009	28-02-2009	11-03-2009
Dr. T. P. D. Rajan	Japan	Asian Foundry Congress	17-05-2008	27-07-2008

**HONOURS AND AWARDS**

Awardee	Awards/Recognition
Dr. Ajayaghosh	Member, International Editorial Advisory Board, ACS, Applied Materials & Interface Thomson Reuters Research Excellence- India Research Front Award DAE-SRC Outstanding Research Award by Dept. Atomic Energy, GOI
Dr. Satyajit Shukla	CSIR Young Scientist Award in Engineering Sciences 2008
Prof. Ashok Pandey	Fellow, International Organization for Biotechnology and Bioengineering (FIOBB) (2008) SCIRUS Topic Page Author, Elsevier Science, UK (2008)
Dr. D. Ramiah	Associate Editor of Photochemistry and Photobiology (From January 2009 onwards)
Dr. M.T. Sebastian	MRSI Medal 2009
Dr. Suresh Das	CRSI Silver Medal in 2009
Dr. P. Prabhakar Rao	Fellow of Electron Microscope Society of India (EMSI) International Centre Diffraction Data award for the significant contribution for inclusion in powder diffraction files.
Dr. Manoj Rama Varma	Fellow of the Institution of Engineers (FIE)
Dr. T.P.D. Rajan	IIF Research Award (2008) by Indian Institute of Foundryman, Calcutta towards the contribution in development of cast metal matrix composites & functionally graded materials for engineering applications. Best Research Paper Award (2008) at National level by Indian Institute of Metals, during 63rd Annual Technical Meeting
Dr. V. S. Prasad	Sri Chitra Prize (2003) by University of Kerala for the author of the best Treatise among pure, applied and technological sciences
Shri. Sumesh George	Young scientist award during Kerala Science Congress (2009)
Ms. Reeta Rani Singhanian	AU-CBT Excellence Award for the best doctoral student for the year 2007, Biotech Research Society of India (2008)
Shri. Syed Ubaid Ahmed	Best Paper Award, International Conference on Bioprocesses in Food Industries (ICBF-2008) & V BRSI Convention, Hyderabad, India (2008)
Ms. Remani K. C. & Mr. Swapankumar Ghosh	Best paper award for oral presentation at Indian Ceramic Society Annual Conference at Jaipur (January 2009)
Mr. K. S. Sibi	Best oral presentation in the EMSI NC – 2009 held at Bundelkhand



Ph.D. DEGREE AWARDED

Student	Thesis Title	Supervisor	University
V.B. Ganga	Design and synthesis of novel macrocycles based on calix[4]arene using spirodienone chemistry	Dr. R. Luxmi Varma	Kerala
S. Anas	Novel synthetic transformations of pentafulvenes towards alkylidene cyclopentenes and azapolycycles	Dr. K. V. Radhakrishnan	Kerala
V.S. Sajisha	Design, synthesis and evaluation of the host-guest interaction in neoglycoconjugates and palladium catalyzed desymmetrization of mesobicyclic hydrazines	Dr. K. V. Radhakrishnan	Kerala
P. Binod	Microbial synthesis of chitinase	Dr. Ashok Pandey	Kerala
S. Babitha	Production of microbial pigments	Dr. Ashok Pandey	Kerala
Sumitra Ramachandran	Production of spores in solid-state fermentation	Dr. Ashok Pandey	Blaise Pascal (France)
Rojan P John	Studies on lactic acid production	Dr. K. M. Nampoothiri	Kerala
G.S. Anisha	Production and characterization of alpha galactosidases from <i>Streptomyces griseoloalbus</i>	Dr. P. Prema	CUSAT
Nicemol Jacob	Production of polygalactouronase and its application on food industry	Dr. P. Prema	Kerala
R.S. Praveen	On-line flow injection in geological and environmental analysis	Dr. T. Prasada Rao	Kerala
P. Pramod	Optical properties of nanoparticles: decorated gold nano rods and carbon nanotubes	Dr. K. George Thomas	CUSAT
P. Chithra	Squaraine based cation probes and self assembly modules: Design, synthesis and properties	Dr. A. Ajayaghosh	Kerala
Beena James	Synthesis and exploration of the chemistry of novel polycyclic cage compounds	Dr. Mangalam Nair	Kerala
S. Ramaswamy	Study of ferruginous and titaniferous impurity minerals in china clay	Dr. Sathy Chandrasekhar	CUSAT



MEMBERS OF THE RESEARCH COUNCIL

CHAIRMAN

Dr. Dipankar Banerjee

Chief Controller R & D (AMS) & D.S
Room No. 301, DRDO Bhawan
Defence Research Development Organisation
New Delhi - 110 011

MEMBERS

Prof. Ashutosh Sharma

Professor, Department of Chemical Engineering
Indian Institute of Technology
Kanpur - 208 016

Prof. K.S. Gandhi

Professor, Department of Chemical Engineering
Indian Institute of Science
Bangalore - 560 012

Dr. M. Radhakrishna Pillai, FASc

Director
Rajiv Gandhi Centre for Biotechnology
Jagathy, Trivandrum - 695 019

Prof. S. Ramakrishnan, FASc

Professor
Department of Inorganic & Physical Chemistry
Indian Institute of Science
Bangalore - 560 012

