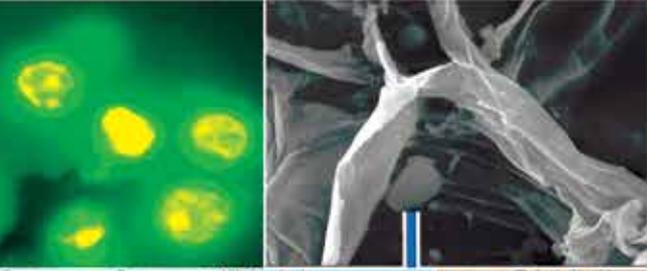


वार्षिक प्रतिवेदन 2014-2015

# Annual Report 2014-2015



सी एस आई आर - राष्ट्रीय अंतर्विषयी विज्ञान तथा प्रौद्योगिकी संस्थान  
**CSIR - National Institute for Interdisciplinary Science & Technology**

(वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद्)  
(Council of Scientific & Industrial Research)  
तिरुवनंतपुरम / Thiruvananthapuram



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CSIR - National Institute for  
Interdisciplinary Science &  
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**CSIR - National Institute for  
Interdisciplinary Science & Technology**

## CONTENTS

	Page No.
Foreword . . . . .	5
Significant Achievements . . . . .	7
Agro-processing & Natural Products . . . . .	19
Biotechnology . . . . .	33
Chemical Sciences & Technology . . . . .	50
Material Science & Technology . . . . .	73
Process Engineering & Environmental Technology . . . . .	92
Planning & Business Development . . . . .	104
Knowledge Resource Centre . . . . .	119
General Information . . . . .	150



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## Foreword

I am extremely glad to present the annual report of CSIR-NIIST for the year 2014-15 to you. While I congratulate all my colleagues of CSIR-NIIST for their hard work and contributions that resulted in a summary of our activities and achievements, I thank the editorial team for putting things together for the timely release of this document.

I am happy to convey to you that over the years, through our scientific achievements, CSIR-NIIST has earned a respectful name in the country and abroad as one of the best research institutions in India. Our strength during these years has been on globally competitive science in the areas of Chemistry, Materials and Biology. On the other hand, our activities in the fields of Agroprocessing, Biotechnology and Process Engineering were focused towards providing technologies and consultancies to MSMEs. Currently, we are putting more effort in attracting private industries in technology and product developments. We are also in the process of reorganizing our activities to suit with the national mission programmes such as Swachabharat, Swasthyabharat, Make in India and Innovate in India. By realizing our strength and weakness, we feel that it is necessary to put more stress on converting our knowledge into technologies and products with the help of industries. We have already started moving in this direction and hope, I will be able to tell you more on technology front in the coming years.

In this issue of the annual report we have highlighted our achievements for the year 2014-15. During this period, we were able to attract major funding from DSIR (CRTDH) for supporting MSMEs and from GAIL for developing a solar refrigerator. The major ongoing activities during the period are in the areas of healthcare and nutraceuticals, natural products, solid waste management, odour control, bioethanol production, functional dyes, beach mineral processing, light weight alloys, sustainable energy, fluorescent materials and natural fiber extraction. During this period we have created several major facilities such as Confocal Raman Microscope, Femtosecond Transient Absorption Spectrometer, Physical Properties Management System and Chemical Vapour Deposition System. In the technology front, we are in progress with setting up of a fresh ginger processing plant at Wayanad. The white pepper technology developed by CSIR-NIIST has been licensed to many entrepreneurs. We have set up a pineapple fibre extraction plant at Maneed panchayat in Piravom to support the Kudumbasree programme. Our coir fibre extraction process has been implemented at Thavanakkadavu, Cherthala, jointly with Santhigiri Ashram. In addition, through our academic programme under AcSIR a large number of students are pursuing their Ph. D. and summer research projects. Our new silver jubilee building is getting ready for occupancy.

I must put a word of appreciation to all our students and project fellows who work hard for the progress and all colleagues at the CSIR-NIIST as well as Head Quarters for their help, advice and support.

**A. Ajayaghosh**  
Director



## प्रस्तावना

मुझे वर्ष 2014-15की अवधि के लिए सीएसआईआर - एनआईआईएसटी की वार्षिक रिपोर्ट आप को प्रस्तुत करने में अत्यंत खुशी है। मैं सीएसआईआर-एनआईआईएसटी के सभी साथियों को उनकी कड़ी मेहनत और योगदान के लिए बधाई देता हूँ, जिसके फलस्वरूप हमारी गतिविधियों और उपलब्धियों का सारांश तैयार हो चुका है और इस

दस्तावेज़ के समय पर जारी करने में वीजों को एक साथ डालने में संपादकीय टीम द्वारा दिये गये योगदान के लिए मैं उनको धन्यवाद देता हूँ। मुझे आपको यह संप्रेषित करने के लिए खुशी है कि पिछले कुछ वर्षों में, सीएसआईआर-एनआईआईएसटी ने अपनी वैज्ञानिक उपलब्धियों के माध्यम से भारत में सबसे अच्छे अनुसंधान संस्थानों में से एक के रूप में देश में और विदेशों में एक सम्मानजनक नाम कमाया है। इन वर्षों के दौरान हमारी ताकत वैश्विक रूपसे प्रतिस्पर्धी विज्ञान के रसायन विज्ञान, पदार्थ और जीवविज्ञान के क्षेत्रों पर केंद्रित किया गया है। दूसरी ओर, कृषि प्रसंस्करण, जैव प्रौद्योगिकी और प्रोसेस इंजीनियरिंग के क्षेत्र में हमारी गतिविधियाँ, एमएसएमई के लिए प्रौद्योगिकियों और परामर्श उपलब्ध कराने की दिशा में केंद्रित की गयी। वर्तमान में, प्रौद्योगिकी और उत्पाद विकास में निजी उद्योगों को आकर्षित कराने में हम और अधिक प्रयास में लगे रहे हैं। हम, स्वच्छ भारत, स्वास्थ्य भारत, मेक इन इंडिया, भारत में नवाचार जैसे राष्ट्रीय मिशन कार्यक्रमों के अनुरूप हमारी गतिविधियों के पुनर्गठन की प्रक्रिया में भी लगे रहे हैं। हमारी ताकत और कमजोरी को स्पष्ट रूप से समझने के बाद, हम यह महसूस करते हैं कि उद्योगों की मदद से हमारे ज्ञान को प्रौद्योगिकियों और उत्पादों में परिवर्तित कराने में और अधिक ज़ोर देने की आवश्यकता है। हमने पहले से ही इस दिशा में आगे बढ़ना शुरू कर दिया है और मैं आशा करता हूँ कि आने वाले वर्षों में प्रौद्योगिकी के क्षेत्र में प्रगति के बारे में आपको और अधिक बताने में सक्षम हो जाऊँगा।

वार्षिक रिपोर्ट के इस अंक में हमने वर्ष 2014-15 की हमारी उपलब्धियों पर प्रकाश डाला है। इस अवधि के दौरान, एमएसएमई के समर्थन के लिए डीएसआईआर (सीआरटीडीएच) से और सौर रेफ्रिजरेटर के विकास के लिए जीएआईएल से प्रमुख फंडिंग को आकर्षित कराने में हम सक्षम थे। इस अवधि के दौरान हो रही प्रमुख गतिविधियाँ स्वास्थ्य तथा न्यूट्रास्यूटिकल्स, प्राकृतिक उत्पादों, ठोस कचरा प्रबंधन, गंध नियंत्रण, जैवइथेनॉल उत्पादन, कार्यात्मक रंजक, समुद्र तट खनिज प्रसंस्करण, हल्के वजन मिश्र, स्थायी ऊर्जा, फ्लोरोसेंट सामग्री और प्राकृतिक फाइबर निकासी के क्षेत्रों में हैं। हमने इस अवधि के दौरान कोनफोकल रमन माइक्रोस्कोप, फेमटोसेकन्ट क्षणिक अवशोषण स्पेक्ट्रोमीटर, भौतिक गुण प्रबंधन प्रणाली और रासायनिक वाष्प जमाव प्रणाली जैसी कई प्रमुख सुविधाओं की संस्थापना की। प्रौद्योगिकी के क्षेत्र में, वायनाड में एक ताजा अदरक प्रसंस्करण संयंत्र की स्थापना का कार्य प्रगति पर है। सीएसआईआर-एनआईआईएसटी द्वारा विकसित सफेद मिर्च प्रौद्योगिकी के लिए कई उद्यमियों को लाइसेंस दिया गया है। कुडुंबश्री कार्यक्रम को समर्थन देने के लिए हमने पिरवम् में मनीड़ पंचायत में अनानास फाइबर निष्कर्षण संयंत्र स्थापित किया है। संस्थान द्वारा विकसित कॉयर फाइबर निकालने की प्रक्रिया को शन्तिगिरी आश्रम के साथ संयुक्त रूप से थवनाक्कडव, चेतला में लागू किया गया है। इसके साथ ही साथ, एसीएसआईआर के तहत हमारे शैक्षिक कार्यक्रम के माध्यम से छात्रों की एक बड़ी संख्या उनकी पीएचडी और ग्रीष्म शोध परियोजना कर रही हैं। हमारा नया रजत जयंती भवन उपयोग के लिए तैयार हो रहा है।

प्रगति के लिए कड़ी मेहनत करने वाले हमारे सभी छात्रों और परियोजना फैलो को तथा सीएसआईआर-एनआईआईएसटी एवं सीएसआईआर मुख्यालय के सभी सहयोगियों को अपनी मदद, सलाह और समर्थन के लिए मुझे सराहना करनी चाहिए।

**ए अजयघोष**  
निदेशक



## HIGHLIGHTS

CSIR-NIIST as in the previous years has handled a large number of in-house, network, grant-in-aid, sponsored and consultancy projects covering a full spectrum of activities in the multidisciplinary areas of biological, chemical, material and environmental sciences. Emphasis has been laid to develop synergized core competencies through high quality basic research, as well as industrially and socially relevant application oriented research. The Institute showed a steady measurable performance during the reporting period. There were 244 publications having an average impact factor of 3.351. The number of sponsored/Grant-in-aid projects increased to 78 from 27 projects for the previous year. Similar trend was observed in the number of consultancy projects from 7 for 2013-14 to 23 for 2014-15. Ten international patents were granted and same number of new patents were filed during this period. The increase in the ECF generation was about 32% from the previous year. Twenty seven agreements/MOUs were signed with different external agencies for technology transfer and research collaborations.

The institute continued to augment its facili-

ties to be at par with the international standards. A state of the art new building for the Chemical Sciences and Technology Division was constructed in the campus with an area of about 40000 Sq.ft. This building named as "SIR CV RAMAN BLOCK" was inaugurated on February 02, 2015. A new



Inauguration of Sir CV Raman Block

Confocal Raman Microscope system,  $\alpha$ -300 R model consisting of an excitation laser, a microscope with different objectives including water and oil emulsion objectives, and a spectrometer

with CCD detector of resolution around  $1\mu\text{m}$  was installed. Femtosecond transient absorption spectrometer and a Chemical Vapour Deposition (CVD) system were also added to the sophisticated instrument facilities. Another major facility created during the year is the Physical Property Measurement system (PPMS). It is a cryogen free dynacool facility. The hallmarks of PPMS are automation and ease of use where measurements can be performed over a wide range of magnetic fields and temperatures.



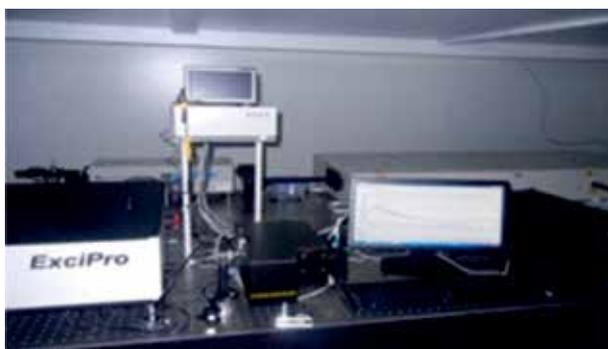
## Progress in R&D Programs

Agro-processing and natural products division focuses on oil seeds, spices and herbals. These areas are identified because of their relevance and economic importance to the region and the nation. A technology Business Incubator is operational under the division and it has taken up



Confocal Raman Microscope

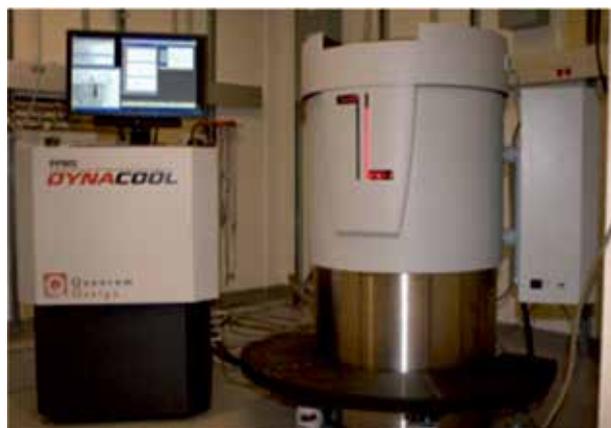
several programmes which were beneficial to the MSME's in the country. Setting up a commercial venture for the processing of fresh ginger and vegetables having 7.5 TPD capacity at Meenangadi, Wayanad is in progress and commissioning of the plant is expected by the end of 2015. As part of societal program many pilot scale trails were conducted for producing the concentrated palm neera syrup and the product was supplied for test marketing. Scale up studies on process development for bio active recovery from spent



Femtosecond Pump-Probe Transient Absorption Spectrometer

Ayurvedic material is continuing and 2- 5kg batch level for pepper, cumin & turmeric spents have been completed.

In the area of biotechnology, significant contributions were made in the production of value-added chemicals such as industrial enzymes, biofuels, biopolymers, organic acids, bio-based processes development, development of functional foods and their formulations for potential health benefits and development of microbial consortium for biodegradation. Know-how for the production of cellulase from *Penicillium janthinellum* developed and laboratory technology has been transferred to an industry. An envi-



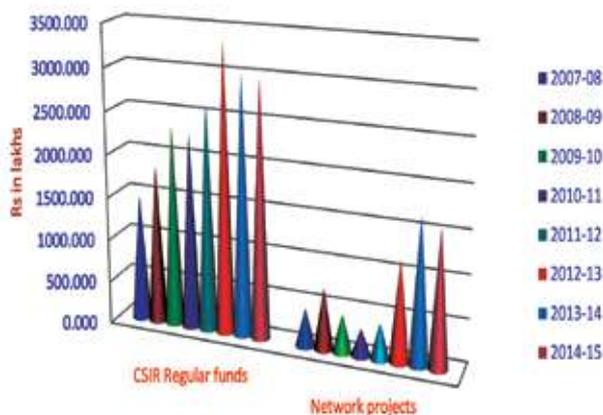
Quantum Design – Cryogen Free Physical Property Measurement System

ronment-friendly pulp bleaching process using recombinant xylanase gene expressed in *K. lactis* developed which is highly alkaline and thermo-tolerant. Lactic acid bacteria (LAB) offer unique health benefits as probiotics and nutraceuticals. A strain of *Lactococcus* sp, which produces 2, 4- di-tert- butyl phenol (2, 4 DTBP) showing antifungal and antioxidant compound was isolated.

The Chemical Science and Technology Division is carrying out its research and develop-

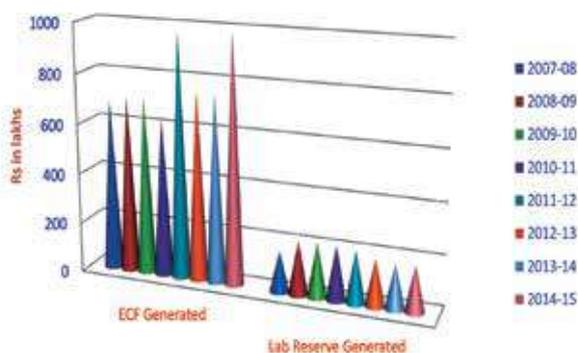


## CSIR Expenditure during 2007-2015



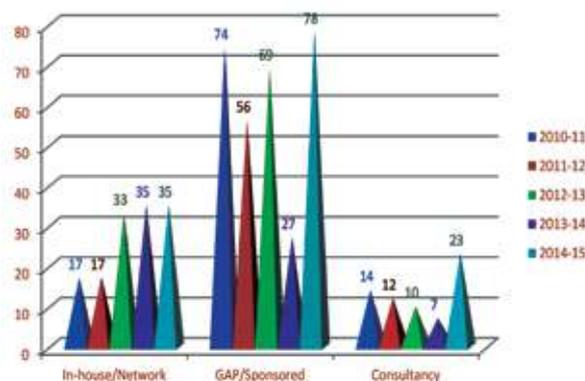
ment activities through concerted, interdisciplinary, collaborative efforts on fundamental and applied aspects of photochemistry and related areas, diagnostics and in the isolation/synthesis of new bioactive molecules as well as development of synthetic organic methodologies for the fine chemical industry. Using the principles of molecular self-assembly and fluorescence modulation, a self-erasable security marker for checking the authenticity of documents at point of care has been developed. Detection of TNT at picomolar level in water and nanogram level in vapour phase achieved using a combined fluorescence and quartz crystal microbalance method. Symmetrical diiodinated benzothiazolium squaraine

## External fund generation during 2007-2015



(SQDI), one of the newly developed photo sensitizers, was found to be an efficient photo sensitizer for Photodynamic therapy (PDT) applications and did not elicit acute toxicity to normal tissues in the absence of light. A new colorimetric chemosensor based on diethyl aminoquinoline carbaldehyde was designed which can selectively detect both  $\text{Cu}^{2+}$  and  $\text{Hg}^{2+}$  ions with an easy, well-defined naked-eye visible colour change. Electrochemical sensors were also designed for simultaneous determination of ascorbic acid, dopamine, uric acid and acetaldehyde. A biocompatible surface enhanced Raman scattering (SERS) based nanotag for ultra sensitive detection and imaging of human cancer has

## Distribution of projects during 2010-15

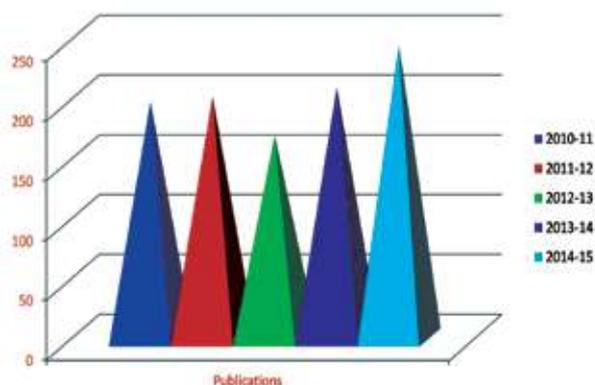


been developed. Compared with conventional time consuming immuno-cytochemistry technique, this method is non-invasive, fast and accurate which prompted to extend further investigation using real patient cervical smear samples. Computational methods were developed for designing systems capable of water splitting and  $\text{CO}_2$  insertion reactions. The modeled mechanisms were consistent with the experimental findings.

In the ongoing program on novel functional materials for applications in energy,

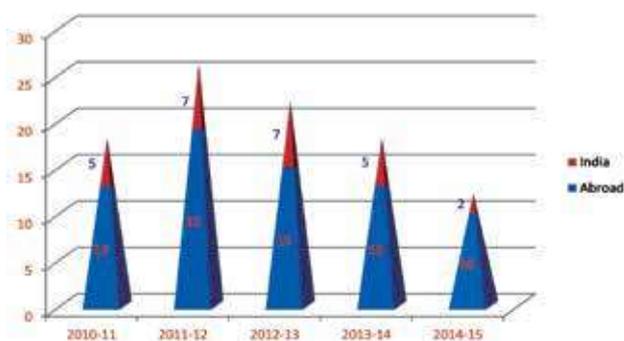


### Number of Publications



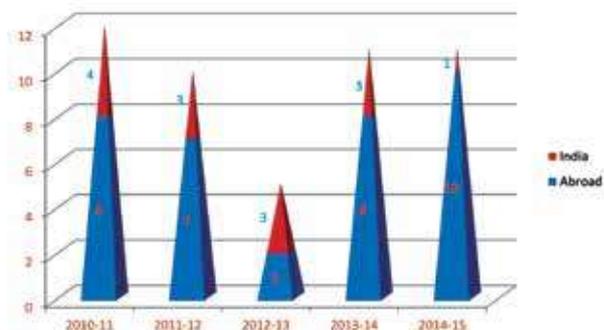
electronic and transport sectors, the focus was on the development of electronic materials, advanced superconductors, super ionic conductors, magnetic materials functional ceramics, composites, nano-coatings and porous materials, development of advanced polymers, light alloys and functionally gradient metal matrix composites. A new series of environment friendly intense yellow, blue, red and green inorganic pigments were synthesized having high infrared reflectance for cool roof and surface coating applications. A series of rare-earth activated phosphor materials for white light emitting diode applications were synthesized and their photo-physical properties were studied. A promising green packaging material by incorporating modified ZnO nanostructure in gelatine matrix was developed to get rid-off environmen-

### Patents Filed



tally unsafe polyethylene polymer packaging material. Phosphates of rare earth materials (REPs),  $\text{LaPO}_4$  in particular, in the form of coatings and monoliths exhibited complete non-wetability and inertness towards molten metals. These properties, coupled with their excellent chemical and thermal stability, ease of processing and machinability as well as their versatile photo-physical and emission properties, make them good candidate for diverse applications. Highly dispersed isotactic polypropylene (iPP) nanocomposites were prepared by incorporating two different sized Mg-Al LDH nanoparticles. Incorporation of low loadings of sonicated LDH

### Patents Granted



particles showed substantial effect on thermal stability, spherulite size, crystallinity and crystallization half-time. A facile approach was developed to design and synthesize a series of polystyrene clay nanocomposite (PSC) coatings containing different adduct modified clay. PSC coatings offered enhanced protection against corrosion than pristine polystyrene (PS) coating.

Several important research programs were undertaken under the main theme of innovative technologies for environmental management and value addition to natural resourc-



es. A new project on Common Research and Technology Development Hub (CRTDH) for environmental intervention in MSMEs was initiated with DSIR-NIIST collaboration to undertake R&D for problems of common interest to MSMEs. The institute provided the design of an odour control system to Karnataka Urban Infrastructure Development & Finance Corporation Limited, Bengaluru, for the BBMP (Bengaluru Municipal Corporation) to install a 500 tpd integrated solid waste management plant at Kudlu. The environmental technology group has been monitoring the spatio-temporal distribution of perchlorate in the contaminated area around Keezhmad. Recently analytical support to the special committee constituted by the Ernakulam district collector to study perchlorate contamination in Keezhmad area was also provided. Anaerobic systems for plant fibre extraction and for treatment of biomass wastes have been receiving good recognition from users and demonstration plants have been setup. Environmental impact assessment for renewal of mining lease for KMML, Chavara and enhancement of mineral sand production as well as mapping of leachate from the iron oxide storage pond on the water quality of wells along the groundwater flow directions were conducted and mitigation measures were suggested. Virtual Casting Solver, integrated with 3D Foundry's casting design software AutoCAST, has been upgraded. A new module, 'Gas and venting module', developed to predict blowholes during filling for a given design, is being benchmarked against industrial castings. This module was transferred to 3D Foundry Tech Pvt Ltd under a new license.

## Honours and Awards

Several scientists and research fellows have been bestowed with honours, awards and recognitions this year also. Some of the important ones are as follows. Dr A Ajayaghosh received the prestigious J. C. Bose National Fellowship 2015 of DST, ISAS National Award for Excellence in Science and Technology 2014 of Indian Society of Analytical Scientists and CHEMTECH CEW Award 2015 for Leadership and Excellence in Research and Development. Chandran Menon Memorial Award for Applied Research and Innovative Technology 2015 by the Institute of Indian Foundrymen (IIF), Kolkata was conferred to Dr T P D Rajan. Dr K V Radhakrishnan featured in the League of Extra Ordinary Chemists, TCI-India -League of Extraordinary Chemists from Tokyo Chemical Industries (India) Pvt. Ltd. Dr M L P Reddy was selected as Fellow of Andhra Pradesh Academy of Sciences, 2014. Dr P Binod and Dr Vandana Sankar received Kerala State Young Scientist Award 2014. Dr R Sindhu received Reviewer Award 2014 from Elsevier in the area Industrial Crops and Products. A large number of Best paper, Best oral presentation and Best poster awards were received by the young researchers for the papers presented in the national and international conferences.