Dr. Pradeep

Senior Scientist
Tata Research Development & Design Centre
54B, Hadapsar Industrial Estate
Pune - 411 013

Prof. D.V. Khakhar

Director
Indian Institute of Technology
Powai, Mumbai - 400 076

Dr. S.L. Govindwar

Adviser
Department of Biotechnology
Block-2, 7th Floor, CGO Complex
Lodhi Road, New Delhi - 110 003

Dr. M.G. Kulkarni

Head, Polymer Science & Engineering
National Chemical Laboratory
Pashan Road, Pune - 411 008

**Prof. B.K. Mishra**

Director
Institute of Minerals and Materials Technology
Bhubaneswar - 751 013

Dr. B.C. Pai

Acting Director
National Institute for Interdisciplinary Science & Technology (NIIST)
Trivandrum - 695 019

Dr. Naresh Kumar

Head
Planning & Performance Division
CSIR, Rafi Marg
New Delhi - 110 001

SECRETARY**Dr. A. Sundaresan**

Head
Agroprocessing & Natural Products Division
National Institute for Interdisciplinary Science & Technology (NIIST)
Trivandrum-695 019

MEMBERS OF THE MANAGAMENT COUNCIL

CHAIRMAN

Director, NIIST

MEMBERS

Dr. A.K. Gupta, Scientist, NPL, New Delhi
Dr. Suresh Das, Scientist, NIIST
Dr. U. T.S. Pillai, Scientist, NIIST
Dr. K.Madhavan Namboothiri, Scientist, NIIST
Dr. (Mrs.) S. Savithri, Scientist, NIIST
Dr. C.S. Bhat, Scientist, NIIST
Shri. K. Prasad, Technical Officer, NIIST
COFA, NIIST

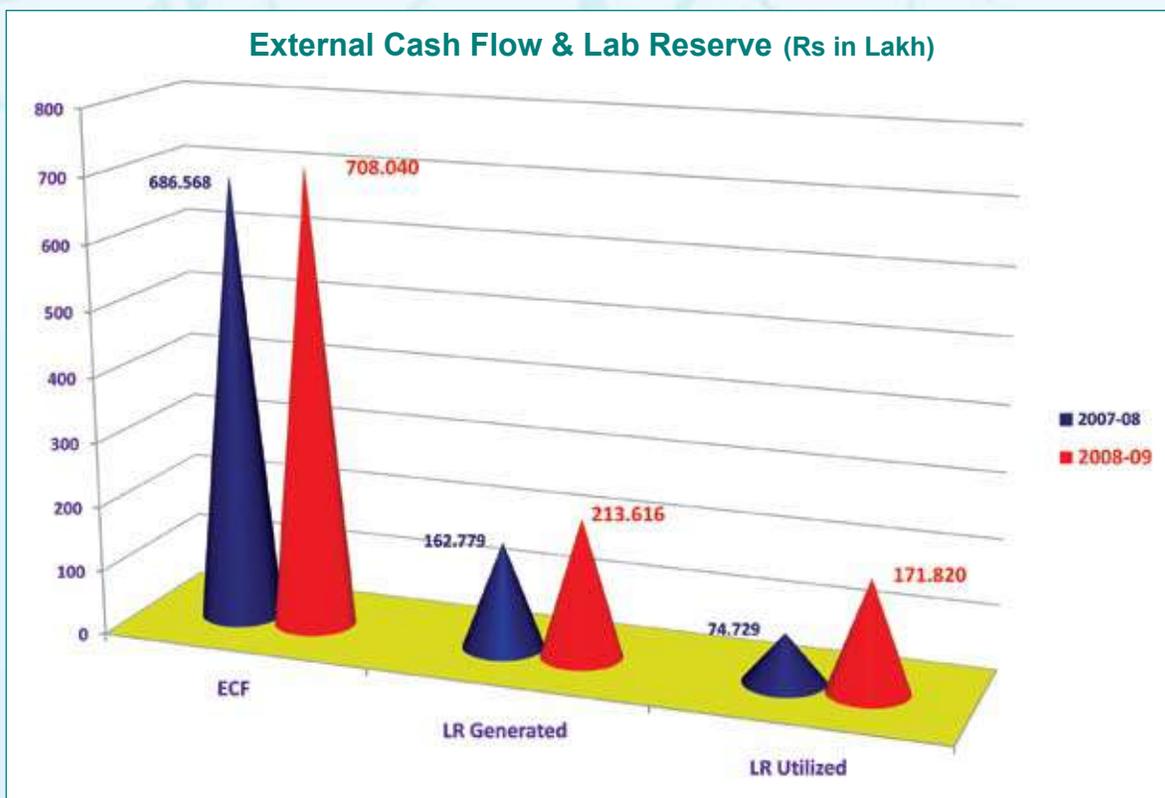
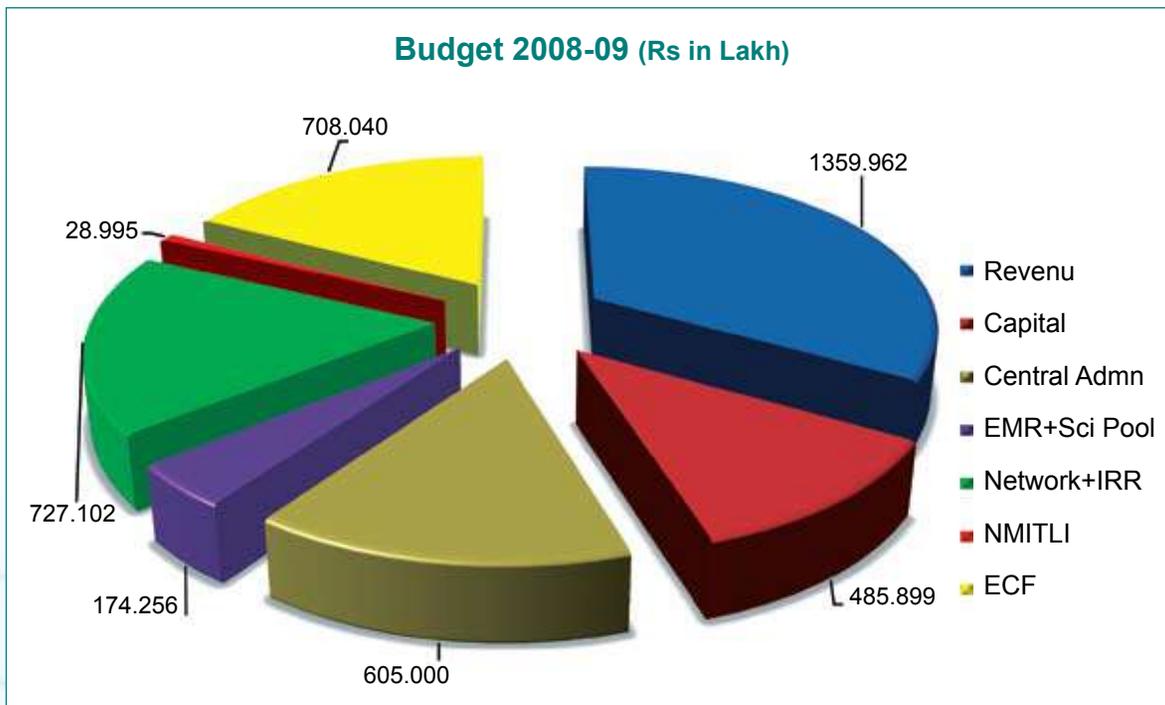
MEMBER-SECRETARY