## Other activities

As a part of the charter to provide human resource development, several conferences, training programmes, lecture series, workshops and seminars were organized. Twenty nine students were awarded Ph D degree during the reporting period. The institute continued to render instrumentation support



to external clientele from industries and academia.

The National technology day, National Science day, CSIR Foundation day and NIIST Annual day were celebrated. The institute was kept open during these days for students and public to have a glimpse of the activities being undertaken. In addition, Hindi awareness week, Vigilance awareness, etc were also celebrated with different activities. Institute

carried out intensive cleanliness campaign on 2nd October 2014 as part of the Swachh Bharat Initiative of Prime Minister. The institute successfully organized Shanti Swarap Bhatnagar Memorial Tournament (SSBMT), Indoors-Zonal during September 2014 where eleven CSIR Laboratories/Offices participated in the Indoor Zonal Tournament. The staff club and student association also arranged many functions to celebrate festivals and other social activities.



The process know how for nano  $\text{TiO}_2$  transfer to M/s Krishna Conchem Products Pvt Ltd, Mumbai



## हाइलाइट्स

सीएसआईआर-एनआईआईएसटी ने पिछले वर्षों जैसे जैविक, रासायनिक, पदार्थ और पर्यावरण विज्ञान के अंतर्विषयी क्षेत्रों में गतिविधियों की एक पूरी स्पेक्ट्रम को शामिल करके इन हाउस, नेटवर्क, सहायता- अनुदान, प्रायोजित और परामर्श परियोजनाओं की एक बड़ी संख्या को संभाला है। उच्च गुणवत्ता वाले बुनियादी अनुसंधान, साथ ही औद्योगिक और सामाजिक रूप से प्रासंगिक अनुप्रयोग

उन्मुख अनुसंधान के माध्यम से योगवाहित मूल दक्षताओं के विकास पर जोर रखा गया है। समीक्षाधीन अवधि के दौरान संस्थान ने स्थिर दर्जे का प्रदर्शन दिखाया। 3.351 के औसत प्रभाव कारक के साथ 244 शोधपत्र प्रकाशित किये गये।

प्रायोजित / सहायता अनुदान परियोजनाओं की संख्या ,जो पिछले वर्ष 27 थीं, अब 78 तक वृद्धि हुई। इसी तरह की प्रवृत्ति परामर्श परियोजनाओं की संख्या में देखी गयी, वर्ष 2013-14 में परामर्श परियोजनाओं की संख्या 7 थी, वर्ष 2014-15 में इसकी संख्या 23 हैं। इस अवधि के दौरान दस अंतरराष्ट्रीय पेटेंट प्रदान किये गये और नए पेटेंटों की एक समान संख्या दर्ज की गयी। ईसीएफ में पिछले वर्ष की तुलना में लगभग 32% की वृद्धि हुयी। प्रौद्योगिकी हस्तांतरण और

अनुसंधान सहयोग के लिए विभिन्न बाहरी एजेंसियों के साथ 27 करारों / समझौता ज्ञापनों पर हस्ताक्षर किए गए।

अंतरराष्ट्रीय मानकों के बराबर होने के लिए संस्थान अपनी सुविधाओं को बढ़ाने का काम जारी रखा। रसायन विज्ञान तथा प्रौद्योगिकी प्रभाग के लिए संस्थान परिसर में लगभग 40000 वर्ग फीट के क्षेत्रफल के साथ



सर सीवी रमन ब्लॉक का उद्घाटन

एक अत्याधुनिक नये भवन का निर्माण किया गया। "सर सीवी रमन ब्लॉक" के रूप में नामित इस इमारत का उद्घाटन 2 फ़रवरी 2015 को किया गया। एक नई कॉन्फोकल रमन माइक्रोस्कोप प्रणाली,  $\alpha$ -300 आर मॉडल की

संस्थापना की गयी, जिसमें एक उत्तेजना लेजर, पानी और तेल के मिश्रण के अभिदृश्य सहित विभिन्न अभिदृश्यों के साथ एक माइक्रोस्कोप और  $1\mu\text{m}$  आसपास के रिज़ॉल्यूशन के सीसीडी डिटेक्टर के साथ एक स्पेक्ट्रोमीटर शामिल है। फेमटोसेकंड क्षणिक अवशोषण स्पेक्ट्रोमीटर और रासायनिक वाष्प जमाव (सीवीडी) प्रणालियों भी परिष्कृत साधन सुविधाओं के साथ जोड़ी गयी हैं। वर्ष के दौरान बनाई गई एक अन्य प्रमुख सुविधा है- भौतिक गुणधर्म मापन प्रणाली



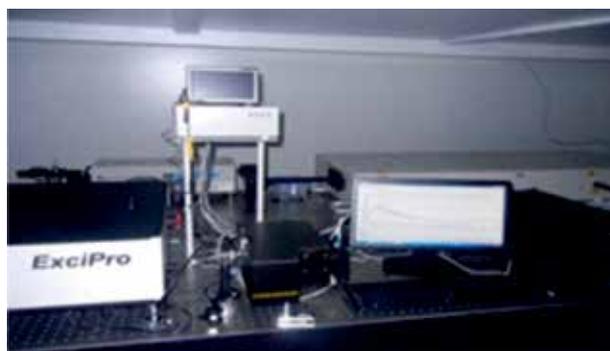
(पीपीएमएस)। यह एक क्रायोजन मुक्त डायनाकूल सुविधा है। पीपीएमएस की विशेषता स्वचालन और उपयोग में आसानी हैं, जहां चुंबकीय क्षेत्र और तापमान की एक विस्तृत श्रृंखला पर माप किया जा सकता है।

## अनुसंधान एवं विकास कार्यक्रमों में प्रगति



कॉन्फोकल रमन माइक्रोस्कोप

कृषि प्रसंस्करण तथा प्राकृतिक उत्पाद प्रभाग का ध्यान तिलहन, मसाले और जड़ी-बूटियों पर केंद्रित है। इन क्षेत्रों की पहचान इस क्षेत्र और देश के लिए अपनी प्रासंगिकता और आर्थिक महत्व की वजह से की जाती है। प्रभाग के तहत एक प्रौद्योगिकी बिजनेस इनक्यूबेटर चालू है और इसने देश में एमएसएमई के लिए फायदेमंद कई कार्यक्रम को ले लिया है। मीनंगाडी, वायनाड में ताजा अदरक और सब्जियों के प्रसंस्करण के लिए 7.5 टीपीडी क्षमता वाला एक व्यावसायिक उद्यम की स्थापना का कार्य प्रगति पर है और संयंत्र वर्ष 2015 के अंत तक चालू होने



फेमटोसेकंड पंप-प्रोब ट्रांसिएंट अब्सॉर्प्शन स्पेक्ट्रोमीटर

की उम्मीद है। सामाजिक कार्यक्रम के भाग के रूप में सांद्रित ताड़ नीरा सिरप के उत्पादन के लिए कई पायलट स्केल ट्रेल्स का आयोजन किया गया और उत्पाद को परीक्षण विपणन के लिए आपूर्ति की गई। आयुर्वेदिक सामग्री के मुक्तशेष से जैव सक्रियों की वसूली के लिए प्रक्रिया विकास पर स्केल अप अध्ययन जारी है और काली मिर्च, जीरा और हल्दी मुक्तशेष के लिए 2- 5 किलो बैच स्तर पूरा हो चुका है।

जैव प्रौद्योगिकी के क्षेत्र में, औद्योगिक एंजाइमों, जैव ईंधन, जैवपॉलिमर, कार्बनिक अम्ल, जैव आधारित प्रक्रियाओं का विकास, संभावित स्वास्थ्य लाभ के लिए कार्यात्मक खाद्य पदार्थों और उनके योगों का विकास और जैव निम्नीकरण के लिए माइक्रोबियल कंसोर्शियम

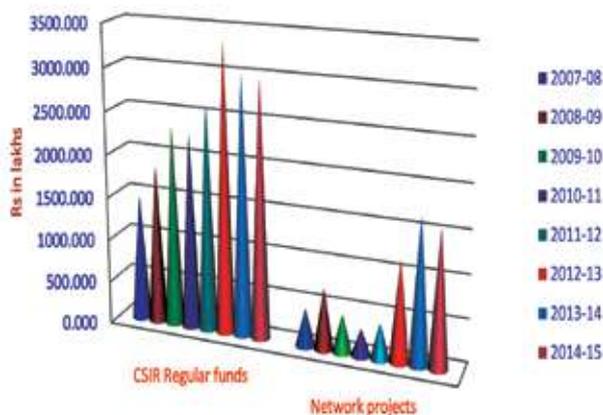


क्वांटम डिजाइन - क्रायोजन मुक्त भौतिक गुणधर्म मापन प्रणाली

का विकास जैसे मूल्य वर्धित रसायनों के उत्पादन में महत्वपूर्ण योगदान दिये गए। पेनिसिलियम जेथिनेल्लुम से सल्लुलेस के उत्पादन के लिए तकनीकी जानकारी विकसित की और प्रयोगशाला प्रौद्योगिकी एक उद्योग को हस्तांतरित कर दी गयी है। एक पुनः संयोजक जइलैनेस जीन द्वारा उत्पादित उच्च एल्कलाइन और थर्मो-सहिष्णु एंडो- जइलैनेस एंजाइम पर्यावरण अनुकूल लुगदी विरंजन प्रक्रिया के लिए के. लैटिस में अभिव्यक्त किया। लैक्टिक एसिड बैक्टीरिया (एलएबी) प्रोबायोटिक्स और न्यूट्रास्यूटिकल्स के रूप में अद्वितीय



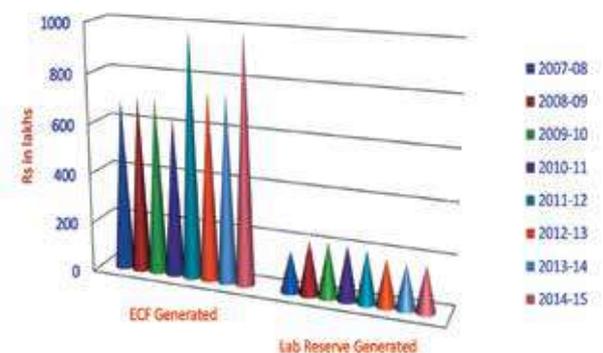
## 2007-2015 के दौरान सी एस आई आर के व्यय



स्वास्थ्य लाभ प्रदान करता है। लैक्टोकोक्स प्रजाति का एक स्ट्रेन पृथक किया गया, जो कवकरोधी और एंटीऑक्सीडेंट यौगिक दिखानेवाला 2, 4 डाइ-ट्रेट-ब्यूटाइल फिनोल (2, 4 डीटीबीपी) का उत्पादन करता है।

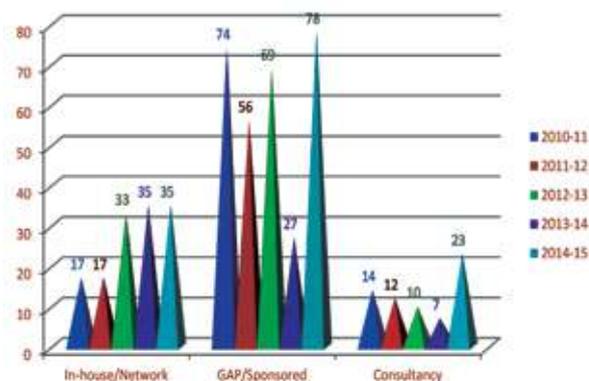
रासायन विज्ञान तथा प्रौद्योगिकी विभाग, अभिमानी, अंतर्विषयी, सहयोगात्मक प्रयासों के माध्यम से फोटो रसायनविज्ञान और संबंधित क्षेत्रों के मौलिक और अनुप्रयुक्त पहलुओं पर, निदान और नए जैव सक्रिय अणुओं के अलगाव / संश्लेषण में और सूक्ष्म रसायन उद्योग के लिए सिंथेटिक जैविक तरीके के विकास में अपनी अनुसंधान व विकास गतिविधियों का संचालन कर रहा है। आणविक स्वतः समुच्चयन और प्रतिदीप्ति मॉड्यूलन के सिद्धांतों का उपयोग करके जाँच के स्थान पर दस्तावेजों की प्रामाणिकता

## 2007-2015 दौरान बाहरी निधि का उत्पादन



की जाँच के लिए एक स्वतः मिटाने योग्य सुरक्षा मार्कर विकसित किया गया। एक संयुक्त प्रतिदीप्ति और क्वार्ट्ज क्रिस्टल सूक्ष्म संतुलन विधि का उपयोग करके पानी में पाइकोमोलर स्तर और भाप चरण में नैनोग्राम स्तर टीएनटी की संसूचन हासिल की। सममित डाइआयोडिनेटड बेंज़ोथियाज़ोलियम स्क्राइन (एसक्यूडीआई), एक नव विकसित फोटो सुग्राहीकर, फोटो गतिशील थेरेपी (पीडीटी) अनुप्रयोगों के लिए एक कुशल फोटो सुग्राहीकर होना पाया गया और प्रकाश के अभाव में सामान्य ऊतकों को तीव्र विषाक्तता नहीं आया। डाइएथिलएमिनोक्यूनोलिन कार्बाल्डिहाइड पर आधारित एक नये वर्णमिति केमोसेंसर का डिज़ाइन किया गया, जो एक आसान, सुनिर्धारित नग्न आंखों दृश्यमान रंग बदलाव के साथ Cu<sup>2+</sup> और Hg<sup>2+</sup>

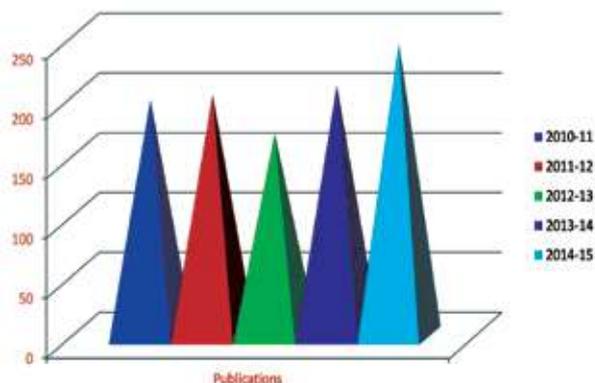
## वर्ष 2010-15 के दौरा परियोजनाओं का वितरण



दोनों आयनों को चुनिंदा पता लगाता है। एस्कॉर्बिक एसिड, डोपामाइन, यूरिक एसिड और एसीटैल्डिहाइड के समक्षणिक निर्धारण के लिए विद्युत संसरो का डिज़ाइन किया गया। मानवीय कैसर की अति संवेदनशील संसूचन और इमेजिंग के लिए एक जैव संगत सतह एन्हांस्ड रमन प्रकीर्णन (एसईआरएस) आधारित नैनोटैग विकसित किया गया। पारंपरिक, समय लेने वाली इम्युनो साइटोरसायनविज्ञान तकनीक की तुलना में यह विधि गैर इनवेसिव, तेजी और सटीक है और इसने वास्तविक रोगी के गर्भाशय ग्रीवा के स्मीयर नमूने का उपयोग करके आगे की जांच



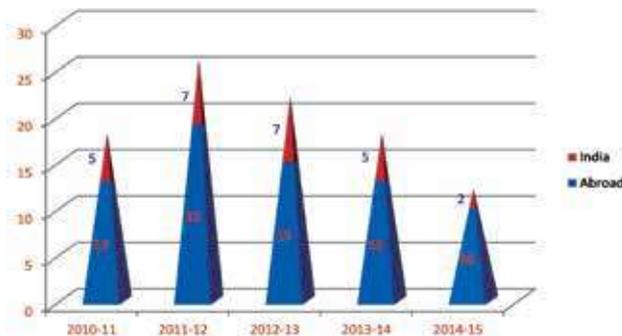
### प्रकाशनों की संख्या



पड़ताल के लिए प्रेरणा दिया। पानी के बंटवारे और कार्बन डाइ ऑक्साइड अंतर्वेश अभिक्रियाओं में सक्षम सिस्टम का डिजाइन करने के लिए कम्प्यूटेशनल तरीके विकसित किए गए और मॉडलिंग किये तंत्र प्रयोगात्मक निष्कर्षों के अनुरूप थे।

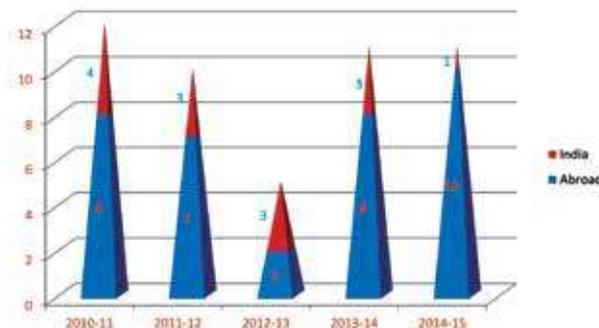
ऊर्जा, इलेक्ट्रॉनिक और परिवहन के क्षेत्रों में अनुप्रयोगों के लिए नूतन कार्यात्मक सामग्री पर चालू कार्यक्रमों का ध्यान, इलेक्ट्रॉनिक सामग्री, उन्नत अतिचालक, सुपर आयनिक कंडक्टर, चुंबकीय सामग्री, कार्यात्मक सिरामिक, कंपोजिट, नैनो कोटिंग्स और पोरस सामग्री, उन्नत पॉलिमर का विकास और हल्के मिश्र और कार्यात्मक ढाल धातु मैट्रिक्स कंपोजिट के विकास पर केंद्रित था। शीतल छत और सतह कोटिंग अनुप्रयोग के लिए उच्च अवरक्त परावर्तन के साथ पर्यावरण के अनुकूल तीव्र पीले, नीले, लाल और हरे रंग के अकार्बनिक पिगमेंट्स की एक नई श्रृंखला का संश्लेषण किया गया। सफेद प्रकाश उत्सर्जक डायोड

### फाइल किए पेटेंट



अनुप्रयोग के लिए दुर्लभ पृथ्वी सक्रिय फॉस्फोर सामग्री की एक श्रृंखला संश्लेषित की गयी और उनके प्रकाश-भौतिक गुणों का अध्ययन किया गया। पर्यावरण की दृष्टि से असुरक्षित पॉलीथीन बहुलक पैकेजिंग सामग्री से छुटकारा पाने के लिए जिलेटिन मैट्रिक्स में संशोधित जिंक ऑक्साइड नैनोसंरचना को शामिल करके एक होनहार हरी पैकेजिंग सामग्री विकसित की गयी। दुर्लभ पृथ्वी सामग्री (आरईपीएस) के फॉस्फेट, विशेष रूप से कोटिंग्स और मोनोलिथ्स के रूप में LaPO<sub>4</sub> ने पिघले हुये धातुओं की ओर संपूर्ण गैर गीलापन और जड़ता प्रदर्शित किया। इन गुणों के साथ उनके उत्कृष्ट रासायनिक और थर्मल स्थिरता, प्रसंस्करण की आसानी और मशीनयुक्तता, साथ ही साथ उनके बहुमुखी प्रकाश-भौतिक और उत्सर्जन गुण विविध

### मंजूर किए पेटेंट



अनुप्रयोगों के लिए उन्हें एक अच्छी सामग्री बनाती है। दो अलग-अलग आकार के Mg-Al LDH नैनोकणों को शामिल करके अत्यधिक परिक्षिप्त ऐसोटैक्टिक पॉलीप्रोपिलिन (आईपीपी) नैनोकंपोजिट तैयार किया गया। सोनिकीकृत एलडीएच कणों के कम लोडिंग के समावेश ने थर्मल स्थिरता, स्फेरुलिट आकार, स्फटिकता और क्रिस्टलीकरण आधे समय पर पर्याप्त प्रभाव दिखाया। विभिन्न अभिवर्तन संशोधित मिट्टी युक्त पॉलीस्टीरिन मिट्टी नैनो कंपोजिट (पीएससी) कोटिंग्स की एक श्रृंखला के डिजाइन और संश्लेषण के लिए एक सरल दृष्टिकोण विकसित किया गया। पूर्वकालीन पॉलीस्टीरिन (पी एस) कोटिंग से पीएससी



कोटिंग्स, संस्कारण के खिलाफ वर्धित संरक्षण प्रदर्शित किया।

पर्यावरण प्रबंधन के लिए नवीन तकनीकों और प्राकृतिक संसाधनों के मूल्य संवर्धन के मुख्य विषय के अंतर्गत कई महत्वपूर्ण शोध कार्यक्रम किए गए। एमएसएमई के आम हित की समस्याओं के लिए अनुसंधान एवं विकास का कार्य करने के लिए डीएसआईआर-एनआईआईएसटी के सहयोग से एमएसएमई में पर्यावरण हस्तक्षेप के लिए आम अनुसंधान और प्रौद्योगिकी विकास केंद्र (सीआरटीडीएच) पर एक नई परियोजना शुरू की गयी। संस्थान ने बीबीएमपी (बंगलुरु नगर निगम) के लिए कुड्लू में 500 टीपीडी एकीकृत ठोस कचरे के प्रबंधन के लिए एक संयंत्र स्थापित करने में कर्नाटक अर्बन इंफ्रास्ट्रक्चर विकास एवं वित्त निगम लिमिटेड, बंगलुरु को एक गंध नियंत्रण प्रणाली का डिजाइन प्रदान किया। पर्यावरण प्रौद्योगिकी समूह द्वारा कीषमाड के आसपास के दूषित क्षेत्र में परक्लोरेट के स्थानिक-कालिक वितरण की निगरानी कर दिया गया है। हाल ही में एर्नाकुलम जिला कलेक्टर द्वारा गठित विशेष समिति को कीषमाड क्षेत्र में परक्लोरेट संदूषण का अध्ययन करने के लिए विश्लेषणात्मक समर्थन भी प्रदान किया गया। पादप फाइबर की निकासी के लिए और बायोमास कचरे के उपचार के लिए अवायवीय प्रणालियों के लिए उपयोगकर्ताओं से अच्छी मान्यता प्राप्त की गयी है और प्रदर्शन संयंत्रों की स्थापना की गई है। केएमएमएल, चवरा के लिए खनन पट्टे का नवीकरण के लिए पर्यावरण प्रभाव आकलन और खनिज रेत उत्पादन की वृद्धि, साथ ही साथ भूजल प्रवाह की दिशाओं के साथ कुओं के पानी की गुणवत्ता पर लोहा आक्साइड भंडारण तालाब से लीचेट की मैपिंग का संचालन किया गया और शमन उपायों का सुझाव दिया गया। 3 डी फाउंड्री का कास्टिंग डिजाइन सॉफ्टवेयर, ऑटोकास्ट, के साथ एकीकृत वर्चुअल कास्टिंग सॉल्वर

का अपग्रेडेशन किया गया है। एक दिये डिजाइन में भराव के दौरान झटका छेद की भविष्यवाणी के लिए एक नया मॉड्यूल, 'गैस और वेटिंग मॉड्यूल' विकसित किया गया और औद्योगिक कास्टिंग के खिलाफ इसका बेंचमार्क किया जा रहा है। एक नये लाइसेंस के तहत इस मॉड्यूल को 3 डी फाउंड्री टेक. प्राइवेट लिमिटेड को हस्तांतरित किया गया।

## सम्मान और पुरस्कार

कई वैज्ञानिकों और रिसर्च फ़ैलो को इस साल भी सम्मान, पुरस्कार और मान्यताओं से सम्मानित किये गये हैं। उनमें से कुछ महत्वपूर्ण निम्नानुसार हैं:- डॉ ए अजयघोष को डीएसटी का प्रतिष्ठित जेसी बोस नेशनल फ़ैलोशिप 2015, विज्ञान तथा प्रौद्योगिकी में उत्कृष्टता के लिए भारतीय विश्लेषणात्मक वैज्ञानिक सोसायटी का आईएसएस राष्ट्रीय पुरस्कार-2014, और अनुसंधान एवं विकास के क्षेत्र में नेतृत्व और उत्कृष्टता के लिए केमटेक.सीईडब्ल्यू अवार्ड 2015। डॉ टी पी डी राजन को भारतीय संधानीकर्मी संस्थान (आईआईएफ), कोलकाता से एप्लाइड रिसर्च और अभिनव प्रौद्योगिकी -2015 के लिए चंद्रन मेनन मेमोरियल पुरस्कार से सम्मानित किया गया। डॉ के वी राधाकृष्णन को टोक्यो केमिकल इंडस्ट्रीज (इंडिया) प्राइवेट लिमिटेड के समाचार पत्र में "असाधारण केमिस्ट के संघ" में चित्रित किया गया। डॉ एमएलपी रेड्डी को आंध्र प्रदेश विज्ञान अकादमी -2014 के फ़ेलो के रूप में चयनित किया गया। डॉ पी बिनोद और डॉ वंदना शंकर को केरल राज्य युवा वैज्ञानिक पुरस्कार 2014 से सम्मानित किया गया। डॉ आर सिंधु को एल्सेविअर से औद्योगिक फसलों और उत्पादों के क्षेत्र में समीक्षक पुरस्कार प्राप्त हुआ। राष्ट्रीय तथा अंतरराष्ट्रीय सम्मेलनों में प्रस्तुत कागजात के लिए युवा शोधकर्ताओं को एक बड़ी संख्या में बेस्ट पेपर, बेस्ट मौखिक प्रस्तुति और बेस्ट पोस्टर पुरस्कार प्राप्त हुए।



## अन्य गतिविधियां

चार्टर के मानव संसाधन विकास प्रदान करने के भाग के रूप में कई सम्मेलनों, प्रशिक्षण कार्यक्रमों, व्याख्यान श्रृंखलाओं, कार्यशालाओं और संगोष्ठियों का आयोजन किया गया। उनतीस छात्रों को समीक्षाधीन अवधि के दौरान पीएचडी डिग्री से सम्मानित किया गया। उद्योगों और शिक्षाविदों से बाहरी ग्राहकों को इंस्ट्रुमेंटेशन सहायता प्रदान करने का कार्य जारी रखा।

संस्थान में राष्ट्रीय प्रौद्योगिकी दिवस, राष्ट्रीय विज्ञान दिवस, सीएसआईआर स्थापना दिवस और एनआईआईएसटी वार्षिक दिन मनाये गये। छात्रों और सार्वजनिक को संस्थान में हो रही गतिविधियों की एक

झलक देने के लिए इन दिनों को आम दिवस के रूप में मनाया गया। इसके अलावा, विभिन्न गतिविधियों के साथ हिंदी जागरूकता सप्ताह, सतर्कता जागरूकता सप्ताह आदि भी मनाये गये। प्रधानमंत्री के स्वच्छ भारत मिशन के भाग के रूप में 2 अक्टूबर 2014 को संस्थान में गहन स्वच्छता अभियान चलाया गया। संस्थान ने सितंबर 2014 के दौरान शांति स्वरूप भटनागर मेमोरियल टूर्नामेंट (एसएसबीएमटी) इंडोर -जोनल का सफलतापूर्वक आयोजन किया, जहां ग्यारह सीएसआईआर प्रयोगशालाओं / कार्यालयों ने इंडोर जोनल टूर्नामेंट में भाग लिया। त्योहारों और अन्य सामाजिक गतिविधियों का जश्न मनाने के लिए स्टाफ क्लब और छात्र संघ ने कई कार्यों की व्यवस्था की।



मेसेर्स कृष्णा कॉन्केम. प्रोडक्ट्स प्राइवेट लिमिटेड, मुंबई को नैनो TiO<sub>2</sub> की प्रक्रिया जानकारी का हस्तांतरण



## AGROPROCESSING & NATURAL PRODUCTS DIVISION

The core competence of Agroprocessing and Natural Products Division is in technology development for the post harvest processing of oil seeds, spices & natural resources. Significant contributions have also been made by the group in the biological screening of bioactives from plant sources for their effectiveness against certain disorders. A multidisciplinary team comprising of Chemical Engineers, Biologists, Food technologists and microbiologist backed by excellent analytical and pilot plant facilities form the backbone of the division. The technology incubator set up with support from Government of Kerala has benefited several small and medium scale enterprises within the state. The major highlights of the activities of the division are :

### Highlights

- Application of RADD drying for drying of ginger powder under implementation in a commercial scale
- Erection of plant and machinery for the integrated processing of fresh ginger at Wayanad in progress. Plant to be commissioned in November 2015
- Studies on Formulated Spice Blends ( FSB ) with nutraceutical benefits
- Bilobalide attenuates ROS generation and protects 3T3-L1 adipocytes from hypoxia induced mitochondrial dysfunction
- Apigenin ameliorated tunicamycin induced ER stress associated with oxidative stress and decreased adiponectin secretion in 3T3-L1 adipocytes
- Punicic acid ameliorated TNF- $\alpha$  induced alterations in ATP production, O<sub>2</sub> consumption and transmembrane potential in 3T3-L1 adipocytes
- Cerium nanoparticles synthesized using aqueous *Centella asiatica* extract exhibited *in vitro* radical scavenging activity
- The ethyl acetate extract of *Tribulus terrestris* L ameliorated ischemia induced oxidative stress, transmembrane potential and apoptosis in H9c2 cells
- Chebulagic acid activates PPAR $\gamma$  and increases glucose uptake in 3T3-L1 adipocytes through GLUT4 expression and adiponectin secretion
- Flavonoids (quercetin, naringin, hesperidin) upregulate GLUT4, Irs and Akt gene in differentiated L6 myoblast pointing to the fact that signalling pathway of these flavonoids overlaps with that of insulin in the management of diabetes
- Bacterial strain isolated from the Western Ghats forest soil of Wayanad, Kerala, India was identified as *Paenibacillus elgii* by 16S rRNA gene sequencing which recorded significant broad spectrum activity against plant and human pathogenic microorganisms



## कृषि प्रसंस्करण तथा प्राकृतिक उत्पाद प्रभाग

कृषि प्रसंस्करण तथा प्राकृतिक उत्पाद प्रभाग की मुख्य सक्षमता, तिलहन, मसाला और प्राकृतिक संसाधनों के फसलोत्तर प्रसंस्करण के लिए प्रौद्योगिकी विकास में है। कुछ अव्यवस्था या रोगों के खिलाफ पादप स्रोतों के प्रभाव के लिए उनके जैव सक्रियों के जैविक स्क्रीनिंग में भी समूह द्वारा महत्वपूर्ण योगदान दिया गया है। प्रभाग, केमिकल इंजीनियर्स, जीव विज्ञानियों, खाद्य प्रौद्योगिकीविदों और सूक्ष्मजीव विज्ञानियों शामिल बहुविषयी समूह तथा उत्कृष्ट विश्लेषणात्मक तथा पायलट संयंत्र सुविधाओं द्वारा समर्थित है। केरल सरकार के समर्थन के साथ स्थापित प्रौद्योगिकी इनक्यूबेटर से राज्य के भीतर कई छोटे और मध्यम स्तर के उद्योग लाभान्वित हुये हैं। प्रभाग की गतिविधियों की मुख्य विशेषताएं निम्न हैं :

### मुख्य विशेषताएं

- अदरक पाउडर को सुखाने के लिए आरएडीडी शुष्कन अनुप्रयोग व्यावसायिक पैमाने में कार्यान्वयन के तहत है
- वायनाड में ताजा अदरक के एकीकृत प्रसंस्करण के लिए संयंत्र और मशीनरी के उत्पादन का कार्य प्रगति में है और संयंत्र नवंबर 2015 में चालू हो जाएगा
- न्यूट्रास्यूटिकल लाभ के साथ तैयार किये गये स्पाइस मिश्रणों (एफएसबी) पर अध्ययन
- बाइलोबालिड, आरओएस के उत्पादन को कम करता है, हाइपोक्सिया प्रेरित माइटोकॉण्ड्रियल रोग से 3T3-एल1 अडिपोसिट्स की रक्षा करता है
- एपीजेनिन ने ऑक्सीडेटिव तनाव से जुड़े टुनिकामाइजिन प्रेरित ईआर तनाव का सुधार किया और 3T3-एल1 अडिपोसाइट्स में एडिपोनेक्टिन स्राव की कमी की
- पुनिसिक एसिड ने एटीपी उत्पादन में टीएनएफ- $\alpha$  प्रेरित परिवर्तन, ऑक्सीजन की खतप और 3T3-एल 1 अडिपोसाइट्स में ट्रांस झिल्ली क्षमता में सुधार किया
- जलीय सेंटेला हल्दी निकाल का उपयोग करते हुए संश्लेषित सैरियम नैनोकणों ने इन *विट्रो* मूलक समार्जक गतिविधि प्रदर्शित की
- *ट्रिबुलस टेरिस्ट्रिस* एल के एथिल एसीटेट निकाल ने H9C2 सेल में स्थानिकारकता प्रेरित ऑक्सिडेटिव तनाव, ट्रांस झिल्ली क्षमता, और एपोप्टोसिस का सुधार किया
- केबुलाजिक एसिड PPAR $\gamma$  को सक्रिय करता है और 3T3-एल1 अडिपोसाइट्स में GLUT4 अभिव्यक्ति और एडिपोनेक्टिन स्राव के माध्यम से ग्लूकोज उद्ग्रहण की वृद्धि करती है
- विभेदित एल6 पेशीकोरक में, फ्लेवोनोंयड्स (क्वेरसेटिन, नरिजिन, हेस्पेरिडीन) GLUT4, Irs and Akt जीन को विनियमित करता है, जो इस तथ्य की ओर इशारा करता है कि मधुमेह के प्रबंधन में इन फ्लेवोनोंयड्स के संकेतन मार्ग इंसुलिन के साथ अतिव्यापन करता है
- वायनाड, केरल, के पश्चिमी घाट की जंगली मिट्टी से अलग किये बैक्टीरियल स्ट्रेन को 16 आरआरएनए जीन अनुक्रमण द्वारा पैनीबेसिलस एलजी के रूप में पहचान की गई और इसने पौधे और मानव रोगजनक सूक्ष्मजीवों के खिलाफ महत्वपूर्ण बोर्ड स्पेक्ट्रम गतिविधि दर्ज की है



## Technology Business Incubation Centre (TBIC) in Agro-processing

Extension of technical support for development of new products and modification of existing process operations to various industries in Kerala continued during this year under the TBIC. Some of the major activities were:

### (a) New product development - Margarine for bakery products



Baking industry employ specific fat for application in cakes, puffs, biscuits pastries etc for achieving softness, for air entrapment, shelf stability, crispiness and melting features in mouth. Margarine, like butter, is a water-in-fat emulsion, with tiny droplets of water dispersed uniformly throughout a fat phase in a stable crystalline form. The pilot scale product development of margarine specific for application in cakes was undertaken through a consultancy project under TBIC. Further product characterization were also carried out using equipments like GC, DSC and XRD for evaluating the fatty acid profile and physical characteristics which ultimately decided fat performance in final product. Trials were also conducted to develop TFA free / reduced margarines.

### (b) Banana based products

Pilot scale process development studies were conducted for producing flakes from raw banana for blending with oats and other ingredients for making functional breakfast, payasam mix, upma mix etc. After primary processing the raw banana was subjected to a series of processing operations and dried in a fluid bed drier before final crushing and sieving to achieve the desired particle size. The product samples were test marketed and the quality evaluation of the product also completed.



### (c) Product evaluation & drying of jack fruit

Technical consultancy was extended to an incubate for evaluation of the jack fruit based products developed and assisted them in standardizing the process and products.

### (d) Development of palm neera syrup

As part of societal program many pilot scale trails were conducted for producing the concentrated palm neera syrup and the product was supplied for test marketing.



## Setting up of 7.5 TPD fresh ginger & vegetable processing facility at Wayanad



Implementation of the project for setting up a commercial venture for the processing of fresh ginger and vegetables having 7.5 TPD capacity at Meenangadi, Wayanad continued during this period. The project is sponsored by Govt of Kerala engineered through CSIR NIIST and MILMA as implementation agency. The major products are cleaned/waxed ginger /vegetables and dry ginger powder. The equipments designed based on the technical inputs from CSIR-NIIST have been fabricated and are at various stages of erection. The civil work for the plant had been completed. The commissioning of the plant is expected in 2015.

## A study on optimizing the material utilization in Ayurvedic industry by replacing plant roots by benign herbal parts and by developing new bio active applications for herbal spent material

As a follow up of the activities, the following tasks were carried out by CSIR NIIST together with Kottakkal Arya vaidya Sala (AVS):

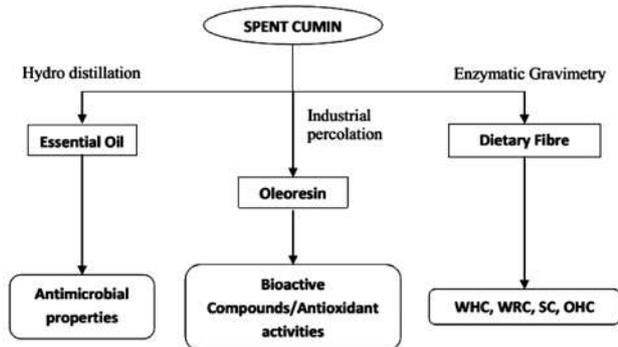
A. Scale up studies on process development for bio active recovery from spent material. Completed the study in 2- 5kg batch level for pepper, cumin and turmeric spents. The yield and process conditions were optimized. Isolation of active ingredients such as piperine and curcumin as well as functional food and dietary fiber isolation from spent cumin were completed.

Spent Cumin (SC) generated and discarded as waste from M/s. AVS Kottakkal was screened as source for essential oil, oleoresin and dietary fibre for possible value addition. The essential oil, oleoresin and dietary fibre extracted were investigated for its antimicrobial activity, phytochemical composition and antioxidant activity and functional properties respectively. Spent Cumin was found to be a valuable source of cumin volatile oil, bioactive compounds and dietary fibre, even after the processing it had undergone during the preparation of Ayurvedic decoction. The study demonstrated that phenolic compounds extracted from spent cumin (SCM) beneficially modulated all three distinct phases of carcinogenesis (initiation, promotion, and progression) by altering pathways involved in control of cell division and growth, apoptosis and metastasis and the activity was comparable to that of raw cumin (RCM). The results indicated that there is a great potential to develop value added products from spent cumin in the form of nutraceutical and functional food products.

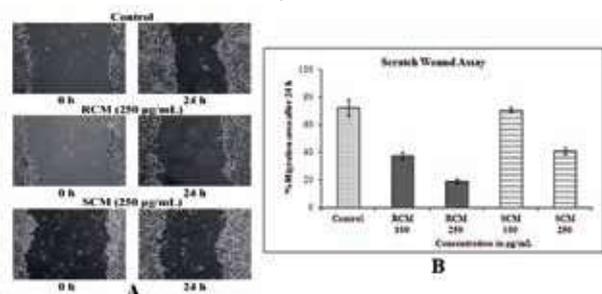
- B. As a substitute for a plant root, chemical and biological screenings of extracts from various plant parts were continued. Anti inflammatory and anti diabetic activity studies by *in vitro* models are in progress.
- C. As per the studies conducted with the plant leaves, antidiabetic and anti-inflammatory properties were comparable to the root extracts though the constituents isolated from them differ in chemical profiling.



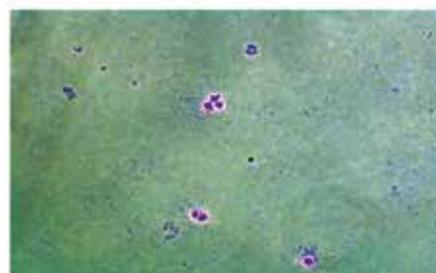
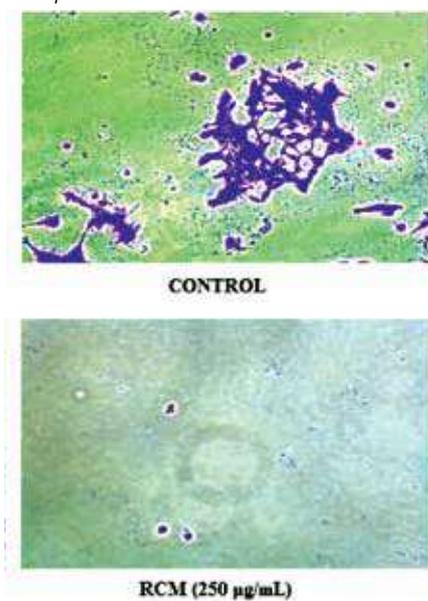
D. Biological studies of the formulations derived from various plant parts of *Aegle marmelos* were also screened and comparable activity was found with respect to antidiabetic effect



Process for extraction of value added products from spent cumin



Scratch Wound Assay. (A) Representative images for scratch wound assay at higher concentrations of RC and SC. (B) Average percentage of cell migration of three independent experiments  $\pm$  standard deviation.



SCM (250 µg/mL)

Colony Formation Assay. Representative images obtained after 24 h treatment with 250 µg/mL concentration of RCM and SCM.

### New Initiatives to boost agriculture productivity through maximizing pre and post-harvest yields



Fluid bed dryer



Dehumidified dryer

The broad objective of the program was to develop commercially viable drying mechanism for the post-harvest processing of various agro produces for shelf life

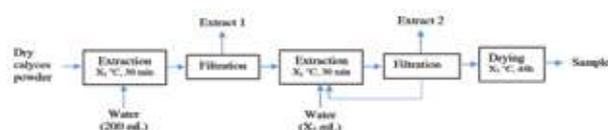


enhancement and accordingly Fluid Bed & Dehumidified drying methods were developed and standardized in pilot scale for drying of crops like ginger, turmeric, jack fruit, banana etc. Drying characteristics were standardized for various raw materials. Optimization of process parameters and process costing were completed. Commercialized units of FBD and dehumidified drier models are currently in implementation stage in the projects for M/s. HAFED, Haryana and MRCMPU, Wayanad for turmeric and ginger processing.

### Effect of re-extraction parameters and drying temperature on the functional properties of Red sorrel (*Hibiscus sabdariffa* L.) calyces residues

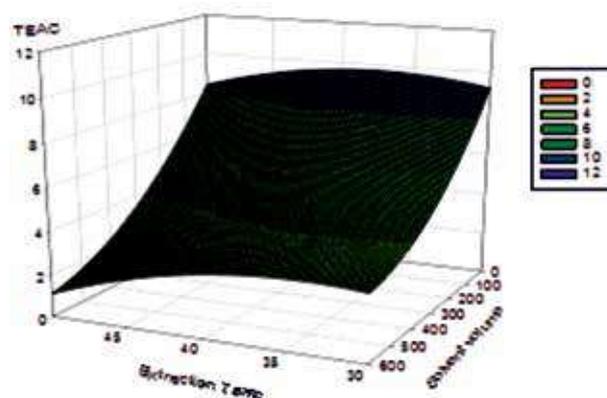
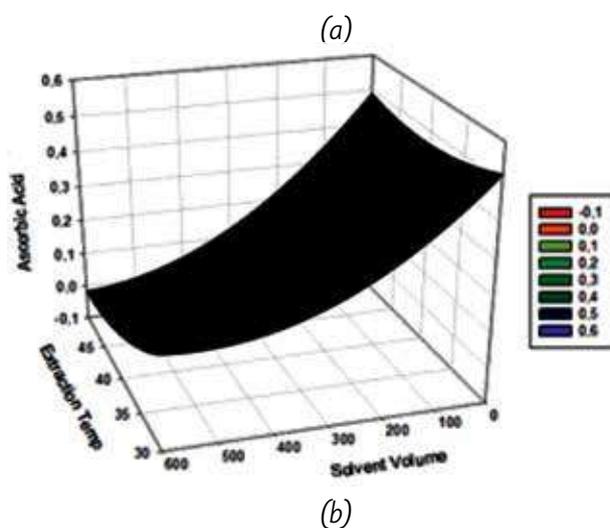
*Hibiscus sabdariffa* L., commonly known as red sorrel, is a herbaceous plant that belongs to the family of Malvaceae. It is cultivated in tropical and subtropical areas of both north and south hemispheres, and it yields up to 500 kg of red edible calyces per hectare. There is a growing interest in this plant due to its high anthocyanins content, as the concentration of anthocyanins in red sorrel calyces are reported to be as high as 1.5 g/kg<sup>-1</sup> of dry matter. Most of the studies on *Hibiscus sabdariffa* L. are interested in the extraction of bioactives from the calyces. The residue of the calyces after the extraction is reported to be a good source of dietary fibre. In this respect, the present study was undertaken with an objective to investigate the effect of the re-extraction procedure at low temperature on the quality of *Hibiscus sabdariffa* L. calyces residues as potential industrial source of dietary fibre (DF) and antioxidants (phenolic compound such as anthocyanins). Three explainable parameters were studied: the extraction temperature, the total solvent volume as a function of the re-extraction steps and the drying temperature. The effects of these parameters on the system responses viz., ascorbic acid content, total phenolic content (TPC), total flavonoid content (TFC), DF and antioxidant activity were evaluated and modeled using the response surface methodology (RSM) with respect to 3 factors Doehlert experimental design. Mathematical models were obtained for

the effect of re-extraction parameters on ascorbic acid, TPC, TFC, ABTS, SDF, and SDF/IDF ratio. The suitability of each response model was judged using the average absolute deviation method and the calculation of the Bias factors. No significant difference was observed for the total dietary fiber content among different samples. The study indicated that *Hibiscus sabdariffa* L. calyces residues can be a potential source of additive/ingredient for the food industry and the re-extraction at lower temperatures further improves the dietary fibre composition of the residue.



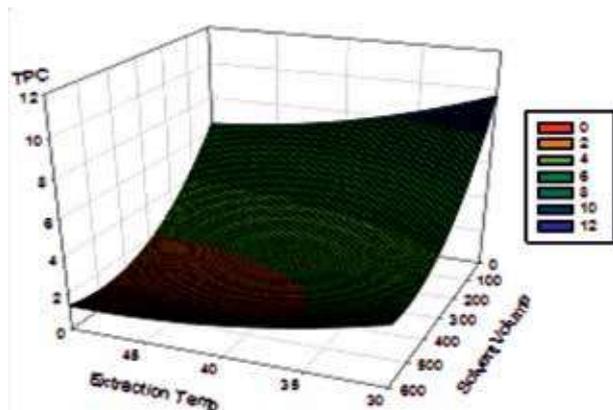
Block diagram of the re-extraction process

Block diagram of the re-extraction process  
Estimated response

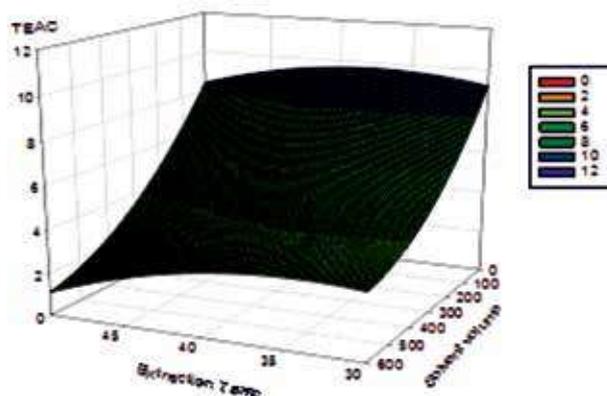




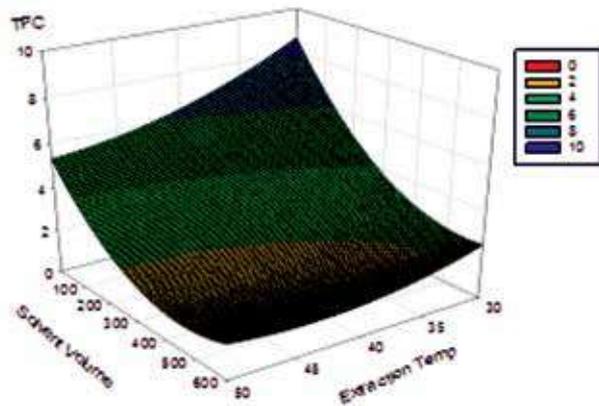
(c)



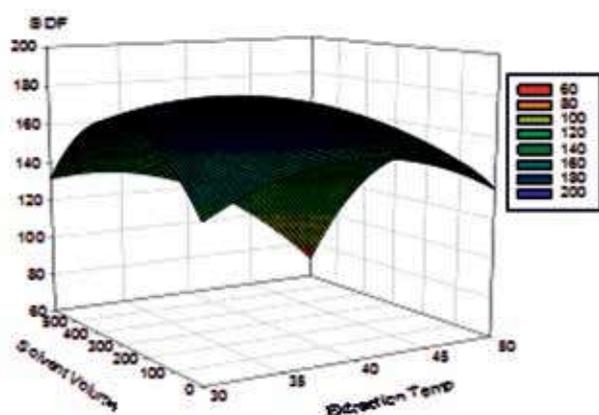
(f)



(d)



(e)



surfaces of Ascorbic Acid (a), ABTS (b), TPC (c), TFC (d), SDF (e), and SDF/IDF (f) as functions of solvent volume (mL) and extraction temperature ( $^{\circ}\text{C}$ ) for drying temperature =  $40^{\circ}\text{C}$

### Development of functional food products from spices for better health management

Spices are esoteric food adjuncts that have been used as flavoring/coloring agents and as preservatives for thousands of years. Spices have also been recognized to possess medicinal properties and their use in traditional systems of medicine has been on record for a long time. Based on the traditional knowledge and recent research finding, there is great scope to develop new value added products from spices in the form of nutraceuticals and functional food products, going beyond the concept of conventional products. With this background the functional food products from spices and herbs were developed for the prevention and management of diabetes and cardiovascular diseases. Nutraceutical/functional food products in the form of dry seasoning mix and bag based beverage using the water extracts of spices/herbs in combination with other bioactive rich fruits like amla, jamun and pomegranate developed. The products were screened for acceptability by sensory analysis.