COA/AO, NIIST



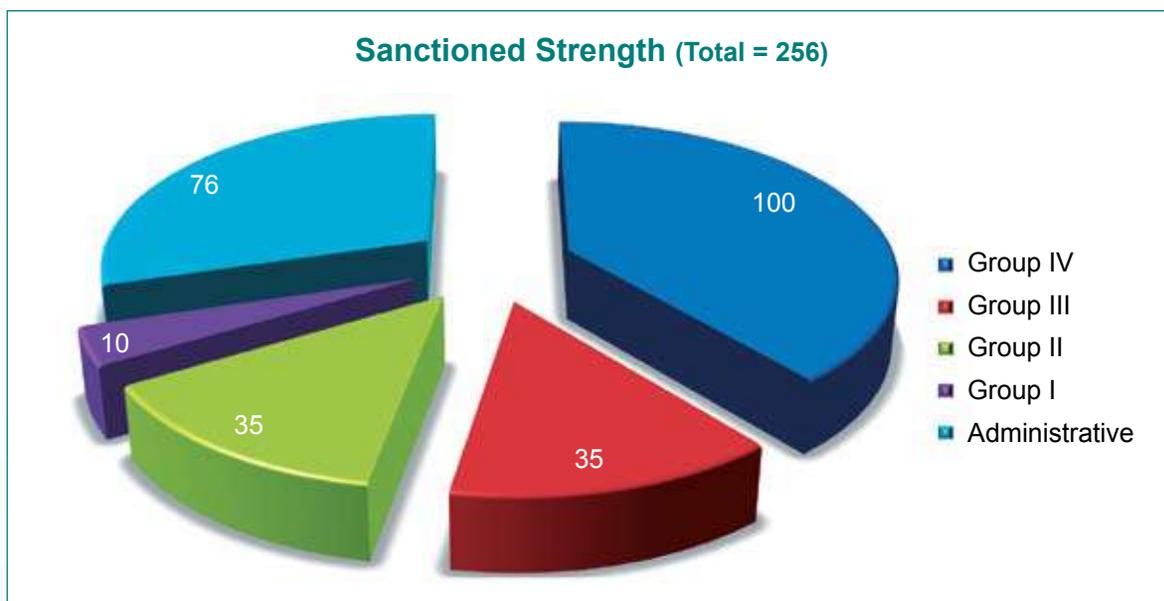


BUDGET AT A GLANCE





STAFF



LIST OF STAFF as on 31-03-2009

Director's Office

PROF T K CHANDRASHEKAR	DIRECTOR	(Resigned 07/11/2008)
DR B C PAI.....	ACTING DIRECTOR	
MR S SURESHKUMAR	SCIENTIST G	
MRS SARADA NAIR	PRIVATE SEC	
MR K S G KURUP.....	SR STENO(ACP)	(Retired 31/05/2008)
MR B AJAYAKUMAR.....	TECH	GR 2-3
MR A KRISHNANKUTTY.....	TECH	GR 1-4
MR P B VIJAYAKUMAR	TECH	GR 1-4

R & D DIVISIONS

Agro-processing & Natural Products Division

DR A SUNDERESAN	SCIENTIST F (Head)
MRS B SANKARIKUTTY AMMA.....	SCIENTIST F
MR M M SREEKUMAR	SCIENTIST F
DR C BALACHANDRAN	SCIENTIST F
DR N GOPALAKRISHNAN.....	SCIENTIST EII (Vol.Retired 01/04/2008)
MR THOMAS SAMUEL.....	SCIENTIST EII
MRS A NIRMALA MENON	SCIENTIST EII
MRS OMANAKUTTY AMMA	SCIENTIST EI
DR(MRS) K P PADMAKUMARI AMMA	SCIENTIST EI
DR K G RAGHU	SCIENTIST EI
MR V V VENUGOPALAN	SCIENTIST C



MRS M V RESHMA.....SCIENTIST C
DR (MRS) P NISHA.....SCIENTIST B
MR P JAYAMURTHY.....SCIENTIST B
MR R BABU.....TECH OFF E1
DR (MRS) BEENA JOY.....TECH OFF E1
MRS L PRASANNA KUMARI.....TECH OFF C
MR D R SOBAN KUMAR.....STA
MR P V THAMPY.....TECH GR 2-4
MR R SUKUMARAN.....TECH GR 1-4
MRS ANNAMMA MATHEW.....SR STENO(ACP)

Biotechnology Division

DR ASHOK PANDEY.....SCIENTIST F (Head)
DR (MRS) P PREMA.....SCIENTIST F
DR K MADHAVAN NAMPOOTHIRI.....SCIENTIST EI
DR RAJEEVKUMAR SUKUMARAN.....SCIENTIST C
MISS D KUMUTHA.....SCIENTIST B (*Resigned 31/05/2008*)
MISS D S SUGANYA.....SCIENTIST B (*Resigned 31/01/2009*)
DR(MRS) B VIJAYALAKSHMI AMMA...TECH OFF E1
MR P N SIVANKUTTY NAIR.....TECH GR 2-3
MR K M PRAKASH.....TECH GR 2-3

Chemical Sciences & Technology Division

DR SURESH DAS.....SCIENTIST G (Head)
DR T PRASADA RAO.....SCIENTIST G
DR (MRS) SATHYCHANDRASEKHAR.SCIENTIST F (*Retired 31/12/2008*)
DR (MRS) A JAYALAKSHMI.....SCIENTIST F
DR (MRS) MANGALAM S NAIR.....SCIENTIST F
DR (MRS) T EMILIA ABRAHAM.....SCIENTIST F
DR M LAKSHMIPATHY REDDY.....SCIENTIST F
DR AJAYAGHOSH.....SCIENTIST F
DR K R GOPIDAS.....SCIENTIST F
DR D RAMAIAH.....SCIENTIST F
DR K GEORGE THOMAS.....SCIENTIST EII
DR (MRS) R LUXMI VARMA.....SCIENTIST EII
DR A SRINIVASAM.....SCIENTIST EI
MR P SHANMUGHAM.....SCIENTIST EI (*Transferred 31/07/2008*)
DR K V RADHAKRISHNAN.....SCIENTIST EI
DR (MRS) J D SUDHA.....TECH OFF E1
MR ROBERT PHILLIP.....STA
MRS S VIJI.....STA
MISS SAUMINI MATHEW.....STA



Materials & Minerals Division

DR K G K WARRIER.....	SCIENTIST G (Head)
DR R M PILLAI.....	SCIENTIST G (Head) (Retired 31/05/2008)
DR P N MOHANDAS.....	SCIENTIST G (Retired 31/05/2008)
DR PETER KOSHY.....	SCIENTIST G
DR U SYAMAPRASAD.....	SCIENTIST G
DR C PAVITHRAN.....	SCIENTIST G
DR M T SEBASTIAN.....	SCIENTIST G
MR K HARIKRISHNA BHAT.....	SCIENTIST F
DR JOSE JAMES.....	SCIENTIST F
DR P PRABHAKAR RAO.....	SCIENTIST F
MR M C SHAJI.....	SCIENTIST F
MR K SUKUMARAN.....	SCIENTIST F
DR U T S PILLAI.....	SCIENTIST F
DR V JOHN.....	SCIENTIST EII (Retired 31/08/2008)
DR A R R MENON.....	SCIENTIST EII
DR SWAPAN KUMAR GHOSH.....	SCIENTIST EII
DR MANOJ RAAMA VARMA.....	SCIENTIST EII
DR M RAVI.....	SCIENTIST EII
MR S ANANTHAKUMAR.....	SCIENTIST EII
MR P KRISHNA PILLAI.....	SCIENTIST EI (Retired 31/03/2009)
DR T P D RAJAN.....	SCIENTIST C
DR S V SHUKLA.....	SCIENTIST C
DR A SRINIVASAN.....	SCIENTIST C
MR M SUNDARARAJAN.....	SCIENTIST B
MR P MUKUNDAN.....	TECH OFF E2 (Retired 31/10/2008)
MR S G K PILLAI.....	TECH OFF E2
MRS M E KOCHU JANAKI.....	TECH OFF E2
MR S VELUSAMY.....	TECH OFF E1
DR V S PRASAD.....	TECH OFF E1
MR M BRAHMA KUMAR.....	TECH OFF E1
MR K K RAVIKUMAR.....	TECH OFF E1
MR M CHANDRASEKHARAN.....	TECH OFF C
MR P PERUMAL.....	TECH OFF C
MR P GURUSAMY.....	TECH OFF C
MR M R CHANDRAN.....	TECH OFF B
MR M R NAIR.....	TECH GR 2-4 (Retired 31/01/2009)
MR S SASIBHOOSHAN.....	TECH GR 2-4
MR T SOMAN.....	TECH GR 2-4
MR V ANTONY.....	TECH GR 2-3
MR V SREEKANTAN.....	TECH GR 1-4