*In vitro* studies to ascertain the bioactivity of the products developed for the proposed health benefits are in progress.

### Functional vegetable oils for addressing malnutrition due to vitamin a deficiency

Vitamin A is an essential nutrient needed in small amounts for the normal functioning of the visual system, and maintenance of cell function for growth, epithelial integrity, red blood cell production, immunity and reproduction. Red palm oil is the richest naturally occurring source of beta-carotene, a carotenoid that the human body can convert into usable vitamin A (retinol). Studies have shown that various carotenoids possess protective properties against certain types of cancers. CSIR-NIIST has developed a process for the production of natural carotene and vitamin E rich red palmolein (RPO). CSIR has taken up a major programme on S&T Interventions to Combat Malnutrition in Women and Children'. Under this initiative, CSIR-NIIST is assessing the acceptability of blends of RPO with commonly used vegetable oils for culinary cooking purpose as a functional vegetable oil. The target groups for field trials were identified. Agency for implementation and ethical clearance are being obtained.

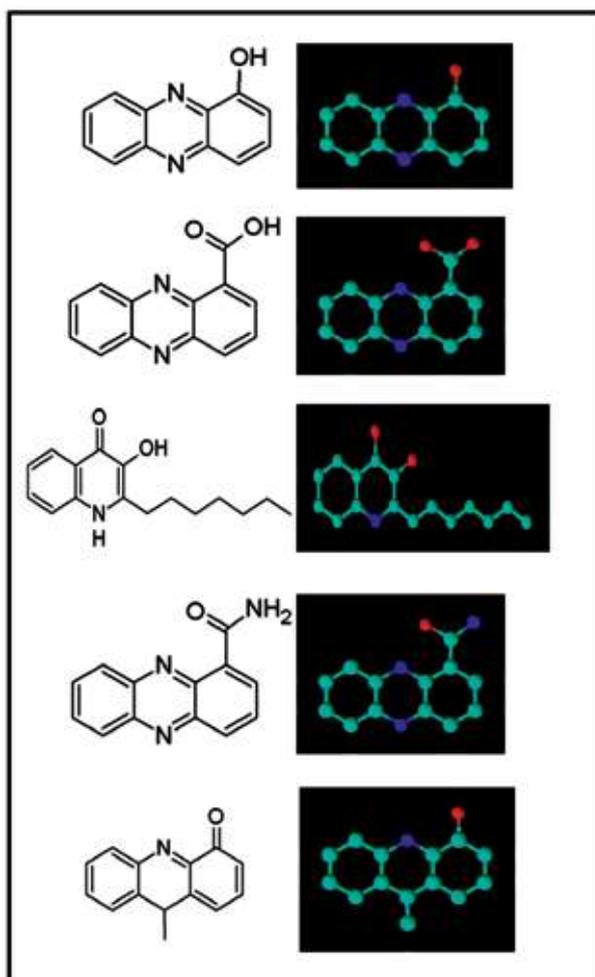
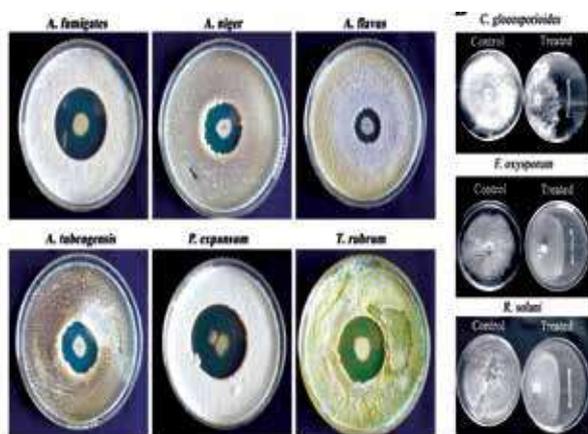
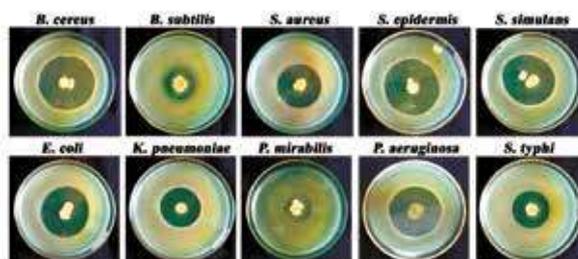
### Bioprocessing of botanicals for active ingredient isolation- Enzymatic route

Enzyme-assisted extraction of bioactive compounds from plant sources, particularly for food and nutraceutical purposes were evaluated under this programme. Extraction of lycopene from tomato processing waste and carotenoids from chilli was optimized using a consortium of commercial enzymes. These enzymes were produced in house using microorganisms isolated from Western Ghats region. Conditions such as temperature for extraction, types of enzymes and enzyme concentration and incubation time were optimized for extraction of lycopene and carotenoids. Further optimization of the extraction phytochemicals

were being carried out using these in house enzymes. Process development studies are also underway to scale up the process.

### Bioactive metabolites from plant growth promoting rhizobacterial strains and its application in agriculture and medicine

Two plant growth promoting bacterial strains, PM 105 and FPO4 were isolated from a tea plantation soil from the North Eastern region of India and rhizosphere of rice plant root from Gujarat. These were identified earlier as fluorescent *Pseudomonas aeruginosa* through classical and 16S rRNA gene sequencing. Further studies with these strains confirmed broad spectrum antifungal activity against ten fungal pathogens viz. *Aspergillus flavus*, *A. fumigatus*, *A. niger*, *A. tubingensis*, *Candida albicans*, *Colletotrichum gloeosporioides*, *Fusarium oxysporum*, *Penicillium expansum*, *Rhizoctonia solani*, *Trichophyton rubrum* besides growth promoting property in cow pea (*Vigna unguiculata*) and pigeon pea (*Cajanus cajan*). Four major compounds viz. 1-hydroxy phenazine, pyocyanin, phenazine-1-carboxylic acid, 2-heptyl-3-hydroxyl-4(1H)-quinolone, phenazine-1-carboxamide were purified and characterized from crude extracts of this strain by various spectral data. 1-hydroxy phenazine and phenazine-1-carboxamide were active against all the fungi tested. The highest activity of 4 µg/ml by phenazine-1-carboxamide was recorded against *Trichophyton rubrum*, a human pathogen responsible for causing athlete's foot, jock itch, ringworm and fingernail fungus infections, followed by *Candida albicans* and *Candida tropicalis*. Recently bacterial strain isolated from the Western Ghats forest soil of Wayanad, Kerala, India was identified as *Paenibacillus elgii* by 16S rRNA gene sequencing and this organism recorded significant broad spectrum activity against plant and human pathogenic microorganisms tested.

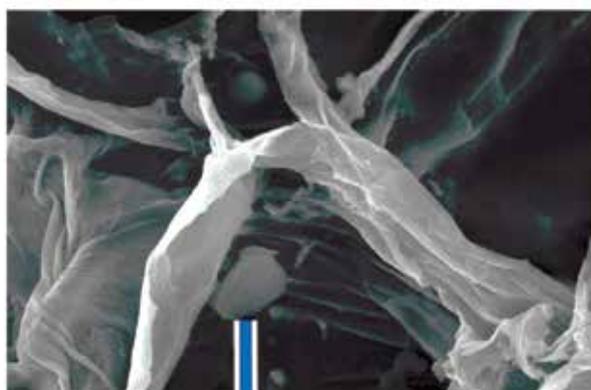
Bioactive compounds isolated from *Pseudomonas* strainsAntifungal activity of live *Paenibacillus elgii* against test pathogensAntibacterial activity of live *Paenibacillus elgii* against test pathogens

### Endophytic bacterial flora of the rice plants from the acidic soils of Kuttanad, Kerala and their exploitation in improved paddy cultivation

Rice plant samples were collected from the various part of Kuttanad region in Alleppey, Kerala. The potent microorganisms from soil, root, pseudo stem and leaf of the collected samples were done in five different media viz. *Pseudomonas* isolation agar, Nutrient Agar, *Actinomyces* isolation agar, Potato dextrose agar and Yeast mannitol agar. During the isolation process of endophytic organisms, an emphasis was given for the *Actinomyces* strains. The presence of endophytic organism in the cortex region of root samples was located through scanning electron microscopy. The confirmation of these studies is in progress. The isolated strains were also tested for their *in vitro* antagonism against *Rhizoctonia solani*, the sheath blight pathogen of rice plants. The strains showing potential antagonism were also screened against six plant fungal and ten human pathogens for their broad spectrum antimicrobial activity. The strains showed *in vitro* antagonism against *R. solani* were selected for further studies. The plant growth promoting activity of the isolated strains were also initiated with some the strains against rice plants in pots under nursery conditions. An enhanced root length, shoot height and fresh and dry weight was recorded in bacterial treated rice plants over their non-bacterized control plants.



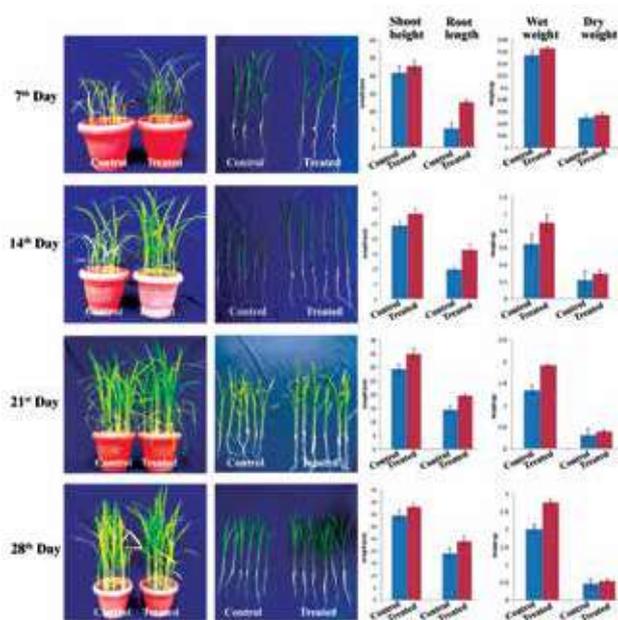
Scanning electron microscopy pictures of the TS of rice root from Kuttanad showing endophytes



Endophytic microorganism



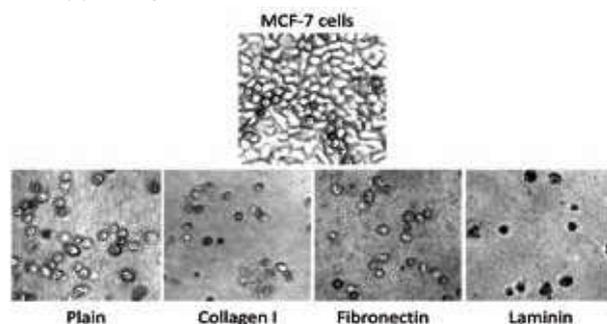
In vitro antagonism of isolated strain against *R. solani*



Plant growth property of the isolate against rice

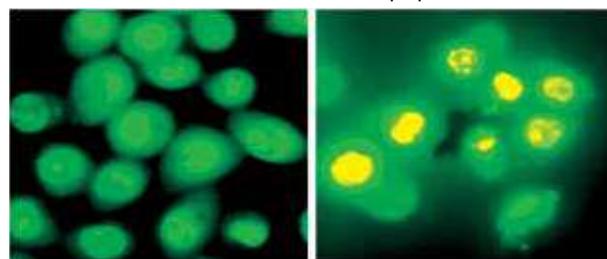
### Role of extracellular matrix on detachment induced cell death promoted by *M. alba* lectin (MLL)

*Morus alba* leaf lectin (MLL) was purified in two stage affinity chromatographic procedure and were tested in human mammary cancer cells for its ability to induce detachment induced cell death. It was shown previously that on MLL treatment ( $GI_{50}$  concentration 8.5  $\mu\text{g/ml}$ ) more than 80% of cells were detached from the culture plates and matrix metalloproteinase 9 was upregulating in this condition. Further studies on the fate of these detached cells by reseeding them on different matrix coated plates (collagen, fibronectin and laminin) showed that the detached cells were unable to adhere to the plates even in the presence of supporting matrix.



Phase contrast images of detached cells seeded on different matrix proteins

The detached cells were collected and subjected to DNA fragmentation analysis and apoptotic staining by acridine orange/ ethidium bromide staining. Agrose gel electrophoresis and DAPI staining indicated that the detached cells underwent apoptotic DNA fragmentation. Acridine orange/ethidium bromide staining also indicated that detached cells underwent apoptosis.



Nuclear fragmentation shown by DAPI staining



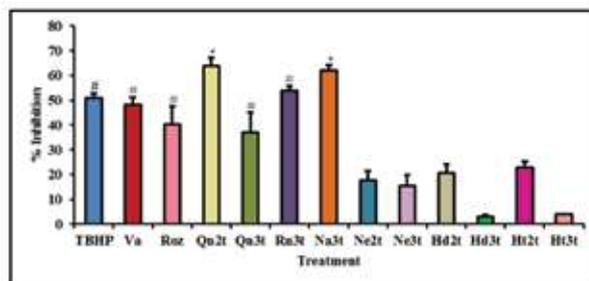
The phosphorylation pattern of foocal adhesion kinase (FAK) upon treatment with MLL was studied. The results indicated phosphorylation of FAK was inhibited on treatment with MLL. In order to study the effect of different matrix proteins on MLL induced detachment of cells, MCF-7 cells were seeded on plain and different matrix coated culture plates and treated with MLL at  $GI_{50}$  concentration. The cells seeded on laminin coated plates were found dead before treatment with MLL indicated that laminin did not support the growth of MCF-7 cells. Collagen and fibronectin did not affect the  $GI_{50}$  value of MLL.

The production of matrix proteins such as collagen, fibronectin and laminin in MLL treated and untreated conditions in MCF-7 cells were studied. The results indicated that the production of fibronectin was significantly high in control cells compared to collagen and laminin. The increased level of fibronectin was found to be decreased to basal level upon treatment with MLL indicated that disturbance in fibronectin mediated signalling helped in the detachment of cells.

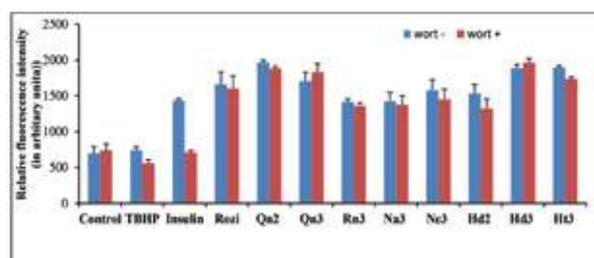
### Comparative evaluation of antidiabetic potential of flavonoids quercetin, naringin, hesperidin and its glycoconjugates under oxidative stress

The oxidative stress induced pathways is known to be associated with the onset of diabetes and its complications. PTP1B has been implicated as the negative regulator of the insulin signaling pathway. Compounds were tested for their PTP1B inhibition potential at its optimum concentration. It was found that Quercetin (10  $\mu$ M), Rutin and Naringin at 100  $\mu$ M exhibited higher percentage inhibition than that of positive control (Sodium orthovanadate). To investigate whether the compounds stimulated glucose uptake is mediated through PI3K activation, the effects of wortmannin, a selective inhibitor of PI3K on flavonoids stimulated glucose uptake was examined which indicated that the insulin signaling pathway upstream of PI 3-kinase was not involved. The studies indicated hypoglycemic

effect of Naringenin in chronic treatment presumably through increased GLUT 4 expression. Moreover, up-regulation of GLUT4, Irs and Akt gene in differentiated L6 myoblast pointing to the fact that signalling pathway of these flavonoids overlaps with that of insulin.



Effect of the flavonoids on inhibition of PTP1B enzyme



Effect of PI3 kinase inhibitor wortmannin on 2-NBDG uptake in L6 myotubes on pretreatment of Quercetin & Rutin.

### Chebulagic acid from *Terminalia chebula* activates PPAR $\gamma$ and enhances insulin sensitivity in 3T3-L1 adipocytes

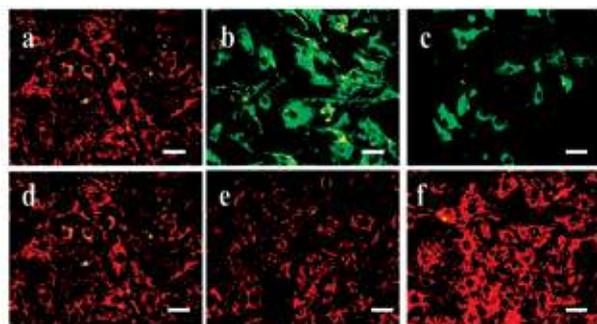
In the present work, the effects of chebulagic acid ( $CH_A$ ) isolated from fruits of *Terminalia chebula* on adipogenesis, glucose transport, and endocrine function of adipocyte were studied. The mRNA expression profile of PPAR $\gamma$  target gene CCAAT/enhancer-binding protein alpha (C/EBP- $\alpha$ ) was analyzed by qRT-PCR. The putative binding mode and the potential ligand-target interactions of  $CH_A$  with PPAR $\gamma$  was analyzed using docking software (Autodock and iGEMDOCKv2). The results showed that  $CH_A$  enhances PPAR $\gamma$  signaling and adipogenesis dose dependently but in a moderate way, less than rosiglitazone. GLUT4



expression and adiponectin secretion was increased by CH<sub>A</sub> treatment. The mRNA expression of PPAR $\gamma$  target gene C/EBP- $\alpha$  was increased in CH<sub>A</sub>-treated adipocytes. The overall results showed that CH<sub>A</sub> can be considered as a partial PPAR $\gamma$  agonist with moderate adipogenic potential and better insulin stimulated glucose uptake capacity.

### Bilobalide ameliorates hypoxia induced oxidative stress, mitochondrial dysfunctions and inflammation in 3T3-L1 adipocytes

Protective effect of curcumin on adipocytes from adverse effects of hypoxia in a dose dependent manner was reported last year. This year the protective role of bilobalide, a bioactive from *Ginkgo biloba*, on hypoxia induced alterations was also evaluated. The results revealed that hypoxia significantly altered all the vital parameters of adipocyte biology like HIF-1 $\alpha$  expression, lactate and glycerol release, reactive oxygen species (ROS) production, lipid and protein oxidation, reduction in antioxidant enzymes status, secretion of inflammatory markers (TNF- $\alpha$ , IL-6, IL-1 $\beta$  and IFN- $\gamma$ ) and mitochondrial functions. The results showed that bilobalide could be considered as an effective lead for the protection of adipocytes from hypoxia induced inflammation, oxidative stress and mitochondrial impairment.



Mitochondrial transmembrane potential changes in normoxic and hypoxic groups analyzed by fluorescent microscopic images: a-normoxia; b-hypoxia; c-valinomycin, d, e, f-hypoxic cells treated with 10, 20 & 50 $\mu$ M of bilobalide

### Tunicamycin-induced ER stress is associated with mitochondrial alterations in 3T3-L1 adipocytes is ameliorated by apigenin

Endoplasmic reticulum (ER) stress is associated with a number of metabolic disorders. The present investigation was aimed to check the mitochondrial alterations in adipocytes with tunicamycin-induced ER stress and modulation by apigenin. For this, differentiated adipocytes were incubated with tunicamycin (2  $\mu$ g/ml) for 18 h, and changes in mitochondrial membrane potential, biogenesis, reactive oxygen species production, and adiponectin secretion were observed. Tunicamycin-induced ER stress altered reactive oxygen species (ROS) (6.34-fold $\uparrow$ ), membrane potential (4.1-fold $\uparrow$ ), mitochondrial biogenesis (2.4-fold $\downarrow$ ), and adiponectin secretion (3.5-fold $\downarrow$ ). From the results, it was concluded that apigenin protected adipocytes from tunicamycin induced ER stress significantly by ameliorating mitochondrial impairment and restoring adiponectin secretion.

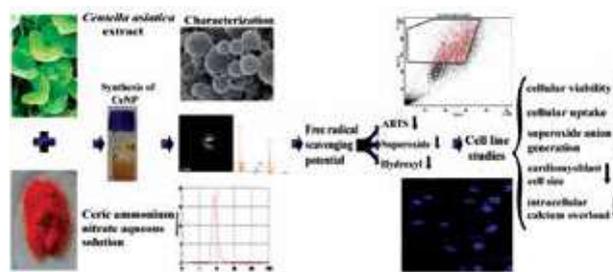
### TNF- $\alpha$ induced insulin resistance and associated mitochondrial dysfunction in 3T3-L1 adipocytes and possible attenuation with punicalic acid, a PPAR $\gamma$ agonist

In this study, punicalic acid (PA), an important phytochemical found in pomegranate seed oil with PPAR $\gamma$  agonist property was evaluated for its ability to ameliorate TNF- $\alpha$  induced mitochondrial dysfunctions in 3T3-L1 adipocytes. For this, the alterations in mitochondrial energetics, biogenesis, transmembrane potential and dynamics in TNF- $\alpha$  induced insulin resistant model of 3T3-L1 adipocytes were examined. PA improved glucose uptake, ROS accumulation, mitochondrial biogenesis and energetic in TNF- $\alpha$  treated cells. In addition, treatment with PA was found to ameliorate TNF- $\alpha$  induced alterations in proteins associated with mitochondrial dynamics like FIS1 and OPA1. These findings suggest that PA can be considered as an active lead for the management of insulin resistance and associated mitochondrial dysfunctions.



## Green synthesis and characterization of cerium nanoparticles using aqueous extract of *Centella asiatica*: Evaluation of free radical scavenging activity and efficacy against cardiac hypertrophy using H9c2 cardiomyoblast cells

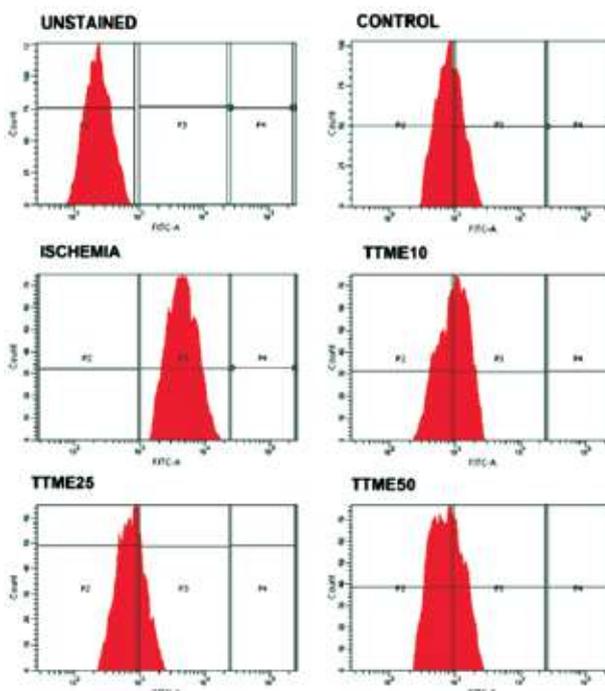
Cerium nanoparticles (CeNPs) of size less than 100nm were synthesized successfully utilizing aqueous *Centella asiatica* extract. HRTEM and SEM studies confirmed the spherical nature of CeNPs. Zeta potential was found to be negative and it has been reported that negatively charged particles diffuse quickly through the cell membrane. Characterizations have also been performed by UV-Vis spectroscopy, EDSX etc. 50-250 µg/ml of CeNPs effectively scavenged reactive oxygen species including ABTS radicals, hydroxyl and superoxide anions with an IC<sub>50</sub> value of 186.53±2.92 µg/ml, 128.99±3.2 µg/ml, and 137.76±0.24 µg/ml respectively. The reducing ability of CeNPs also increased with increasing concentrations. Since *in vitro* chemical assays demonstrated good radical scavenging property of CeNPs, they were taken up for cell culture studies utilizing H9c2 cardiomyoblast cell line to examine their cellular uptake, cytotoxicity and effect on hypertrophy. Absence of cytotoxicity of CeNPs was evident from MTT assay. Moreover, viability was found to increase with increasing concentrations of NPs. Flow cytometric and fluorescence microscopic observations revealed their cellular internalization. DHE incorporation in the cells exposed to higher concentrations of CeNPs showed less generation of super oxide anions and were comparable to control. Taken together, the CeNPs synthesized using aqueous *Centella asiatica* extract proved to be non-cytotoxic with good intracellular uptake and antioxidant potential. Preliminary results also revealed their potential to attenuate cardiomyoblast hypertrophy.



Cerium nanoparticles green synthesized by *Centella asiatica* tested for their free radical scavenging activity

## Cellular alterations in H9c2 cells associated with ischemia are ameliorated by *Tribulus terrestris* (Linn.) via its antioxidant potential

The cardioprotective property of *Tribulus terrestris* L against myocardial ischemia was evaluated in



Flow cytometric analysis of intracellular ROS generation measured using H<sub>2</sub>DCFDA.



a cell line model. First methanolic extract was prepared and subjected to sequential extraction with various solvents. The extract with high phenolic content (*T. terrestris* L. ethyl acetate extract-TTME) was further characterized for its chemical constituents and taken forward for evaluation against cardiac ischemia. HPLC analysis revealed the presence of phenolic compounds like caffeic acid, chlorogenic acid and 4-hydroxybenzoic acid. H9c2 cells were pretreated with TTME for 24h before the induction of ischemia. A significant increase in reactive oxygen species generation (56%), superoxide production (18%), loss of plasma membrane integrity, dissipation of transmembrane potential, permeability transition pore opening and apoptosis had been observed during ischemia. However, pretreatment with TTME was found to significantly attenuate the alterations caused by ischemia. The results revealed a scientific basis for the usage of *T. terrestris* L. against cardiac diseases.



## BIOTECHNOLOGY DIVISION

The vision of the Biotechnology division is to undertake R&D and industrial consultancy in the frontier areas of Biotechnology, which include (a) Bioprocess & product development, (b) Energy & environment, and (c) Health & genomics. These activities are well aligned with the priority sectors of CSIR such as Affordable health care and Energy & environment. The Division also has a dedicated Centre for biofuels for exclusive R&D on 2<sup>nd</sup> generation bioethanol. Novel microbes are being isolated and deposited in the NII Culture collection under the environmental biodiversity programme. Some of the achievements during the year are given below.

### Highlights

- Know-how for the production of cellulase from *Penicillium janthinellum* developed through classical mutagenesis and using solid-state fermentation. The laboratory technology has been transferred to an industry on non-exclusive basis.
- Highly alkaline and thermo-tolerant endo-xylanase enzyme produced by a recombinant xylanase gene expressed in *K. lactis* for an environment-friendly pulp bleaching process.
- *AnsB* gene isolated from *E. coli*, which coded for asparaginase was successfully cloned into pPink HC- $\alpha$  plasmid and transformed into protease knock out pichia pink strain.
- Among the nine signal peptides from different industrially important filamentous fungi studied,  $\beta$  glucosidase and glucoamylase secretion signals from *A. niger* was highly secreting the "Enhanced Green Fluorescent Proteins (EGFP)" and was higher than the  $\alpha$ MF signal peptide
- Isolated a strain of *Lactococcus* sp, which produces 2, 4- di-*tert*- butyl phenol (2, 4 DTBP) showing antifungal and antioxidant compound. The compound demonstrated fungicidal activity against *A. niger*, *F. oxysporum* and *P. chrysogenum*.
- Two potential novel plant growth promoting strains were identified from *pokkali* rice fields, which were named as *Arthrobacter pokkali* sp.nov and a novel genera *Oryzibacter plantistimulans* gen. nov. sp. nov.



## जैव प्रौद्योगिकी प्रभाग

जैव प्रौद्योगिकी प्रभाग का विजन, जैव प्रौद्योगिकी के अग्रणी क्षेत्रों में अनुसंधान व विकास तथा औद्योगिक कंसल्टेंसी कार्य शुरू करना है, जिसके अंतर्गत (क) बायोप्रोसेस तथा उत्पाद विकास, (ख) ऊर्जा व पर्यावरण, और (ग) स्वास्थ्य और जीनोमिक्स शामिल हैं। उक्त गतिविधियों, सीएसआईआर के प्राथमिकता वाले क्षेत्रों जैसे सस्ती स्वास्थ्य देखभाल और ऊर्जा व पर्यावरण के साथ अच्छी तरह से गठबंधन कर रही हैं। दूसरी पीढ़ी के जैव इथेनॉल पर विशेष अनुसंधान एवं विकास के लिए इस प्रभाग में जैव ईंधन के लिए एक समर्पित केंद्र भी है। पर्यावरण जैव विविधता कार्यक्रम के तहत नॉवेल रोगाणुओं को पृथक करके एनआईआई संवर्धन संग्रह में जमा किया जा रहा है। वर्ष के दौरान प्राप्त उपलब्धियों में से कुछ नीचे दिए गए हैं।

### मुख्य विशेषताएं

- ठोस अवस्था किण्वन के प्रयोग से और शास्त्रीय उत्परिवर्तजनन के माध्यम से *पेनिसिलियम जैथिनेल्लम* से सेल्लुलेस उत्पादन के लिए तकनीकी जानकारी विकसित की। प्रयोगशाला प्रौद्योगिकी एक उद्योग को गैर-अनन्य आधार पर स्थानांतरित कर दी गयी है।
- एक पुनः संयोजक जइलैनेस जीन द्वारा उत्पादित उच्च एल्कलाइन और थर्मो-सहिष्णु एंडो- जइलैनेस एंजाइम पर्यावरण अनुकूल लुगदी विरंजन प्रक्रिया के लिए *के. लैटिस* में अभिव्यक्त किया।
- *ई कोलाई* से पृथक *AnsB* जीन, जो ऐस्पैरजाइनेस के लिए कोडित है, pPink HC  $\alpha$  प्लाज्मिड में सफलतापूर्वक क्लोन किया गया और प्रोटीएस निरसन पिच्यु गुलाबी स्ट्रेन के रूप में आकृति बदल दिया।
- अध्ययन किये विभिन्न औद्योगिक रूप से महत्वपूर्ण नौ संकेत पेप्टाइड्स तंतुल कवकों के बीच *एस्पेर्जिलस नाइजर* से  $\beta$  ग्लूकोसिडस और ग्लुकोएमिलेज स्राव संकेत अत्यधिक “वृद्धित हरी फ्लोरोसेंट प्रोटीन (ईजीपीएफ)” स्रावित किया और यह  $\alpha$ MF संकेत पेप्टाइड की तुलना में अधिक था।
- *लैक्टोकोक्स* प्रजाति का एक स्ट्रेन पृथक किया, जिसने कवकरोधी और एंटीऑक्सीडेंट यौगिक दिखानेवाला 2, 4 डाइ-ट्रेट- ब्यूटाइल फिनोल (2, 4 डीटीबीपी) का उत्पादन किया। यौगिक ने *ए. नाइजर*, *एफ.ऑक्सीस्पोरम* और *पी.क्राइयोजीनम* के खिलाफ कवकनाशी गतिविधि का प्रदर्शन किया।
- पोक्काली चावल के खेतों से, पौधों की वृद्धि को बढ़ावा देनेवाले दो शक्य नूतन उपभेदों की पहचान की गई, जिन्हें *ऑथ्रीबैक्टेर पोक्कली स्पी. नव.* और एक नूतन वंश *ओरीज़िबक्टेर प्लॅटिस्टिमुलांस जेन. नव. स्पी. नव.* नामित किया गया।



## BIOPROCESSES AND PRODUCTS DEVELOPMENT

### Industrial enzymes

#### Molecular cloning, expression, characterization and production of novel alkaline xylanases

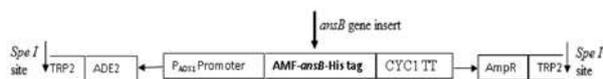
**Production of a highly alkaline xylanase from *Bacillus pumilus* and its application for paper and pulp industry:** The production of a cellulase-free alkaline xylanase from *Bacillus pumilus* MTCC 5015 by submerged fermentation with the aim of its application in bio-bleaching was studied. Various process parameters affecting xylanase production by the culture adopting a Plackett-Burman design (PBD) as well as response surface methodology (RSM) showed maximum activity with 4% yeast extract, 0.08% magnesium sulphate, 30 h of inoculum age, incubation temperature of 33°C and pH 9.0. Media engineering improved a five-fold increase in enzyme production. Scanning electron microscopy showed significant changes on the surface of xylanase treated pulps as a result of xylan hydrolysis. Increased roughness of paper carton fibers was clearly visible in scanning electron micrograph, which was due to the action of xylanase, which opened the micro fibrils present on the surface. There was no such change observed in the untreated pulp. These results clearly demonstrated that the *B. pumilus* MTCC 5015 xylanase was effective in bio-bleaching of paper carton.

**Production of a recombinant xylanase using a *Kluyveromyces lactis* and its application in bio-bleaching:** The production of recombinant xylanase using a *Kluyveromyces lactis* GG799 strain with a plasmid vector pKLAC1 carrying xylanase coding gene (*XynA*) isolated from *Bacillus pumilus* MTCC 5015 was studied employing statistical

approaches based on Response Surface Methodology (RSM), which led to an enhancement in extracellular xylanase production (200 IU /mL). Maximum xylanase production was obtained when 2% of cas-amino acid was used along with 5% of galactose (inducer) with an inoculum size of 2.75% when incubated for 48 h with a pre-inoculum age of 24 h (273 IU/mL). Thus, a four-fold increase in activity from 70 IU/mL to 273 IU/mL could be achieved. SDS-PAGE analysis showed that the relative molecular mass of glycosylated XynA was about 35.0 kDa. The partially purified enzyme when used for the bio-bleaching of paper carton, showed its effective application in bleaching.

#### Cloning and expression of L-asparaginase from *E. coli* in eukaryotic expression system

L-Asparaginase is an anti-cancer agent which prevents the proliferation of cancerous cells by decreasing the level of asparagine in the blood. L-asparaginase from *Escherichia coli* which is encoded by *ansB* gene is widely used because of its substrate specificity and less glutaminase activity. The expression studies were conducted in yeast, which has many added advantages like protein folding and processing. The expression studies were carried out in a new protein expression system based on the yeast *Pichia pastoris* called PichiaPink™. *AnsB* gene isolated from *E. coli* which is coded for asparaginase was cloned into pPink HC- $\alpha$  plasmid and transformed into protease knock out pichia pink strain by electroporation. The recombinant enzyme was extracellular and showing the activity of 2.5 IU/ml. It was then purified using Ni-NTA column as the enzyme contains His-tag at the C-terminal end. The new way of expression would be efficient in making the enzyme humanized by glycosylation patterns, which is similar to mammals.



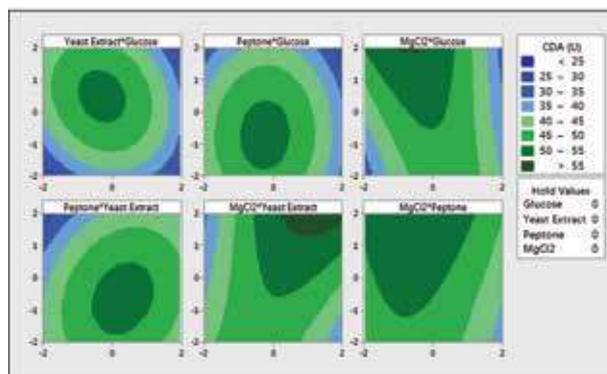
Linearized vector map of pPink $\alpha$ -HC with ansB gene after transformation. Linearization was done with SpeI restriction enzyme in which its site of restriction locates at TRP2 locus, which is clear from the diagram

## Stereo selective production of chiral alcohol using novel microbial oxidoreductase

Optically pure alcohols are important building blocks used in chemical and pharmaceutical industries. Enzymatic process is a very promising synthesis route to produce optically pure alcohols. The aim of present work was to develop a high-throughput assay method for ketoreductase enzyme. Several strains were isolated and evaluated for their specific reduction of chiral alcohols to corresponding ketones. Two isolates appeared promising as they were specifically acting on (R)-(-)-1-(1-naphyl) ethanol.

## Production of chitinolytic enzymes from microbial cultures isolated from coastal environment samples

A fungal strain producing chitin deacetylase isolated from environmental samples collected from coastal regions of south Kerala was identified as *Aspergillus flavus* by morphological characteristics and ITS DNA analysis. Nutritional requirement for maximum production of CDA under submerged condition optimized using statistical methods, including Plackett–Burman and RSM- central composite design resulted a 5.98-fold enhancement in CDA production, giving  $57.69 \pm 1.68$  U CDA in a medium containing ( $\text{g}\cdot\text{L}^{-1}$ ) 30 glucose, 40 yeast extract, 15 peptone and 7  $\text{MgCl}_2\cdot 7\text{H}_2\text{O}$  at initial pH of 7.0 and incubation temperature of 32 °C and 48h of incubation.



Contour plots of CDA activity showing interactions between different variables in the central composite design

## Biorefining of biomass with feruloyl esterase

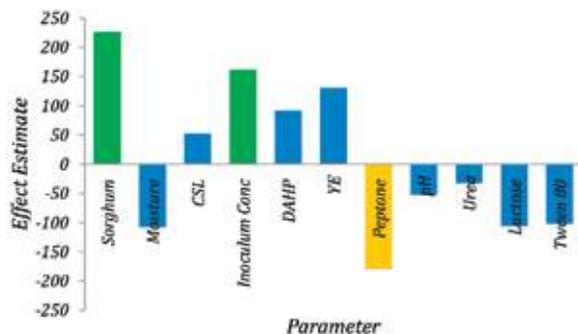
Ferulic acid works as cross links between different strands of polysaccharide macro structure as well as between the polysaccharide and lignin moieties of the hemicelluloses component of the plant cell wall. Naturally dead plant material is utilized by saprophytic fungi that express a plethora of enzymes to degrade the interlinked matrix of polysaccharides and lignin. Feruloyl esterase is one of such enzymes that de-esterify ferulic acid and related phenolic acids from plant cell wall material. The enzyme has been used to synthesize feruloyl glycosides and different feruloylated alcohols. A study has been initiated to produce feruloyl esterase from a fungal culture of *Aspergillus niger* and to understand the biochemical properties of the enzyme.

## Biomass hydrolyzing enzymes

**Acid active xylanase:** A novel fungus capable of producing acid active xylanase, identified using ITS DNA sequencing as *Aspergillus flavus* and designated as *A. flavus* RP 05A, showed potential for enzyme production. The culture produced about 300 IU/ml of enzyme in un-optimized conditions. Statistical design of experiments was used to evaluate the effect of 11 parameters on the production of the enzyme and each parameter was varied following a Plackett & Burman design. Maximal enzyme production of 1500

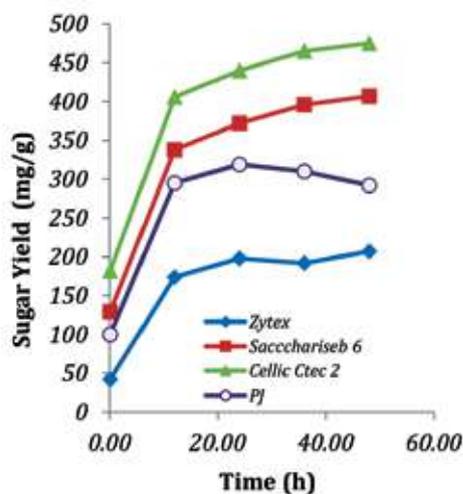


IU/ml was produced and the most important parameters were the concentration on raw carbon source (sorghum stover) and peptone and inoculum density.

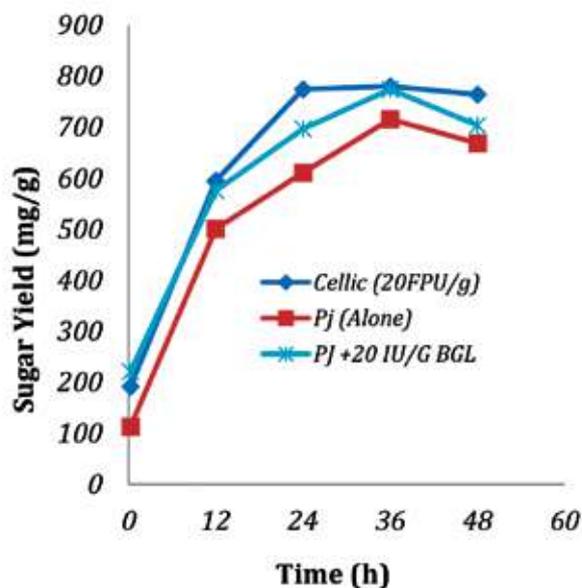


Effect of 11 parameters on the production of the enzyme following a Plackett & Burman design

**Profiling of commercial biomass hydrolyzing enzymes and comparison with NIIST enzymes identifies the importance of beta-glucosidase in the enzyme cocktails:** Biomass hydrolyzing enzymes are blends of various hydrolase activities, which include hemicellulose acting enzymes, and several accessory enzymes in addition to the primary component- cellulase. None of the commercial enzyme cocktails available in the market for biomass hydrolysis comes with a detail of individual activities of different enzymes and the ratio of them in the preparation. Commercial enzyme blends were evaluated for their major activities to analyze the ratios important for biomass hydrolysis, which was compared to their hydrolytic efficiencies. Biomass hydrolyzing enzymes and basic cellulase preparations were analyzed for individual enzyme activities and hydrolysis performance on pretreated rice straw. The hydrolysis study identified that the ratio of beta -glucosidase to cellulase was the most critical since the performance of those enzymes with a high BGL to cellulase ratio performed best compared to the ones, which had low BGL content.



Hydrolysis of acid pretreated rice straw using commercial cellulase preparations and *Penicillium janthinellum* (PJ) enzyme produced at NIIST



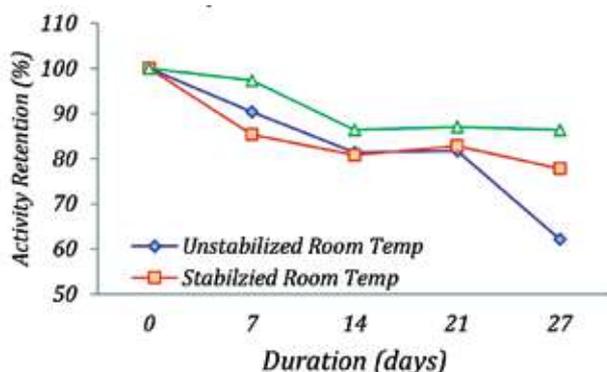
Hydrolysis of alkali pretreated rice straw using PJ enzyme supplemented with BGL in same ratio as the commercial enzyme -Cellic cTEC3 results in performance at par with the commercial enzyme



Enzyme components in the commercially available cellulases and that produced by *Penicillium janthinellum* (PJ- NIIST strain)

Enzyme / Ratio of Components →	BGL to Cellulase	CMCase to cellulase	Xylanase to Cellulase
Cellic	5	50	88
Advanced	1	105	140
Zytex	0.1	30	17
PJ	0.4	38	13

**Studies on the shelf life of *Penicillium janthinellum* cellulase:** Biomass hydrolyzing enzymes like the one produced at NIIST from *P. janthinellum* are high volume low value enzymes which need to perform at 50°C and long term stability at room temperature is highly desired. This will allow transportation of enzyme from its location of production to the biorefinery with minimal cost. Stabilizers are normally added to the enzyme for protection from damages due to microbial attack, or due to protein aggregation, etc. The enzyme preparation produced at NIIST was stored at room temperature and at 4°C without stabilizers and interestingly the enzyme retained more than 90% of its activity after one week of storage. After three weeks, 80% activity was retained, but after three weeks there was ~40% activity loss. Addition of commercial stabilizers did not improve the stability but cold storage was highly effective with ~ 90 % activity retained even after four weeks of storage.



Stability of cellulase produced by *Penicillium janthinellum* (PJ)

The study indicated the need to find effective stabilizing agents for long term room temperature storage of the enzyme. It also indicated that un-stabilized enzyme may be stored for one week without serious activity losses.

**Beta-glucosidase (BGL) immobilized on magnetic nanoparticles for enzyme re-use in biomass hydrolysis:** Cost of the enzymes for biomass hydrolysis is still the major cost involved in the biochemical conversion of biomass to sugars in biorefineries. Studies were conducted to immobilize BGL on magnetic nanoparticles (MnPs) so as to recover them easily after hydrolysis and re-use them. BGL was immobilized on silica coated magnetic nanoparticles surface modified with APTES and the protein was cross linked to the MnPs using glutaraldehyde. Immobilized BGL was supplemented to cellulase for hydrolysis of biomass which allowed very high loading of the BGL, which in-turn resulted in increased reaction rates and shorter duration for attaining maximal sugar yields. The MnPs would be recovered easily after the hydrolysis and was reused for three cycles with more than 80% activity retention indicating the potential of using immobilized BGLs for enzyme re-use in biomass hydrolysis.

### Transfer of technology for the production of cellulase for de-inking application

Cellulases are enzymes that find applications in various industries, including textiles, detergents, paper and pulp, etc. A study was undertaken on the feasibility of using cellulase from *Penicillium janthinellum* for application in the de-inking and refining of paper pulp for recycled paper. The enzyme was produced using a new mutant strain of *P. janthinellum* 2D M1 developed through classical mutagenesis. The enzyme showed excellent performance for de-inking application. The process of the production of the enzyme was developed using solid-state fermentation. The laboratory technology has been transferred to an industry on non-exclusive basis.



### Erection and commissioning of solid-state fermentation pilot plant (*Koji plant facility*)

NIIST Biotechnology Division lab lacked a pilot scale facility to scale-up SSF based technologies. Construction of a solid-state fermentation pilot scale facility (*Koji plant*) has been achieved with financial support from MNRE, TIFAC and DST.