**Process Engineering & Environmental Technology Division**

MR P RAGHAVAN	SCIENTIST G (Head)
DR P P THOMAS	SCIENTIST G (Head)(Retired 31/10/2008)
DR (MRS) ROSCHEN SASIKUMAR.....	SCIENTIST G
MR AJIT HARIDAS	SCIENTIST F
MRS ELIZABETH JACOB	SCIENTIST F
MR J ANSARI	SCIENTIST EII
DR (MRS) S SAVITHRI	SCIENTIST EII
DR V B MANILAL	SCIENTIST EII
DR (MRS) RUGMINI SUKUMAR	SCIENTIST EII
DR M ANBU.....	SCIENTIST EII
DR C H SURESH	SCIENTIST C
DR B KRISHNAKUMAR.....	SCIENTIST C
MRS VIJAYA PRASAD	TECH OFF C
MR V K SHAJIKUMAR.....	TECH OFF A
MR KAROONA SHANKER ROAT	TECH OFF A
MR S RAMASWAMY.....	STA
MR T P PAULOSE.....	TECH GR 2-3
MR T R SURESH KUMAR	TECH GR 2-3

S & T SERVICE DIVISIONS**Civil Engineering and Estate Management Division**

MR V P THOMAS	SCIENTIST F (Head)
MR R RAJEEV	E E (TELEPHONES)
MR K V OONNIKISHNAN.....	E E
MR G CHANDRA BABU.....	AEE (CIVIL)(Transferred 04/08/2008)
MR K PRASAD.....	ASST ENGR
MR B KARTHIK	JR ENGR (CIVIL)
MR P ARUMUGAM	JR ENGR (CIVIL)
MR N GOPALAN	TECH GR 2-4 (Retired 31/05/2008)
MR M JAYADEEP	TECH GR 2-1
MR K S PRAMOD	TECH GR 2-1
MR K SURESH KANNAN.....	TECH GR 2-1
MR U DHARANIPATHY.....	A/C MECHANIC
MR B VIKRAMAN.....	TECH GR 1-4
MR C P NARAYANAN	TECH GR 1-4
MR T V SATHEESH	GR D NON-TECH

Knowledge Resource Centre

MRS SANTOSH BABU	SCIENTIST EI (Head)
MR NITHIYANANTHA VASAGAM.....	SCIENTIST C (Transferred 03/06/2008)
MR V MONI	SCIENTIST B



MR M RAMASAMY PILLAI.....TECH OFF E1
 MRS S MINI.....TECH OFF E1
 MR G SUDHAKARANTECH GR 2-4
 MR G NAGASRINIVASUTECH GR 2-3
 MRS T S LATHA.....AST(G)GR II
 MR PUSHPAKUMAR K R NAIR.....GR D NON-TECH
 MRS P SAVITHRI.....GR D NON-TECH(ACP)

Mechanical Engineering Section

MR P SISUPALAN.....TECH GR 2-4 (*Retired 31/10/2008*)
 MR N J JACOB.....TECH GR 2-4
 MR P M RAGHAVANTECH GR 2-4
 MR HARIDASAN PILLAITECH GR 2-4
 MR N SUDHILAL.....TECH GR 2-4
 MR P SOMANTECH GR 1-4
 MR T T RAJAPPAN NAIRGR D NON-TECH

R&D Planning & Business Development Division

DR V G MOHANAN NAIRSCIENTIST F
 DR C CHANDRASEKARA BHATSCIENTIST EII
 MR D BHEEMESWARSCIENTIST EI
 MR R S PRAVEEN RAJSCIENTIST C
 DR M SANKARANARAYANANTECH OFF E1
 MR P VIJAYAKUMAR.....TECH GR 2-4
 MR M P VARKEYTECH GR 1-4
 MR G SADASIVAN.....TECH GR 1-4
 MRS V J SAROJAKUMARISR STENO(ACP)
 MR K C CHACKO.....GR D NON-TECH

INFRASTRUCTURE DIVISIONS

Administration

MR N S RAJU.....AO
 MRS S SOBHANA.....SO
 MR K F JOSEPH.....SO
 MR T J BABUSECU OFFICER
 MR M K SIVADASANAST(G)GR I
 MRS SISILY POULOSEAST(G)GR I
 MR S SASI KUMARAST(G)GR I
 MR V MOHANAN NAIR.....AST(G)GR I
 MR G K NAIRSR STENO(ACP)
 MRS SREELETHA NAIR.....SR STENO(ACP)
 MRS ELIZABETH THOMAS.....SR STENO(ACP)
 MRS K SUBHADRAMMA.....SR STENO(ACP)(*Retired 31/12/2008*)
 MRS K S LATHIDEVISR HINDI TRNSR
 MR G RAMABHADRANAST(G)GR II
 MRS MERCY JOSEPHAST(G)GR II

MRS SUSAN MATHEW	AST(G)GR II
MR R K RAMESH KUMAR.....	AST(G)GR II
MRS JYOTHI R THAMPI.....	AST(G)GR II
MRS K SARASWATHY	AST(G)GR II(ACP)
MR D JAYAPRASAD	AST(G)GR II(ACP)
MR N RADHAKRISHNAN	TECH GR 2-4 (<i>Expired 27/02/2009</i>)
MR B VENUGOPAL.....	TECH GR 2-4
MR M THOMAS.....	TECH GR 2-4
MR P SURENDRAN.....	TECH GR 2-3
MR B RADHAKRISHNAN	TECH GR 2-1
MR PRAVEEN KANNAL.....	TECH GR 2-1
MRS M GEETHA.....	TECH GR 1-3
MR K UNNIKRISHNAN	GR C NON-TECH
MR P PARAMESWARAN PILLAI	GR C NON-TECH
MRS S LEELA DEVI AMMA	GR C NON-TECH
MR K MADHU	BEARER(ACP)
MR SASIDHARAN.....	BEARER(ACP)
MR A SREEKUMARAN	WASHBOY(ACP)

Finance & Accounts

MR T V SANKARAN.....	COFA
MR A V THOMAS	SO(F&A)
MRS P V VIJI.....	SO(F&A)
MR S RAJU	SR STENO (ACP)
MRS A NESAMONY	AST(F&A)GR I
MR E V R NAIR.....	SR STENO(ACP)
MRS REMANI DEVARAJ	AST(F&A)GR I
MR K G PILLAI.....	AST(F&A)GR I
MRS G GEETHA.....	AST(F&A)GR II
MRS K S VIDYA	AST(F&A)GR II
MR C SIVAKUMARAN	AST(G)GR II
MRS K N INDIRA.....	TECH GR 2-3 (<i>Retired 31/03/2009</i>)
MRS R REMADEVI	RECORD KEEPER

Stores & Purchase

MR M R DEVASIS.....	SPO
MR C M KRISHNADAS	AST(S&P)GR I
MR K D SASIDHARAN.....	AST(G)GR I
MR K SATHEESAN NAIR	AST(S&P)GR I
MR M ANILKUMAR	AST(S&P)GR II
MR V K JITHESH	AST(S&P)GR II
MRS MARIAMMA SAMUEL	SR STENO
MRS L LATHA	TECH GR 2-3
MR G RAMACHANDRAN NAIR.....	TECH GR 1-4 (<i>Retired 31/03/2009</i>)
MR T K GHOSH	GR C NON-TECH
MR G BHAKTHAVALSALAM.....	GR D NON-TECH
MR T K GOPI	GR D NON-TECH



NEW ELECTRIC SUB-STATION

The Institute has an HT service connection since 1991 with power allocation as well as maximum demand of 420 kVA and a 500 kVA 11 KV/415 V distribution transformer. It has become necessary to upgrade the entire power system to suit the higher demand due to futuristic demand and additional requirements increasing every day by new buildings, sophisticated equipments, etc. Complete up-gradation, modernization and standardization of the entire electrical system with three generators, including one new 500 kVA generator, under one roof with programmable logic control (PLC) indoor sub-station were completed. This most modern, automatic power maintain system with PLC, HT panel with motorized control, two 500 kVA transformers and power factor improvement system have a maximum demand (MD) allocation of 700 kVA. The facility was formally inaugurated by the then Director, Prof. T.K. Chandrashekar on 7th Nov, 2008.





संसदीय राजभाषा समिति

संसदीय राजभाषा समिति की दूसरी उपसमिति ने दिनांक 19.9.2008 को संस्थान की राजभाषा कार्यान्वयन संबंधी गतिविधियों का निरीक्षण किया। बैठक में संस्थान के निम्नलिखित अधिकारी उपस्थित थे।

- | | | | |
|----------------------|-------------------|----------------------------|---------------------------|
| 1. डॉ. बी.सी.पै | - उपनिदेशक | 6. श्री टी.वी. शंकरन | - वित्त एवं लेखा नियंत्रक |
| 2. डॉ. अशोक पाण्डेय | - वैज्ञानिक | 7. श्री एम.आर. देवासिस | - भंडार एवं क्रय अधिकारी |
| 3. डॉ. लक्ष्मी वर्मा | - वैज्ञानिक | 8. श्रीमती एस शोभना | - अनुभाग अधिकारी |
| 4. डॉ. डी. रामय्या | - वैज्ञानिक | 9. श्रीमती के. सुभद्राम्मा | - व.आशुलिपिक |
| 5. श्री एन.एस. राजू | - प्रशासन अधिकारी | 10. श्रीमती के.एस.लती देवी | - व. हिंदी अनुवादक |

श्री निखिलेश झा, संयुक्त सचिव (प्रशासन) तथा डॉ. पूरन पॉल, वरिष्ठ हिंदी अधिकारी ने मुख्यालय का प्रतिनिधित्व किया।