Computerized control panel of Koji Room



Koji room showing misting/cooling units and racks for SSF trays

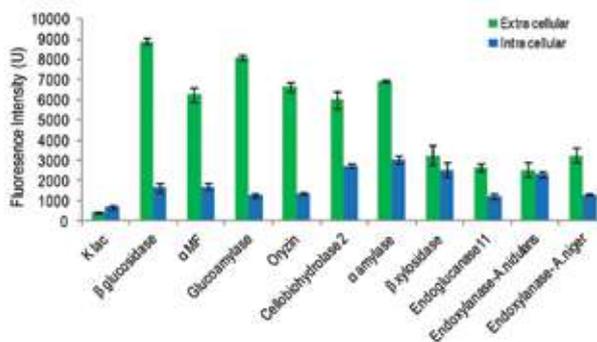


Koji trays showing fungal growth in the SSF medium  
SSF pilot plant

The facility has capability to incubate 108 trays, each with a capacity of about 1.0 kg moldy bran or a total capacity of about 50kg of dry crude enzyme per batch. Temperature and relative humidity can be controlled in the range of 23-40 °C and 50-90% RH, respectively with automatic misting. The chamber has HEPA filtered air inlets and outlets to prevent contamination and escape of spores. With this, it would be possible to undertake studies on SSF process scale-up. The facility has been commissioned and is being tested for SSF production of enzyme using fungal cultures.

### Development of a heterologous protein expression system in filamentous fungus

The fungal signal peptides are highly efficient in secreting extracellular enzymes since filamentous fungi are very good producers of extracellular proteins. Nine signal peptides from different industrially important filamentous fungi, namely *Aspergillus niger*, *Aspergillus nidulans*, *Aspergillus terreus*, *Aspergillus awamori* and *Trichoderma reesei* based on the analysis of extracellular proteome were evaluated in *K. lactis* for secretion of a cloned "Enhanced Green Fluorescent Protein (EGFP)". Among the tested secretion signals,  $\beta$  glucosidase and glucoamylase signals from *A. niger* was highly secreting the EGFP proteins and was higher than the  $\alpha$ MF signal peptide.



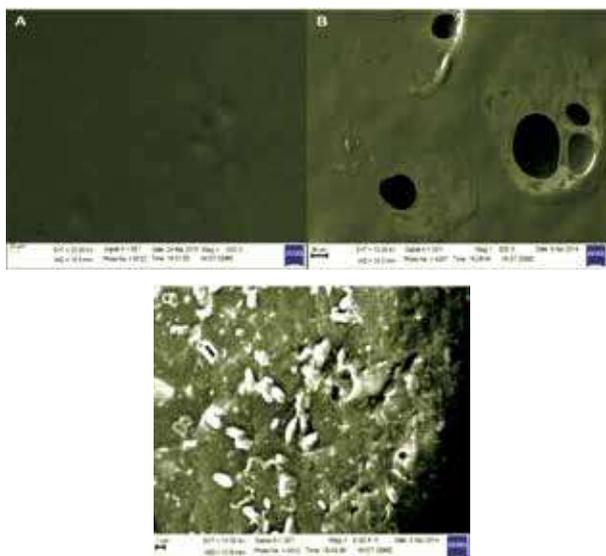
EGFP expression from the native  $\alpha$ MF secretion signal or filamentous fungal secretion signal



## Biopolymers and Biosurfactants

### Microbial degradation of High Impact Polystyrene (HIPS)

Enrichment medium, containing high impact polystyrene (HIPS) with decabromodiphenyl oxide and antimony trioxide as sole carbon source, was used to isolate microbial cultures and their viability in the e-plastic containing mineral medium was further confirmed by triphenyltetrazolium chloride reduction test. Four cultures were identified by 16S rRNA sequencing as *Enterobacter sp.*, *Citrobacter sedlakii*, *Alcaligenes sp.* and *Brevundimonas diminuta*. Biodegradation experiments were carried out in flask level with thin HIPS films as sole carbon source. The comparison of FTIR and NMR analysis of original and degraded e-plastic films revealed structural changes under microbial treatment. Plastic degradation intermediates in the culture supernatant were detected using HPLC analysis. Gravity of biodegradation was validated by morphological changes under scanning electron microscope. All isolates displayed depolymerase activity to substantiate enzymatic degradation of e-plastic.



SEM analysis of biodegradation of e-plastic films using micro-organism. A) Control film, B) Degraded film sample, C) IS01 colonization and attachment to the e-plastic film surface.

### A halo-tolerant mangrove isolate naturally produce polyhydroxy butyrate-covalarate (PHBV) from wide ranging carbon sources

A halophilic mangrove isolate identified by 16 S rRNA sequence as a *Bacillus* spp was capable of using a broad range of carbon sources for growth and the production of polyhydroxyalkonates (PHAs) like polyhydroxybutyrate (P3HB), polyhydroxybutyrate-co-valerate (PHBV) and 4-hydroxyhexanoate (4HHX). The study describes the innate ability of the wild type culture for PHBV production by both propionate and propionate independent pathways. The secreted biopolymer was extracted and characterized physico-chemically. From glucose, % wt of PHBV yield was 73 with a high 3-hydroxyvalerate fraction of 48 mol %. Further, homogenous PHBV nanoparticles of ~164 nm size were prepared for future applications

### Microbial production of 1,3-propanediol from crude glycerol

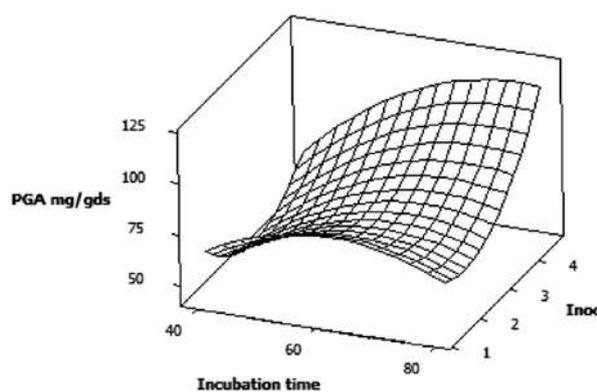
1,3-propanediol (1,3-PDO) is one of the important products used in chemical industry for polyesters production and there has been an increased interest for its synthesis by green technology approach. The aim of this study was to isolate industrially economical fermentative bacteria for the conversion of biodiesel industry based crude glycerol to 1,3-PDO. Among the forty one pure isolates, which were positive for 1,3-PDO production, the best producer was identified as *Klebsiella pneumonia*. This strain grew in vitamin B<sub>12</sub>-free medium containing 20g/l crude glycerol. Plackett-Burman design to find the most effective parameter on 1,3-PDO yield showed glycerol, yeast extract and K<sub>2</sub>HPO<sub>4</sub> having positive effect. A maximum of 25.2 g/l 1,3-PDO was obtained in 24h when the initial crude glycerol concentration was 80 g/l in 5L bioreactor.

### Production of poly-γ-glutamic acid under solid-state fermentation by *Bacillus* sp

Poly-γ- glutamic acid (PGA) is a promising biodegradable polymer with wide applications in the field of



medicine, cosmetics, food and agriculture. Solid-state fermentation was carried for the production of PGA using soy hull as the substrate using *Bacillus* sp. Process parameters such as inoculum size, incubation time and initial moisture content as optimized by response surface methodology showed a yield of 111.2 mg gds<sup>-1</sup> PGA at initial moisture 75%, incubation time 60h and inoculum size 4.7ml. Due to low cost nature of the process, this study could be of economic interest for large-scale production.



Interaction plot between inoculum size and incubation time on PGA yield

## BIOFUELS AND BIOREFINERIES

### Centre for Biofuels and Biofuels Research

#### Alternative strategies for the pretreatment of lignocellulosic biomass for bioethanol production

#### Crude glycerol assisted surfactant pretreatment of chili post harvest residue for bioethanol production

A novel crude glycerol-assisted surfactant pretreatment was developed, which could effectively remove hemicelluloses and lignin and improve the

reducing sugar yield from chili post harvest residue. Under optimal pretreatment conditions, 0.350 g of reducing sugar was produced per gram of pretreated biomass. The conditions of pretreatment were 25% of biomass loading, 4% of PEG, 1% of crude glycerol and 60 min of pretreatment time at 121°C. The results revealed that major fermentation inhibitors like furfural, hydroxymethyl furfural, citric acid, succinic acid and propionic acid were absent in all the samples. Organic acids like formic acid and acetic acid were present at lower level indicating that the hydrolyzate can be used for fermentation without any detoxification.

#### Compositional analysis data of native and crude glycerol assisted PEG pretreated CPHR

Components	Total (%)	
	Native	Pretreated CPHR
Cellulose	39.95	51.54
Hemicelluloses	17.85	10.17
Total lignin	25.32	7.29

The structural changes of native and pretreated biomass investigated by X-ray diffraction (XRD) showed an increase in crystallinity index of the pretreated sample. The results indicated that crude glycerol assisted PEG pretreated chili post harvest residue could be used as a potential feed stock for bioethanol production.

#### Hydrotrope-assisted pretreatment of lignocellulosic biomass and adsorptive removal of fermentation inhibitors formed during pretreatment

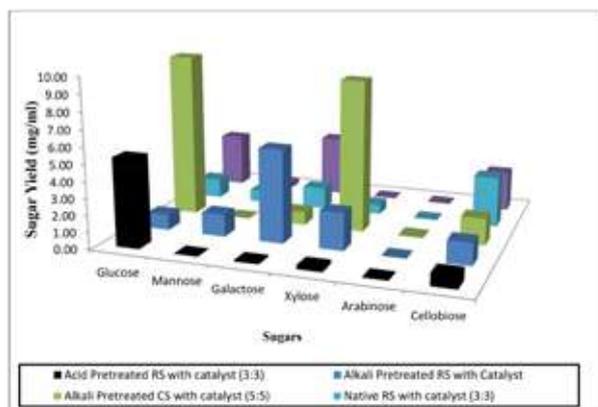
Sodium cumene sulfonate and sodium xylene sulfonate (Na-X) were used as hydrotropes to delignify rice straw. Sodium xylene sulfonate was more efficient with 94% lignin removal. Effect of biomass loading, time, temperature and hydrotrope concentration studied for both the hydrotropes showed the maximum 94% lignin removal with 5% biomass loading at 121°C for 2 h using 30% sodium xylene sulfonate solution.



Maximum 60% lignin was removed using 30% sodium cumene sulfonate with 5% biomass loading at 121°C for 2 h. Compositional analysis of native and delignified rice straw was revealed lower lignin content in the delignified rice straw as compared to the native. There was no loss of cellulose and hemicellulose in the hydrotrope solution, which was highly desirable.

### Biomass hydrolysis using solid acid catalyst

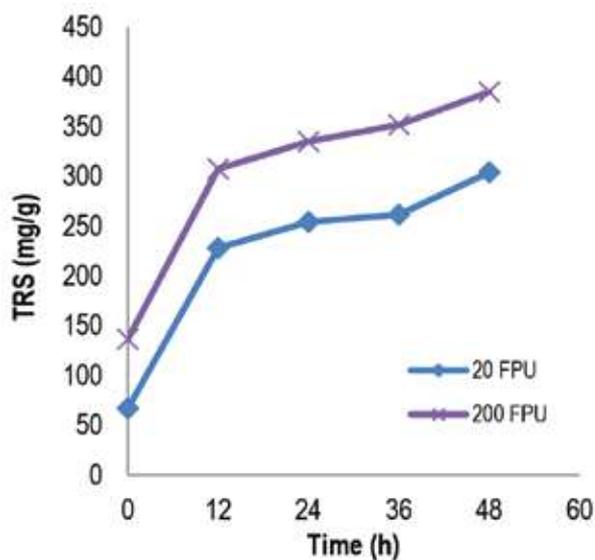
Glycerol-based solid acid catalysts are capable of hydrolyzing the glycosidic linkages in cellulose and hemicellulose and the hydrolysis requires only low retention times. A glycerol-based carbon acid catalyst developed at CSIR-IICT, Hyderabad as a part of joint project was evaluated for the hydrolysis of alkali pretreated rice straw and native cotton stalk. The catalyst released 262 mg/g and 219 mg/g of total reducing sugars in 4 and 6h when reacted at 140 and 160°C, respectively for rice straw and cotton stalk. The catalyst was recovered and reusability was tested for three cycles, which indicated there was no significant loss of efficiency on recycling. Catalytic hydrolysate was used as sugar source for fermentation and *Saccharomyces cerevisiae* grown in it could produce ethanol. Solid acid catalysts could be interesting alternatives to enzymes with further improvements in efficiency.



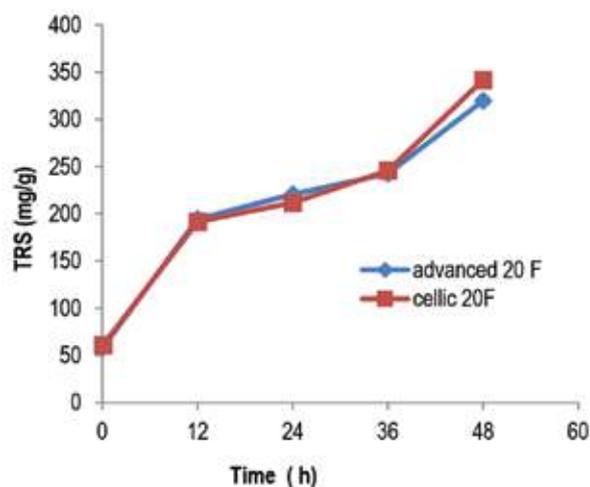
Sugar yields from glycerol based carbon acid catalytic hydrolysis of rice straw and cotton stalk

### Sorghum stover-based biorefinery

In the studies identified the possible best conditions for the pretreatment of sorghum stover biomass with the temperature fixed at 120 °C but the hydrolytic efficiencies seldom reached more than 43% of the theoretical maximum. To test whether the limitation was with the pretreatment, or the enzyme composition, studies were performed at high enzyme loadings and with different enzymes, which showed that 10X loading of enzyme resulted in an increase in sugar yield from 43 to 53% only. Studies were, therefore, conducted with two commercial enzymes designed for biomass hydrolysis at the same enzyme loading of the control (20FPU/ml), but in both cases, the improvement in yield was very less indicating that the pretreatment process was probably the limiting factor and needed further tweaking.



Hydrolysis of acid pretreated SS with increased enzyme dosage do not result in corresponding increase in sugar yields



*Hydrolysis of acid pretreated SS with commercial high efficiency enzymes do not improve the hydrolysis efficiency indicating the need for optimizing pretreatment*

## Algal biorefinery

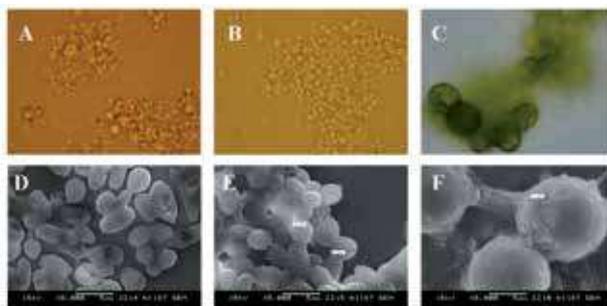
### Cultivation of microalgae in industrial waste water for oil production and removal of toxic organic compounds

Microalgae are one of the most promising alternative sources for sustainable biofuel production, but the biomass production yield, source of water and cost associated with production are significant bottle necks for micro algal biofuel. Acid pretreatment liquor (APL) from the lignocellulosic ethanol pilot plant at Centre for Biofuels, NIIST was used as medium for biomass and lipid production from *Chlorococcum* sp R-AP13 under mixotrophic condition. The alga utilized C5 (xylose, arabinose, galactose) and C6 (Glucose) sugars present in APL as carbon sources, and could survive in the presence of inhibitors such as furans and sugar breakdown products. *Chlorococcum* sp. R-AP13 removed almost completely the sugars, furfural and HMF in the APL during its growth and produced 1.8 g/L of biomass. The lipid yield was 0.568 g/L when supplemented with agricultural grade NPK

(18:18:18) mixture. Photo-tropically grown control in synthetic medium in comparison supported production of only 0.8 g/L of biomass and 0.19 g/L of lipids. FAME profile of fatty acids indicated that the oil was rich in oleic acid (18.1) with ~41% of the oil being this fatty acid, followed by palmitic acid (16.1) and stearic acid (18.0) which formed, respectively ~30 and 15% and of the oil. Fatty Acid Methyl Ester (FAME) was synthesized from the algal oil using acid catalysis and was evaluated for its physicochemical properties and suitability as biodiesel using BiodieselAnalyzer® software, which indicated its compliance to EN 14214 and ASTM D6751. The ability of the alga to grow in biomass acid pretreatment liquor is particularly interesting for value addition of this byproduct, which is otherwise difficult to process.



*Photograph showing mixotrophic growth of Chlorococcum sp. R-AP13 in acid pretreatment liquor*



*Morphological changes of Chlorococcum sp RAP13 cultivated in APL : Phase contrast images of mixotrophically grown algal cells on APL , A: Rice straw APL, B: Sorghum biomass APL, C: Phototrophic control and its corresponding SEM images (D, E, F)*



## Biochemical and molecular investigation on stress mediated lipid accumulation and biomass productivity in microalgae

**Dissolved inorganic carbonate sustains the growth, lipid and biomass yield of *S. quadricauda* under nitrogen starved condition:** *Scenedesmus quadricauda* lipid yield increases, with drastic reduction in biomass under nitrogen starved condition. In order to sustain the biomass yield, dissolved inorganic carbonate sources of varying concentration was supplemented. The results showed addition of  $\text{Na}_2\text{CO}_3$  at 1.5g/L concentration maintains the biomass yield ( $0.25 \pm 0.01$  g/L). Cell number being the primary parameter determines the biomass yield was maintained steadily ( $257 \times 10^4$  cells/ml) under nitrogen starved condition in the presence of  $\text{Na}_2\text{CO}_3$ . However, carbonate sources did not improve the total photosynthetic pigments. The total chlorophyll content (Chl a and Chl b) showed drastic reduction of 0.091 to 0.022 mg/L in the presence of  $\text{Na}_2\text{CO}_3$  (0.5 g/L) and it was showing negative values under stress after 3<sup>rd</sup> day. Similarly, the lower carotenoid value of 0.121 mg/L was recorded for sodium carbonate (0.5 g/L). The extremely significant ( $p < 0.0001$ ) difference was observed for the carbonate source (primary factor) on biomass yield throughout the study period. Whereas the increasing concentration (0.5, 1.0, 1.5 and 2.0 g/L) of individual DIC did not have any influence on biomass yield under study condition.  $\text{Na}_2\text{CO}_3$  and  $\text{NaHCO}_3$  treated cultures exhibited mono-unsaturated fatty acid as dominant fraction as 84.70 and 84.28% respectively. Furthermore, the level of saturated and mono-unsaturated fatty acids were 69.79% and 90.02% in the presence of  $\text{KHCO}_3$  and  $\text{K}_2\text{CO}_3$ , respectively. Considering the above evidence, sodium carbonate and sodium bicarbonate could be a preferred carbonate source in an open pond for large-scale biomass production.

Dry biomass yield of *S. quadricauda* grown in different inorganic carbonate source under nitrogen depleted condition

Carbonate source	Concentration (g/L)	Dry biomass (g/L)
$\text{Na}_2\text{CO}_3$	Control	0.035±0.005
	0.5	0.29±0.02
	1.0	0.26±0.01
	1.5	0.25±0.01
	2.0	0.225±0.005
$\text{NaHCO}_3$	Control	0.035±0.005
	0.5	0.25±0.01
	1.0	0.245±0.015
	1.5	0.23±0.02
	2.0	0.255±0.005
$\text{K}_2\text{CO}_3$	Control	0.035±0.005
	0.5	0.035±0.005
	1.0	0.045±0.005
	1.5	0.03±0.01
	2.0	0.055±0.005
$\text{KHCO}_3$	Control	0.035±0.005
	0.5	0.045±0.005
	1.0	0.055±0.015
	1.5	0.07±0.00
	2.0	0.07±0.01

**Biochemical characterization of nutritional stress responsive enzyme in *S. quadricauda*:** *Scenedesmus quadricauda*, an oleaginous micro alga synthesizes high lipid content under nutritional stress. Nitrogen is one of the major nutrients for the growth of microalgae thus its absence in culture medium creates stress to the algal cells. This nutritional stress will increase the triacylglycerol accumulation in *S. quadricauda* cultures. *S. quadricauda* was cultured in BBM containing full nitrogen strength/devoid of nitrogen. Maintained the culture till it reached maximum cell density. Subsequently the cells were centrifuged washed with distilled water and transferred to nitrogen free medium. The total proteins from the two conditions were extracted and resolved by 12% SDS PAGE. The SDS PAGE results revealed that algal proteins were differentially expressing in stressed and normal cells.

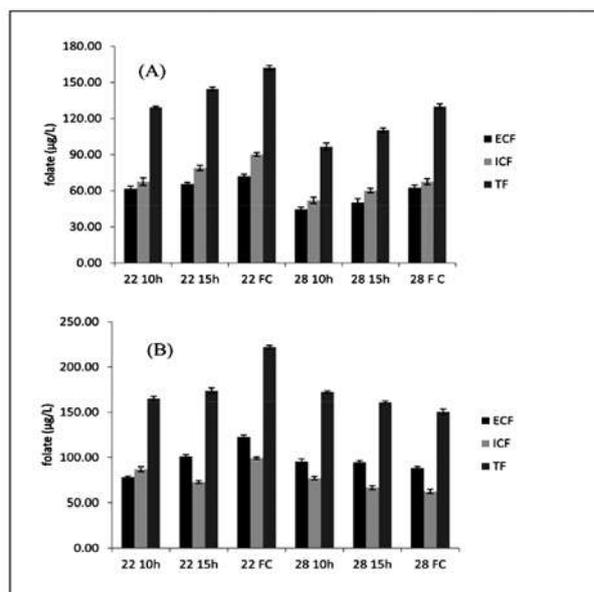


## HEALTH AND GENOMICS

### Probiotics and nutraceuticals

#### Encapsulated *Lactococcus lactis* with enhanced gastrointestinal survival for the development of folate enriched functional foods

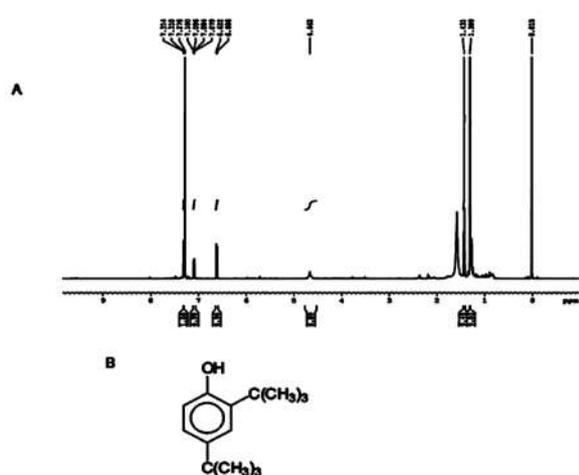
Two lactic acid bacteria (LAB) isolated from cow's milk were identified as *Lactococcus lactis* strains and designated as *L. lactis* CM22 and *L. lactis* CM28. They were immobilised by co-encapsulation using alginate and mannitol and by hybrid entrapment with skim milk, glycerol,  $\text{CaCO}_3$  and alginate. The encapsulated cells survived better in simulated gastrointestinal conditions compared to the free cells. The percentage survival of probiotics encapsulated by hybrid entrapment method was 62.74% for *L. lactis* CM22 and 68% for *L. lactis* CM28. Studies to check their efficacy in fermentative fortification of skim milk and ice cream revealed an enhancement in folate level.



Fermentative fortification of folate in skim milk and ice cream by free and encapsulated probiotics (A) Skim milk (B) Ice cream, ECF – Extracellular folate, ICF – Intracellular folate, TF – Total folate 22 10h – Encapsulated *L.lactis* CM22, 10h fermentation; 22 15h – Encapsulated *L. lactis* CM22, 15h fermentation; 22 FC - *L. lactis* CM22 (free cells), 8h fermentation; 28 10h – Encapsulated *L. lactis* CM28, 10h fermentation; 28 15h – Encapsulated *L.lactis* CM28, 15h fermentation; 28 FC - *L. lactis* CM28 (free cells), 8h fermentation.

#### 2, 4- di-tert- butyl phenol as the antifungal, antioxidant bioactive purified from a newly isolated *Lactococcus* sp

The volatile organic compound 2, 4- di-tert- butyl phenol (2, 4 DTBP) was purified from the cell free supernatant of a newly isolated *Lactococcus* sp. by solvent extraction and chromatographic techniques. Molecular characterization of the compound by ESI-MS,  $^1\text{H}$  NMR and FTIR analysis revealed the structure,  $\text{C}_{14}\text{H}_{22}\text{O}$ . The fungicidal activity was demonstrated against *A. niger*, *F. oxysporum* and *P. chrysogenum* by disc diffusion assay.