समिति के समक्ष प्रस्तुत निरीक्षण प्रश्नावली के आधार अनेक प्रश्न पूछे गए। समिति ने राजभाषा कार्यान्वयन की प्रगति की जांच की और इस बात पर जोर दिया कि वैज्ञानिकों का कर्तव्य है उनकी उपलब्धियों को भारत के आम जनता तक पहुँचाना। इसके लिए भविष्य में अधिकाधिक अनुसंधान पत्रों का प्रकाशन हिंदी में होना अनिवार्य है। संस्थान के प्रतिनिधियों ने आश्वासन दिया कि राजभाषा कार्यान्वयन को और अधिक मजबूत करने के लिए संस्थान की ओर से सभी प्रयास किये जाएंगे।

उत्कृष्ट राजभाषा कार्यन्वयन के लिए संस्थान को तिरुवनंतपुरम् नगरराजभाषा कार्यान्वयन समिति से वैजयंती एवं योग्यता पत्र प्रदान किया गया



वैजयंती एवं योग्यता प्रमाणपत्र स्वीकार करते हुए संस्थान के कार्यकारी निदेशक डॉ.

बी.सी.पै तथा प्रशासन अधिकारी श्री एन. एस. राजू



हिंदी दिवस / हिंदी सप्ताह

राष्ट्रीय अंतर्विषयी विज्ञान तथा प्रौद्योगिकी संस्थान, तिरुवनंतपुरम् में तारीख 15 सितंबर को हिंदी दिवस तथा 24 सितंबर से 29 सितंबर तक हिंदी सप्ताह समुचित ढंग से मनाया गया। पूरे सप्ताह के दौरान राजभाषा के प्रचार प्रसार के लिए परियोजना स्टाफ, अनुसंधान छात्र आदि सहित संस्थान के संपूर्ण स्टाफ सदस्यों तथा उनके स्कूली छात्रों के लिए निम्नलिखित प्रतियोगिताएं आयोजित की गयीं।

कर्मचारियों के लिए आयोजित प्रतियोगिताएं
हिंदी टिप्पण/ आलेखन
हिंदी श्रुतलेखन
हिंदी पठन
हिंदी प्रश्नोत्तरी
हिंदी गीत

कर्मचारियों के स्कूली छात्रों के लिए आयोजित प्रतियोगिताएं
हिंदी निबंध लेखन
हिंदी अनुवाद
हिंदी गीत

हिंदी दिवस का औपचारिक उद्घाटन 15 सितंबर 2008 को अपराह्न 3.30 बजे संपन्न हुआ। डॉ. ए. के. गुप्ता, वैज्ञानिक घ्जी ड, राष्ट्रीय भौतिक प्रयोगशाला, नई दिल्ली ने कार्यक्रम का औपचारिक उद्घाटन किया। उन्होंने अपने भाषण में राष्ट्रीय भौतिक प्रयोगशाला, नई दिल्ली में राजभाषा कार्यान्वयन के लिए किये जा रहे प्रयासों पर प्रकाश डाला। डॉ. बी.सी.पै, उपनिदेशक, एन आई आई एस टी, तिरुवनंतपुरम् ने समारोह की अध्यक्षता की। उन्होंने अपने अध्यक्षीय भाषण में राजभाषा कार्यान्वयन की संवैधानिक अपेक्षा तथा संस्थान में संसदीय राजभाषा समिति द्वारा हाल में किए गए निरीक्षण के दौरान उठाए गए आपत्तियों पर प्रकाश डाला और स्टाफ सदस्यों के ध्यान में यह लाया गया कि संस्थान म प्रशासनिक कार्यों में राजभाषा हिंदी का उपयोग बढ़ रहा है, किन्तु विज्ञान तथा प्रौद्योगिकी के क्षेत्र में इसका ज़्यादा प्रयोग नहीं होता है। उन्होंने वैज्ञानिकों से अपील किया कि वैज्ञानिक उपलब्धियों को भारत की आम जनता तक पहुँचाने के लिए अनुसंधान पत्र हिंदी में भी प्रकाशित किया जाए। उन्होंने अपने भाषण में यह भी सूचित किया कि सूचना प्रौद्योगिकी के बदलते परिवेश में हिंदी भाषा ने अपना स्थान प्राप्त कर लिया है।

अपने भाषण में उन्होंने सी- डाक, पुणे द्वारा हिंदी साफ्टवेयर निर्माण का प्रारंभ, कंप्यूटर के माध्यम से हिंदी का प्रशिक्षण, राजभाषा विभाग के हिंदी पोर्टल, राजभाषा विभाग द्वारा घोषित विभिन्न पुरस्कार योजनाएं आदि का संक्षिप्त विवरण प्रस्तुत किया।



उद्घाटन सत्र के बाद इस साल के युवा वैज्ञानिक पुरस्कार से सम्मानित डॉ. सत्यजित वी. शुक्ला ने सिरैमिक नैनो तकनॉलजी पर हिंदी में पावर पॉइन्ट प्रस्तुतीकरण दिया ।