Structure elucidation of 2,4 di-tert-butyl phenol.  
<sup>1</sup>H NMR spectrum (A) structure of 2,4 DTBP (B)

### Physicochemical characterization of an exopolysaccharide produced by a newly isolated *Weissella cibaria*

A high molecular weight (3037kDa) dextran-like polysaccharide was purified from the culture broth of a probiotic *Weissella cibaria*. Dry weight of the EPS obtained after ethanol precipitation was 6.35g/L using sucrose as carbon source and was further purified by phenol: chloroform: isoamyl alcohol (25:24:1, v/v) extraction and acetone precipitation to white powder with 52% recovery. Rheological characterization revealed that it has a pseudoplastic behavior and showed a temperature tolerance up to 280°C in thermogravimetric analysis. Fourier Transform Infra Red (FTIR) spectra showed the characteristic peaks of polysaccharide such as hydroxyl group,  $\alpha$ -pyranose, asymmetrical C-H stretching vibration of methyl group and carbonyl hydrogens of D-glucopyranose. The <sup>1</sup>H Nuclear Magnetic Resonance (NMR) spectrum showed resonances of hydrogen corresponding to the glucosyl residue, a repeat unit of the biopolymer. The cell viability analysis of normal L6 cells treated with the *Weissella* exopolysaccharide showed that it was non-cytotoxic even up to 500 $\mu$ g/ml level. A 0.2% (w/v) supplementation of EPS in 2% (w/v) wheat

starch preparation reduced the degree of syneresis up to 45% and up to 75% with 1% EPS.

### Development of a process for the production of poly unsaturated fatty acids (PUFA) from fungal sources

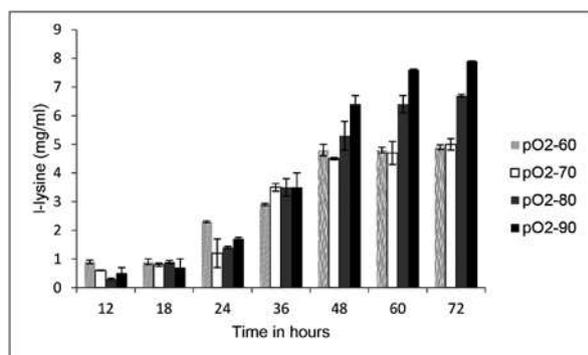
The major aim of the study was to isolate novel cultures present in the Western Ghats regions of Kerala for poly unsaturated fatty acid. Fifteen fungal cultures were isolated from the soil samples and all these strains were evaluated for the production of PUFA under both solid and submerged conditions. The analysis of the fatty acid profiling of these strains revealed that the strain (identified as *Fusarium* sp.) is a potent producer of both GLA and DHA. Hence this strain was selected for the further experiments. The optimization of culture condition for increased production of biomass and PUFA were tried using a statistical experimental design. The study resulted in an improved biomass yield as well as PUFA production with maximum GLA of 724 mg/l and DHA of 132 mg/l. The best condition optimized as glucose concentration of 50 g/l, ammonium sulphate concentration 3 g/l and incubation time of four days. The study concludes that the isolated strain is a potent producer of PUFA. This strain is growing very well in solid-state fermentation using coconut oil cake as the substrate and producing DHA and GLA. This also provides an opportunity for the production of PUFA by cheap means. Moreover, further studies on metabolic engineering approaches with this strain may generate a commercial process with a diverse range of PUFAs.

### Jackfruit Seed (JFS) hydrolysate, an unexplored agro residual raw material for L-lysine production

The potential of jackfruit seed (JFS) hydrolysate was evaluated for L-lysine production by *Corynebacterium glutamicum* DM 1729 under submerged fermentation. Variation in L-lysine titre was used as



scale to select the parameter range and production trend. The L-lysine titres obtained in shake flasks was 8.0 mg/ml in 72 h, and similar yield was sustained in parallel fermenter in 60 h of incubation. Further, statistical tools were used to improve the fermentation conditions and the yield. Parametric evaluation of physical and biological factors was carried out, and the significant variables affecting L-lysine production was identified by Plackett-Burman design. Rate of the aeration was identified as one of the critical parameters for the production. Box-Behnken Design under response surface methodology was employed to establish a relationship between the chosen factors and the response to arrive at the optimal factor settings and the best L-lysine titres. The maximum L-lysine titre was 13mg/ml. The interactions between initial concentrations of reducing sugar, ammonium sulphate and the incubation period resulted in 30% conversion of the fermentable sugars in the jackfruit seed hydrolysate to L-Lysine. Recovery of the amino acid from the fermented broth was accomplished by ion exchange chromatography using acidic cation exchange resins such as Seralite SRC120 and WRC 50, and the homogeneity was verified using TLC and HPLC.



Lysine production under different aeration conditions in a parallel fermenter

## Microbial detection and degradation of pesticide residues

There has been substantial increase in the uses of chemical pesticides as they help in increasing crop

yield and hence food security. But their residues in food represent a global public health challenge. A study has been initiated with organophosphates, chlorpyrifos (*O,O*-diethyl *O*-3,5,6-trichloro-2-pyridyl phosphorothioate). Six bacterial cultures isolated from the contaminated environment (P1A, P2A, P3A-1, P3A-2 and P3D) were evaluated for their pesticide tolerance along with *E. coli* strains Dh5 $\alpha$  and BL21 (DE3). Of these, P3A-1, P3A-2, P3D, Dh5 $\alpha$  and BL21 (DE3) showed tolerance to chlorpyrifos concentration as high as 1000 ppm. Basic understanding on the response of *E. coli* strains to chlorpyrifos by growth pattern analysis up to 100 ppm of pesticide has been established.

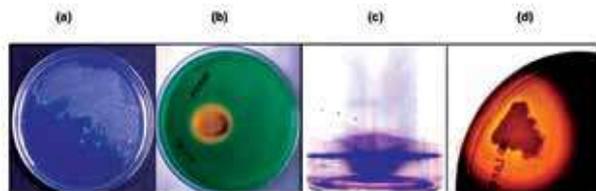
## Plant-Microbe Interaction

### PGPR tools for improving crop productivity in stressed agricultural systems

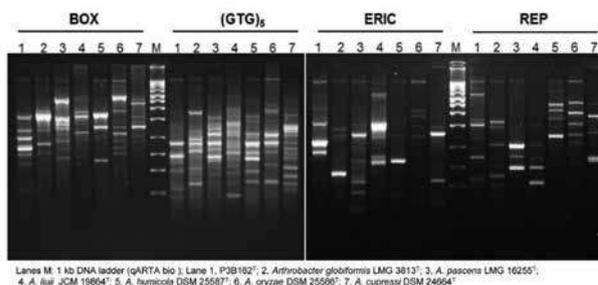
***Arthrobacter pokkali* sp nov. A novel plant growth promoting bacterium from pokkali rice rhizosphere:** A novel yellow colony-forming bacterium, designated P3B162<sup>T</sup>, was isolated from the rhizosphere soil of pokkali rice from Kerala, India. Strain P3B162<sup>T</sup> possesses plant growth attributes such as utilization of 1-aminocyclopropane-1-carboxylic acid (ACC), produce plant hormone, indole acetic acid (IAA), siderophore production and can form biofilm. Cells were Gram-staining-positive, strictly aerobic, non-motile, catalase-positive, and oxidase-negative and follow a rod-coccus cycle. Strain P3B162<sup>T</sup> grew optimally at pH 7.0, in the presence of 0.5-1% NaCl and at temperature 28-30 °C. 16S rRNA phylogenetic analysis placed the strain P3B162<sup>T</sup> within the genus *Arthrobacter*, exhibiting 16S rRNA gene sequence similarity of 98.17% to 97.33% with *Arthrobacter globiformis* LMG 3813<sup>T</sup>, *Arthrobacter pascens* LMG 16255<sup>T</sup>, *Arthrobacter liuii* DSXY973<sup>T</sup>, *Arthrobacter humicola* DSM 25587<sup>T</sup>, *Arthrobacter oryzae* DSM 25586<sup>T</sup>, respectively and less than 97.33% with other type strains of *Ar*



*throbacter* species. The *recA* gene analysis showed highest similarity with *A. liuii* JCM 19864<sup>T</sup> (94.74 %) and less than < 91% with all type strains of *Arthrobacter*. Chemotaxonomically strain P3B162<sup>T</sup> possesses main characters which belong to the genus *Arthrobacter*. Genomic fingerprinting methods using different set of primers, it was clearly observed that the DNA fingerprints of strain P3B162<sup>T</sup> was evidently different from the DNA fingerprinting patterns of closely related *Arthrobacter* species. The DNA G+C content was 64.0 mol%. Strain P3B162<sup>T</sup> exhibited a DNA-DNA relatedness value of < 50% to the type strains of *A. globiformis* LMG 3813<sup>T</sup>, *A. pascens* LMG 16255<sup>T</sup>, *A. liuii* DSXY973<sup>T</sup> and could be differentiated from its closest related species by differences in many phenotypic characteristics. On the basis of the data obtained, strain P3B162<sup>T</sup> is considered to represent a novel species of the genus *Arthrobacter*, for which the name *Arthrobacter pokkali* sp.nov. is proposed.



Plant growth beneficial traits of strain P3B162<sup>T</sup> by *invitro* plate assays. (a) Plate showing growth of strain P3B162<sup>T</sup> after an incubation of 7 days on minimal agar medium supplemented with 3mM ACC. (b) Plate showing positive siderophore production by forming an orange halo zone around the grown cells after 7 days of incubation. (c) A glass tube assay showing biofilm formation of strain P3B162<sup>T</sup> after an incubation of 24 h at 30°C. Adherence of the cells was detected by staining with crystal violet that is shown as a ring. (d) Plate assay showing positive for pectinase by formation of a halo zone around the grown cells in pectin amended minimal medium on treatment with iodine after an incubation of 7 days



PCR-based genomic fingerprinting using following primers; BOX, (GTG)<sub>5</sub>, ERIC and REP performed between strain P3B162<sup>T</sup> and its phylogenetically closest *Arthrobacter* type strains

**Isolation and functional characterisation of a novel marine gammaproteobacteria: proposal as *Oryzibacter plantistimulans* gen. nov. sp. nov. (KCTC 42150<sup>T</sup>=LMG 28271<sup>T</sup>):** Two novel bacterial isolates, L1E4 and L1E11 were isolated from the *pokkali* rice rhizosphere, which utilized ACC as sole nitrogen source, which was confirmed through TLC plate assay, resulting the quantification values ranging from 1-3 μMol/mg/h. Further samplings in 2014 from kaippad and mangroves resulted in similar L1E11 like strains (seven strains) based on their phenotypic properties (colony morphology) from ACC amended isolation medium. Based on the partial 16S rRNA analysis, all these strains were assigned to L1E11 strain as they shared high 16S rRNA similarity of 99.6% to 100 % among each other. Intra-species diversity was accessed by genomic fingerprinting using rep-PCR (GTG)<sub>5</sub> and grouped these 9 strains into three profiles indicating genetic diversity among these novel isolates. Complete taxonomic characterization was performed with isolates L1E11, 33, 228, 308. The 16S rRNA gene sequence was performed and the results showed that this novel isolates shared very low 16S rRNA gene similarity with many gamma proteobacteria. Based on these results it is concluded that strain L1E11 as the type strain and proposed as novel genus for which the name *Oryzibacter plantistimulans* gen. nov. sp. nov. is proposed. Currently, root



colonization studies by using GFP tagging of L1E11 are on-going.

## NII Culture Collection

The NII-Microbial Culture Collection and Gene Bank (NIICC) is a national facility established in 2008. Presently, the NIICC holds collectively over one thousand cultures, including Actinomycetes, Bacteria, Fungi and Yeasts. Generally, cultures are preserved by 20% glycerol stocks, either in ultra-deep freezer (-80°C) or in liquid nitrogen container (-196°C). NII also holds a dedicated in-lab DNA Sequencing facility; eight capillary DNA sequence machine (model 3500 ABI), mainly used in research programs relating to microbial diversity, ecology and taxonomy.

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## CHEMICAL SCIENCES AND TECHNOLOGY DIVISION

Main focus of the Chemical Sciences and Technology Division (CSTD) during 2014-2015 was research and development in: (1) Organic electronics (photovoltaics, lighting, organic field effect transistors, thermo-electrics etc.), (2) Sensing and diagnostics (developing sensors, diagnostic and imaging probes, drug delivery etc.) and (3) Natural products and organic synthesis (total synthesis, synthetic methodologies, catalyst development and theoretical chemistry). Besides this, the division was also involved in 12<sup>th</sup> five year plan network projects in interdisciplinary areas to develop materials for various applications including energy and healthcare.

Members of the division have published more than 80 papers in internationally reputed journals with high impact factor. Given below are some of the highlights of the division during the year 2014-2015, along with brief abstracts of the results published in various international peer reviewed journals.

### Highlights

- Developed  $\pi$ -gelators for sensing of explosives, and prevention of currency counterfeiting
- Developed donor-acceptor assemblies having coaxial p-n hetero junctions with high photoconductivity.
- Developed near infrared organic dye nano particles for sensing biomolecules like serum albumin proteins
- Developed photosensitizer functionalized gold quantum clusters for fluorescence imaging assisted photodynamic therapy.
- Demonstrated a simple and elegant method for producing 2D sheet like superstructures of CdTe quantum dots.
- Developed luminescent perovskite based sensors for explosives
- Developed electrochromic devices with long term cyclic durability using solid polymer electrolytes
- A biocompatible surface enhanced Raman scattering (SERS) based nanotag for ultra sensitive detection and imaging of human cancer developed.
- Developed targeted drug delivery system for treatment of cervical cancer cells
- A novel method developed for introducing multifunctionalities for synthesis of calixarene peptoids.
- Designed electrochemical sensors for simultaneous determination of ascorbic acid, dopamine, uric acid and acetaldehyde.
- X-ray structure database analysis of molecular assemblies containing azo ( $-N=N-$ ) and ethylene ( $-C=C-$ ) bridges achieved.
- Computational method developed for designing systems capable of water splitting and  $CO_2$  insertion reactions



## रसायन विज्ञान तथा प्रौद्योगिकी विभाग

वर्ष 2014-2015 के दौरान रासायनिक विज्ञान तथा प्रौद्योगिकी प्रभाग (सीएसटीडी) का मुख्य ध्यान (1) कार्बनिक इलेक्ट्रॉनिक्स (फोटोवोल्टिक, प्रकाश व्यवस्था, कार्बनिक क्षेत्र प्रभाव ट्रांजिस्टर, थर्मो-इलेक्ट्रिक्स आदि), (2) संवेदन और निदान (सेंसरों के विकास, नैदानिक और इमेजिंग प्रोब्स, दवा वितरण आदि) और (3) प्राकृतिक उत्पादों और कार्बनिक संश्लेषण (पूर्ण संश्लेषण, कृत्रिम तरीके, उत्प्रेरक विकास और सैद्धांतिक रसायन विज्ञान) में अनुसंधान और विकास पर केंद्रित था। इसके अलावा 12वीं पंचवर्षीय योजना की अंतर्विषयी क्षेत्रों की नेटवर्क परियोजनाओं में ऊर्जा और स्वास्थ्य सहित विभिन्न अनुप्रयोगों के लिए सामग्री के विकास में भी प्रभाग शामिल किया गया। प्रभाग के सदस्यों ने उच्च प्रभाव कारक के साथ अंतरराष्ट्रीय स्तर पर प्रतिष्ठित पत्रिकाओं में 80 से अधिक प्रकाशनों को प्रकाशित किया है। वर्ष 2014-15 के दौरान प्रभाग की शोध गतिविधियों की कुछ मुख्य विशेषताओं तथा विभिन्न अंतरराष्ट्रीय सहकर्मि समीक्षित पत्रिकाओं में प्रकाशित परिणामों के संक्षिप्त सार नीचे दिए जाते हैं।

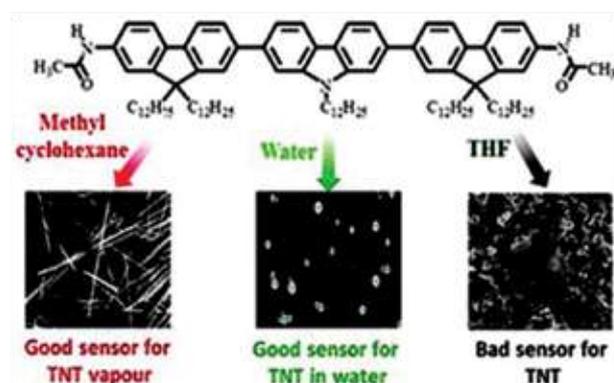
### अुसंधा की मुख्य विशेषताएं

- विस्फोटकों का संवेदन के लिए और करेंसी जालसाजी के रोकथाम के लिए  $\pi$ -जेलीकर विकसित किया
- उच्च फोटो चालकता के साथ समाक्षीय पी-एन असमलैंगिक जंक्शनों युक्त दाता-स्वीकर्ता असेंबलियों का विकास किया
- सीरम एल्यूमिन प्रोटीन्स जैसे जैव अणुओं के संवेदन के लिए निकट अवरक्त कार्बनिक डाई नैनो कणों का विकास किया
- प्रतिदीप्ति इमेजिंग सहायता प्राप्त फोटोडायनामिक थेरेपी के लिए फोटो सुग्राहीकर क्रियाशील गोल्ड प्रमात्रा समूह विकसित किया
- CdTe क्वांटम डॉट्स के सुपरस्ट्रक्चर जैसे 2 डी शीट के उत्पादन के लिए एक सरल और शिष्ट विधि का प्रदर्शन किया
- विस्फोटकों के लिए संदीप्तिशील पेरोवस्काइट आधारित सेंसर विकसित किया
- ठोस बहुलक इलेक्ट्रोलाइट्स का उपयोग करके दीर्घकालिक साइक्लिक स्थायित्व के साथ विद्युत क्रोमिक उपकरणों का विकास किया
- मानवीय कैंसर के अति संवेदनशील संसूचन और इमेजिंग के लिए एक जैव संगत सतह एन्हांस्ड रमन प्रकीर्णन (एसईआरएस) आधारित नैनोटेग विकसित किया
- ग्रीवा कैंसर की कोशिकाओं के उपचार के लिए लक्षित दवा वितरण प्रणाली विकसित की
- कैल्क्सएरिनेपेटोइड्स के संश्लेषण के लिए बहुअभिलाक्षणीकता की प्रस्तुति के लिए एक नवीन विधि विकसित की
- एस्कॉर्बिक एसिड, डोपामाइन, यूरिक एसिड और एसीटैल्डिहाइड के समकालिक निर्धारण के लिए विद्युत रासायनिक सेंसर का डिज़ाइन किया
- AZO (-एन=एन-) और एथिलीन (-सी=सी-) सेतु युक्त आणविक असेंबलियों के एक्स-रे संरचना डेटाबेस विश्लेषण हासिल की
- पानी के बंटवारे और कार्बन डाइ ऑक्साइड सम्मिलन अभिक्रियाओं के लिए सक्षम सिस्टम के डिज़ाइन के लिए कम्प्यूटेशनल विधि विकसित की



## A carbazole–fluorene molecular hybrid for quantitative detection of TNT using a combined fluorescence and quartz crystal microbalance method

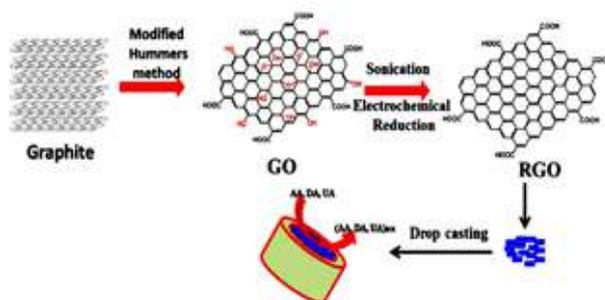
A combined fluorescence and quartz-crystal microbalance approach for the quantitative sensing of nitroaromatics, particularly TNT, using morphologically different self-assemblies of a carbazole bridged fluorene (CBF) derivative developed. Picomolar level detection of TNT was possible in water by the CBF nanoparticles and nanogram level TNT sensing



in the vapour phase could be achieved with the CBF supramolecular rods. A quantitative detection of the adsorbed TNT by the QCM technique on these nanostructures reveals the importance of the morphological features of the self-assembled supramolecular structures for sensing of various analytes (Ajayagosh *et al. Phys. Chem. Chem. Phys.*, **2014**, *16*, 18896-901).

## Electrochemically synthesized partially reduced graphene oxide modified glassy carbon electrode for individual and simultaneous voltammetric determination of ascorbic acid, dopamine and uric acid

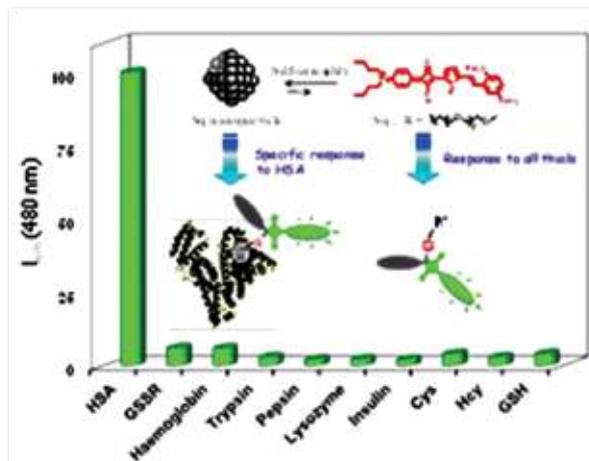
An efficient and simple approach for the preparation of a partially reduced graphene oxide modified glassy carbon electrode (RGO-GCE)



was established. The modification of the RGO-GCE consists of three steps. These include (i) chemical synthesis of graphite oxide by a modified Hummer's method, (ii) exfoliation of graphite oxide to graphene oxide (GO) by ultra-sonication and (iii) controlled partial electrochemical reduction in 0.1 M phosphate buffered medium (pH 3.0) via potentiodynamic cycling (2 cycles) to obtain a partially reduced graphene oxide modified glassy carbon electrodes (RGO-GCE). The behaviour of the RGO-GCE towards ascorbic acid (AA), dopamine (DA) and uric acid (UA) was investigated by differential pulse voltammetry, with an enrichment time of 3 minutes. This showed that the modified electrode has good precision (1.42, 1.92 and 2.20% for AA, DA and UA, respectively) and resolution at pH 3.0 for all three molecules, which enables their individual and simultaneous determination. Under the optimized conditions, the electrochemical sensor showed a wider linear response for AA, DA and UA in the concentration ranges of  $4 \times 10^{-5}$  to  $1 \times 10^{-3}$  M,  $1 \times 10^{-7}$  to  $1 \times 10^{-4}$  M and  $8 \times 10^{-7}$  to  $8 \times 10^{-4}$  M with detection limits of  $4.2 \times 10^{-6}$ ,  $8 \times 10^{-9}$  and  $6 \times 10^{-7}$  M, respectively, based on 3 times the standard deviation of the blank with minimal fouling effects. Detailed spectral (IR and Raman), morphological (SEM and TEM) and electrochemical characterization studies were also conducted. Finally, the performance of the RGO-GCE based sensor was successfully tested for analysing UA and quantitative recoveries of AA and DA in serum samples (Ajayagosh and co-workers, *Anal. Methods*, **2014**, *16*, 8529).