तारीख 24 सितंबर 2008 को कर्मचारियों के लिए हिंदी में टिप्पण / आलेखन / तकनीकी रिपोर्ट लेखन प्रतियोगिता तथा कर्मचारियों के स्कूली छात्रों के लिए हिंदी निबंध लेखन प्रतियोगिता चलाई गई। तारीख 25 सितंबर 2008 को स्टाफ सदस्यों के लिए हिंदी पठन ,श्रुतलेखन तथा हिंदी गीत प्रतियोगिता चलाई गई। कर्मचारियों के स्कूली छात्रों के लिए उसी दिन हिंदी अनुवाद प्रतियोगिता चलाई गई। 26 सितंबर 208 को छात्रों के लिए हिंदी गीत प्रतियोगिता चलाई गई। तारीख 29 सितंबर 2008 को हिंदी प्रश्नोत्तरी आयोजित की गई। सभी प्रतियोगिताओं में स्टाफ सदस्यों तथा स्कूली छात्रों ने बड़े उत्साह से भाग लिए ।

29 सितंबर 2008 को अपराह्न 3.00 बजे आयोजित समापन समारोह में श्री रवाडा चन्द्रशेखर, आई पी एस, उप पुलिस महानिरीक्षक एवं नगर पुलिस आयुक्त मुख्य अतिथि थे। प्रो. टी.के. चन्द्रशेकर, निदेशक एन आई आई एस टी, तिरुवनंतपुरम् ने समारोह की अध्यक्षता की । अपने अध्यक्षीय भाषण में उन्होंने हिंदी सप्ताह समारोह की सफलता के लिए योगदान दिय सभी का साधुवाद किया। मुख्य अतिथि द्वारा विभिन्न प्रतियोगिताओं के विजेताओं को पुरस्कार वितरित किया गया ।

कंप्यूटरों पर हिंदी का प्रयोग - प्रशिक्षण कार्यक्रम

कर्मचारिया को आई एस एम, लीप ऑफीस, जिस्ट -टी टी ट्यूल्स, एम एस वर्ड, पावर पॉइन्ट, ओपण ऑफीस जैसे कंप्यूटर प्रोग्रामों में प्रशिक्षण देने के लिए सी- डैक, तिरुवनंतपुरम से विशेषज्ञों को आमंत्रित करके संस्थान में 23-27 मार्च 2009 के दौरान पाँच दिवसीय प्रशिक्षण कार्यक्रम आयोजित किया गया। आशुलिपिक,, सहायक ग्रेडI, सहायक ग्रेड II तथा सहायक ग्रेड III को प्रशिक्षण के फायदा उठाने के लिए नामित किया था । डॉ. बी.सी.पै, कार्यकारी निदेशक ने कार्यक्रम का उद्घाटन किया । उन्होंने भागीदारों से प्रशिक्षण का पूरा लाभ उठाने का तथा कंप्यूटरों पर हिंदी का अधिकाधिक प्रयोग करने का अनुरोध किया। प्रतिभागियों को आई एस एम, लीप ऑफीस, जिस्ट -टी टी ट्यूल्स, एम एस वर्ड, पावर पॉइन्ट तथा ओपण ऑफीस पर प्रशिक्षण दिया गया। 16 स्टाफ सदस्यों ने कार्यक्रम में भाग लिया। प्रशिक्षण के मूल्यांकन के लिए एक फीड बैक सत्र भी आयोजित किया गया। सभी प्रतिभागियों ने एकमत से व्यक्त किया कि प्रशिक्षण के सैद्धान्तिक तथा प्रायोगिक -दोना पक्ष अत्यंत उपयोगी थे और प्रशिक्षण के दौरान प्राप्त जानकारी की सहायता से वे भविष्य में दक्षतापूर्वक कंप्यूटरों पर कार्यालयीन काम करेंगे ।



सतर्कता जागरूकता सप्ताह-2008 का आयोजन

राष्ट्रीय अंतर्विषयी विज्ञान तथा प्रौद्योगिकी संस्थान, तिरुवनन्तपुरम में तारीख 3 नवंबर से 7 नवंबर 2008 तक सतर्कता जागरूकता सप्ताह मनाया गया। सप्ताह का प्रारंभ तारीख 3 नवंबर 2008 को 11.00 बजे पूर्वाह्न निदेशक के द्वारा स्टाफ सदस्यों को हिंदी और अंग्रेजी दोनों भाषाओं में सतर्कता जागरूकता प्रतिज्ञा दिलाने के साथ हुआ। 4 नवंबर से 6 नवंबर 2008 तक स्टाफ सदस्यों एवं अनुसंधान छात्रों के लिए वक्तृता, कार्टून चित्रण तथा नारा लेखन पर प्रतियोगितायें चलाई गयी। 7 नवंबर 2008 को समापन समारोह तथा पुरस्कार वितरण संपन्न हुआ। डॉ. बी.सी.पै, कार्यकारी निदेशक ने समारोह की अध्यक्षता की। प्रो. टी.के. चन्द्रशेकर, निदेशक ने प्रतियोगिताओं के विजेताओं को पुरस्कार वितरित किया।



National Institute for Interdisciplinary Science & Technology

Council of Scientific and Industrial Research

Industrial Estate P.O., Thiruvananthapuram – 695019, Kerala, India

Tel: +91-471-2490674 / 2490811 / 2490224, Fax: +91-471-2491712 / 2490389

Email: contact@niist.res.in, director@niist.res.in Website: <http://www.niist.res.in>