## Self-assembled near infrared dye nanoparticles as a selective protein sensor by activation of a dormant fluorophore

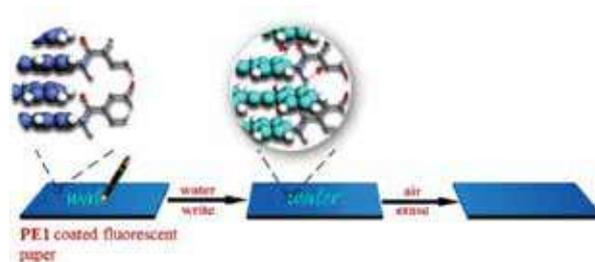


Design of selective sensors for a specific analyte in blood serum, which contains large number of proteins, small molecules and ions, is important in clinical diagnostics. While metal and polymeric nanoparticle conjugates have been used as sensors, small molecular assemblies have rarely been exploited for the selective sensing of a protein in blood serum. How a nonspecific small molecular fluorescent dye can be empowered to form a selective protein sensor as illustrated with a thiol sensitive near-IR squaraine (Sq) dye ( $\lambda_{max} = 670 \text{ nm}$ ,  $\lambda_{em} = 700 \text{ nm}$ ) has been demonstrated. The dye self-assembles to form nonfluorescent nanoparticles ( $D_h = 200 \text{ nm}$ ) which selectively respond to human serum albumin (HSA) in presence of other thiol containing molecules and proteins by triggering a green fluorescence. This selective response of the dye nanoparticles allowed detection and quantification of HSA in blood serum with a sensitivity limit of 3 nM. Notably, the molecular dye in solution was nonselective and responded to any thiol containing proteins and small molecules. The sensing mechanism involves HSA specific disassembly of the Sq nanoparticles to the molecular dye and its subsequent reaction with the thiol moiety of the protein, triggering the green emission of a dormant fluorophore. This study demon-

strated the power of a self-assembled small molecular fluorophore for protein sensing and is a simple chemical tool for the clinical diagnosis of blood serum (Ajayaghosh *et al.* *J. Am. Chem. Soc.* **2014**, 136, 13233-39).

## A slippery molecular assembly allows water as a self-erasable security marker

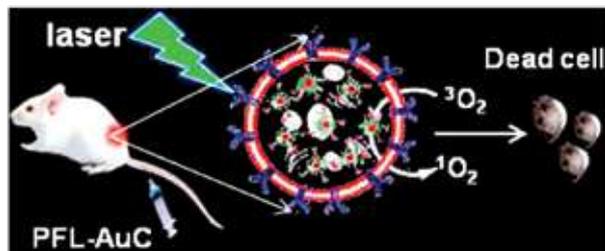
Protection of currency and valuable documents from counterfeit continues to be a challenge. While there are many embedded security features available for document safety, they are not immune to forgery. Fluorescence is a sensitive property, which responds to external stimuli such as solvent polarity, temperature or mechanical stress, however practical use in security applications is hampered due to several reasons.



Therefore, a simple and specific stimuli responsive security feature that is difficult to duplicate is of great demand. The design of a fluorescent molecular assembly on which water behaves as a self-erasable security marker for checking the authenticity of documents at point of care has been developed. The underlying principle involves the disciplined self-assembly of a tailor made fluorescent molecule, which initially form a weak blue fluorescence ( $\lambda_{em} = 425 \text{ nm}$ ,  $\Phi_f = 0.13$ ) and changes to cyan emission ( $\lambda_{em} = 488 \text{ nm}$ ,  $\Phi_f = 0.18$ ) in contact with water due to a reversible molecular slipping motion. This simple chemical tool, based on the principles of molecular self-assembly and fluorescence modulation, allows creation of security labels and optically masked barcodes for multiple documents authentication (Ajayaghosh *et al.* *Sci. Rep.* **5**, 09842; doi: 10.1038/srep09842 (2015)).



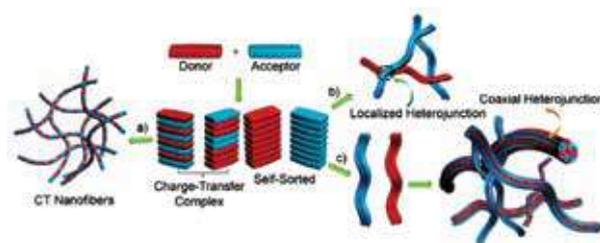
## Fluorescence imaging assisted photodynamic therapy using photosensitizer-linked gold quantum clusters



Fluorescence imaging assisted photodynamic therapy (PDT) is a viable two-in-one clinical tool for cancer treatment and follow-up. While the surface plasmon effect of gold nanorods and nanoparticles has been effective for cancer therapy, their emission properties when compared to gold nanoclusters are weak for fluorescence imaging guided PDT. In order to address the above issues, a near-infrared-emitting gold quantum cluster capped with lipoic acid (L-AuC with (Au)<sub>18</sub>(L)<sub>14</sub>) based nanoplatform with excellent tumor reduction property was synthesized by incorporating a tumor-targeting agent (folic acid) and a photosensitizer (protoporphyrin IX), for selective PDT. The synthesized quantum cluster based photosensitizer PFL- AuC showed 80% triplet quantum yield when compared to that of the photosensitizer alone (63%). PFL-AuC having 60  $\mu\text{g}$  (0.136 mM) of protoporphyrin IX was sufficient to kill 50% of the tumor cell population. Effective destruction of tumor cells was evident from the histopathology and fluorescence imaging, which confirm the *in vivo* PDT efficacy of PFL-AuC (Ajayaghosh *et al.* *ACS Nano*, **2015**, *9*, 5825–32).

## Organic donor–acceptor assemblies form coaxial p–n heterojunctions with high photoconductivity

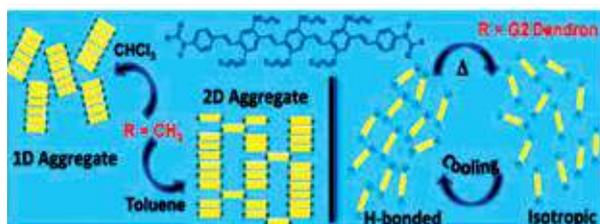
The formation of coaxial p–n hetero junctions by mesoscale alignment of self-sorted donor and acceptor molecules, important to achieve high



photocurrent generation in organic semiconductor-based assemblies, remains a challenging topic. It was shown that mixing a p-type  $\pi$  gelator (TTV) with an n-type semiconductor (PBI) resulted in the formation of self-sorted fibers which were coaxially aligned to form interfacial p–n hetero junctions. UV/Vis absorption spectroscopy, powder X-ray diffraction studies, atomic force microscopy, and Kelvin-probe force microscopy revealed an initial self-sorting at the molecular level and a subsequent mesoscale self-assembly of the resulted supramolecular fibers leading to coaxially aligned p–n hetero junctions.

A flash photolysis time-resolved microwave conductivity (FP-TRMC) study revealed a 12-fold enhancement in the anisotropic photoconductivity of TTV/PBI coaxial fibers when compared to the individual assemblies of the donor/acceptor molecules (Ajayaghosh *et al.* *Angew. Chem. Int. Ed.* **2015**, *54*, 946–50.)

## Effect of the bulkiness of the end functional amide groups on the optical, gelation, and morphological properties of oligo (*p*-phenylenevinylene) $\pi$ -gelators



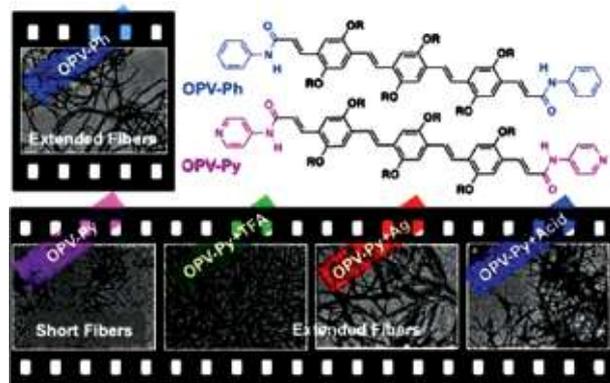
The interplay between hydrogen-bonding and  $\pi$ -stacking interactions was controlled by the bulkiness of the end functional groups, thereby resulting in



aggregates of different types, which led to the gelation of a wide range of solvents. The variable-temperature UV/Vis absorption and fluorescence spectroscopic features of gelators with small end-groups revealed the formation of 1D H-type aggregates in  $\text{CHCl}_3$ . However, under fast cooling in toluene, 1D H-type aggregates were formed, whereas slow cooling resulted in 2D H-type aggregates. OPV amide with bulky dendritic end-group formed hydrogen bonded random aggregates in toluene and a morphology transition from vesicles into fibrous aggregates was observed in THF. Interestingly, the presence of bulky end-group enhanced fluorescence in the xerogel state and aggregation in polar solvents. The difference between the aggregation properties of OPV amides with small and bulky end-groups allowed the preparation of self-assembled structures with distinct morphological and optical features. (Ajayaghosh *et al. Chem. Asian J.* **2014**, *9*, 1830-40).

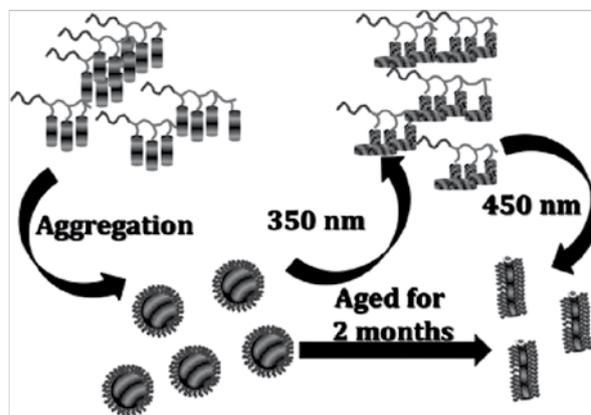
### Pyridyl-amides as a multimode self-assembly driver for the design of a stimuli responsive $\pi$ -gelator

An oligo(*p*-phenylenevinylene) (OPV) derivative connected to pyridyl end groups through an amide linkage (OPV-Py) resulted in a multistimuli responsive  $\pi$ -gelator. When compared to the corresponding phenyl-amide terminated OPV  $\pi$ -gelator (OPV-Ph), the aggregation properties of OPV-Py were found significantly different, leading to multistimuli gelation and morphological properties.



The pyridyl moiety in OPV-Py initially interfere with the amide H-bonded assembly and gelation, however, protonation of the pyridyl moiety with trifluoroacetic acid (TFA) facilitated the formation of amide H-bonded assembly leading to gelation, which is reversible by the addition of *N,N*-diisopropylethylamine (DiPEA). Interestingly, addition of  $\text{Ag}^+$  ions to OPV-Py solution facilitated the formation of a metallo-supramolecular assembly leading to gelation. Surprisingly, ultrasound induced gelation was observed when OPV-Py was mixed with a dicarboxylic acid (A1). A detailed study using different spectroscopic and microscopic experimental techniques, revealed the difference in the mode of assembly in the two molecules and the multi-stimuli responsive nature of the OPV-Py gelation (Ajayaghosh *et al. Chem. Asian J.*, **2015**, DOI: 10.1002/asia.201500331).

### Photoresponsive glycopolymer aggregates as controlled release systems



The use of a new block copolymer made up of poly (azobenzene methacrylate) (PMAzo) and poly (3-O-4-vinylbenzoyl-D-glucopyranose) (PBG) has been demonstrated for the solubilization of water insoluble dyes such as Nile Red in aqueous solutions. This polymer, which is abbreviated as PMAzo-b-PBG, self-assembles into spherical aggregates in water as confirmed by atomic force microscopy. UV irradiation of



the aqueous polymer solution destabilizes the aggregates brought about as a result of the trans-cis isomerization of the MAzo units. Dissociated aggregates reunite to form tubular aggregates when the solution is irradiated with 450 nm light. Nile Red, which is a hydrophobic dye, can be incorporated into these aggregates and subsequently released using UV light. The encapsulation, release, and re-encapsulation of Nile Red are studied using fluorescence spectroscopy (Das *et al. Macromol. Chem. Phys.* **2014**, *215*, 2365–73)

### **Symmetrical Diiodinated Squaraine as an efficient photosensitizer for PDT applications: Evidence from photodynamic and toxicological aspects**

Photodynamic therapy (PDT) is emerging as a promising non-invasive treatment for cancers. It involves three key components; a photosensitizer, light and tissue oxygen. Even though several photosensitizers have been investigated for their use in PDT, they have several disadvantages and hence the search for more effective sensitizers has become important in recent years. The dye selected in the study, symmetrical diiodinated benzothiazolium squaraine (SQDI), is one of the newly developed photosensitizers. The study aimed to evaluate the *in vitro* cytotoxicity of the dye on Ehrlich's Ascites Carcinoma (EAC) cells and to assess the *in vivo* toxicity on Swiss albino mice. The EAC cells were maintained in the peritoneum of mice and used to study the dark toxicity and phototoxicity by Trypan blue dye exclusion method, estimation of Reactive Oxygen Species (ROS), caspase activity and levels of thiobarbituric acid reactive substances (TBARS). The *in vitro* studies revealed that the dye induces toxicity in the presence of light and mediates cell death. The *in vivo* part of the study, which dealt with the toxicity evaluation in the body of Swiss albino mice, was done by analyzing the parameters like

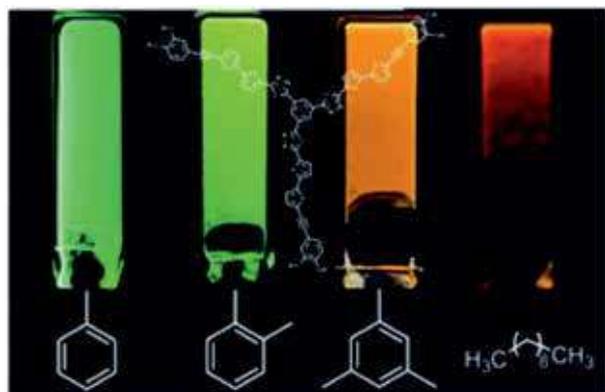
serum glutamate oxaloacetate transaminase (SGOT), serum glutamate pyruvate transaminase (SGPT), lactate dehydrogenase (LDH), creatine kinase (CK) and alkaline phosphatase (ALP). No significant change was observed in the above mentioned parameters in the dye administered group when compared to control. Altogether, this experiment indicates that the SQDI selected for the study may be used as an efficient photosensitizer for PDT applications and does not elicit acute toxicity to normal tissues in the absence of light (Das *et al. Chemico-Biological Interactions*, **2014**, *222*, 44–49).

### **Solvent assisted fluorescence modulation of a C3-symmetric organogelator**

The synthesis and self-assembling properties of C3 symmetric donor-acceptor molecules containing 1,3,4-oxadiazole and bithiophene moieties in the core functionalized with octyl (BTOX8) and dodecyl (BTOX12) substituted phenyl acetylene units at the periphery were investigated. BTOX8 was found to form gels only in aliphatic solvents, whereas BTOX12 formed gels in both aliphatic and aromatic solvents. Photophysical analysis of BTOX12 solutions showed a striking effect of the solvent on the nature of the self-assembled aggregate formed. The studies indicated that in aliphatic solvents such as n-decane the solvent molecules interacted mainly with the alkyl regions of BTOX12. As a result the  $\pi$ - $\pi$  interaction between the neighbouring molecules became feasible resulting in strong excitonic coupling between the neighbouring molecules leading to excimer type emission. In aromatic solvents the solvent molecules interacted mainly with the chromophoric part of BTOX12 resulting in reduced  $\pi$ -stacking between the molecules in the aggregate leading to monomer type emission. Films prepared from aliphatic and aromatic solvents exhibited photophysical properties significantly similar to those observed in the respective solvents. Photophysical studies of the films indicated that the films

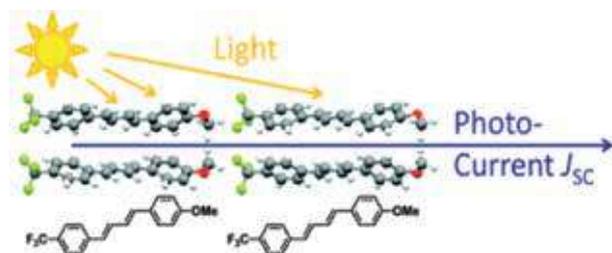


prepared from n-decane exhibited an H-type molecular arrangement whereas the films prepared from toluene exhibited a slipped stack J-type arrangement (Das *et al. J. Mater. Chem. C*, **2014**, *2*, 7039-46.)



### Bulk photovoltaic effect in an organic polar crystal

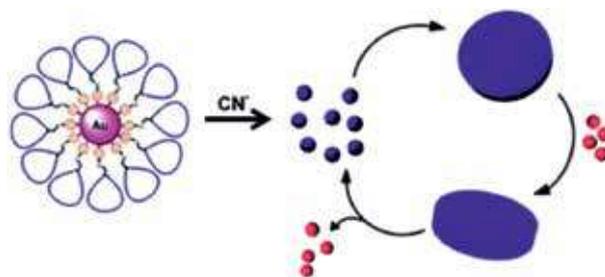
Organic polar crystals from the donor-acceptor substituted 1, 4-diphenyl butadiene can generate a short-circuit photocurrent and a photovoltage upon illumination with near UV light. The photocurrent and photovoltage are attributed to a bulk photovoltaic effect. The bulk photovoltaic effect has been known for inorganic polar crystals for decades and can now also be demonstrated for organic polar crystals (Das *et al. Chem. Commun.* **2014**, *50*, 6530-6533).



### Organic nanoparticles composed of Frechet-type dendrons: Synthesis, characterization, self assembly and reversible guest encapsulation

Novel organic nanoparticles composed of Frechet-type dendrons have been synthesized by a simple

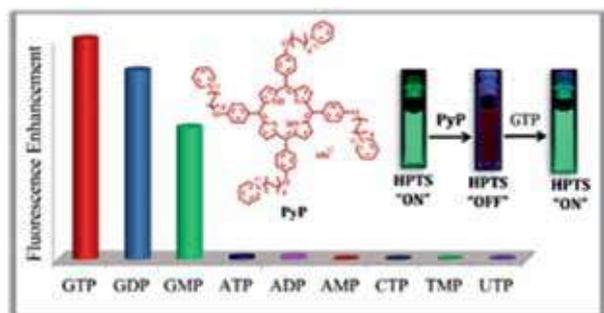
one-pot reaction, which involved etching off the gold core in a first generation gold nanoparticle-cored dendrimer (AuG1). Dissolution of the Au core leads to the generation of numerous dendron radicals in a small volume, which underwent very fast coupling and addition reactions to form the Frechet-type dendron nanoparticles (FDNs). The FDNs were found to be nearly monodispersed with an average size of 3 nm. NMR, TEM and MALDI-TOF analysis suggested that the FDNs are extremely dense organic structures made up of Frechet-type dendrons. Although the FDNs do not contain any self-assembling motifs, such as hydrogen bonding moieties, they exhibited time and concentration dependent morphological transformations, leading to the formation of larger spherical aggregates and fibrous networks. Morphological transformations were probed using TEM, AFM and



DLS studies. The self assembly was found to be reversible. The morphological transformation of FDNs was exploited for the encapsulation and on-demand release of guest molecules (Gopidas *et al. J. Mater. Chem. B*, **2014**, *2*, 5576-84).

### Effective discrimination of GTP from ATP by a cationic tentacle porphyrin through turn-on fluorescence intensity

Selective recognition of nucleotides in aqueous media, especially guanosine based nucleotides, has gained immense attention due to its specific functions in various biological processes. The development of probes that are devoid of hydrogen bonding and selectively recognize nucleosides or nucleotides in the aqueous medium is quite challenging. In this context,

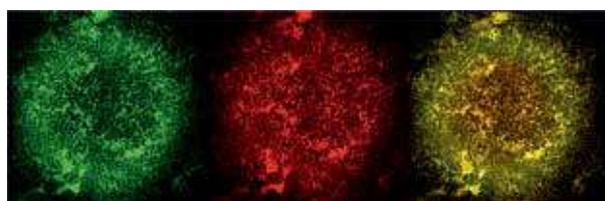


a water soluble cationic porphyrin PyP and its zinc complex Zn-PyP were synthesized and investigated their interactions with various nucleosides and nucleotides in phosphate buffer medium. The results demonstrated that, the porphyrin PyP exhibited selective interactions with the guanosine (G) based nucleotides when compared to other nucleotides and nucleosides. Uniquely, this system in combination with the FID assay can be effectively utilized to develop a fluorescence “turn-on” probe for the selective detection of the G based nucleotides and also to discriminate GTP from ATP in the aqueous medium. Interestingly, the free base porphyrin PyP showed selective interactions with the G-based nucleotides, even in the presence of other nucleotides, through the synergistic effects of both electrostatic and  $\pi$ - $\pi$  stacking interactions. (Ramaiah *et al.*, *RSC Adv.*, **2014**, 4, 30644-47).

### Antimicrobial photodynamic efficiency of novel cationic porphyrins towards periodontal gram-positive and gram-negative pathogenic bacteria

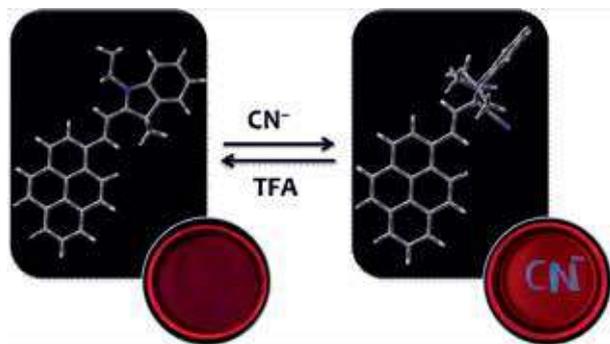
The Gram-negative *Aggregatibacter actinomycetemcomitans* and *Fusobacterium nucleatum* are major causative agents of aggressive periodontal disease. Due to increase in the number of antibiotic-resistant bacteria, antimicrobial photodynamic therapy (aPDT) seems to be a plausible alternative. In this work, the photosensitization was performed on Gram-positive and Gram-negative bacteria in pure culture using new-age cationic porphyrins, namely mesoimidazolium-sub-

stituted porphyrin derivative (ImP) and pyridinium-substituted porphyrin derivative (PyP). The photophysical properties of both the sensitizers including absorption, fluorescence emission, quantum yields of the triplet excited states and singlet oxygen generation efficiencies were evaluated. The studied porphyrins exhibited high ability to accumulate into bacterial cells with complete penetration into early stage biofilms. As compared with ImP, PyP was found to be more effective for photoinactivation of bacterial strains associated with periodontitis, without any signs of dark toxicity, owing to its high photocytotoxicity (Ramaiah *et al.*, *Photochem. Photobiol.*, **2014**, 90, 628-40).



### A reversible dual mode chemodosimeter for the detection of cyanide ions in natural sources

The indolium conjugates based on anthracene and pyrene derivatives were synthesized and their photophysical and anion recognition properties investigated. Of these, the pyrene-indolium based probe exhibited as a dual colorimetric and fluorescent chemodosimeter with ratiometric changes, for the selective and sensitive detection of cyanide ions. The detection limit of the  $\text{CN}^-$  ions by the pyrene probe has been found to be 10 ppb (maximum concentration limit as per EPA guidelines is 200 ppb), while the anthracene-indolium based probe showed a sensitivity of 32 ppb. The nature of recognition has been studied through various techniques such as  $^1\text{H}$ ,  $^{13}\text{C}$  NMR, IR, HRMS, and isothermal titration calorimetry (ITC). These studies confirm that the pyrene conjugate forms a 1,2-adduct in the presence of  $\text{CN}^-$  ions. The kinetic studies employing the probe showed the completion of the reaction within 15 s with a rate constant of  $k' = 0.522 \pm 0.063 \text{ s}^{-1}$ .



Uniquely, this probe can be coated on glass rod, polymer matrix and also on filter paper for the on-site analysis of the  $\text{CN}^-$  ions. Furthermore, by employing this probe, its ability to detect the endogenous cyanide in the seeds of Indian almonds was investigated. Upon gradual addition of the extract from the unripe almonds to the solution containing the pyrene conjugate, ratiometric changes both in the absorption and fluorescence intensity were observed. The endogenous cyanide ion concentration in the extract was determined to be  $ca. 100 \pm 12$  ppm when compared to the extract from the degreased commercially available almonds, which showed negligible changes (Ramaiah *et al. Chem. Asian J.* **2014**, *9*, 1636–42).

### Sensitive naked eye detection of hydrogen sulfide ( $\text{H}_2\text{S}$ ) and nitric oxide (NO) by aza-BODIPY dyes in aqueous medium

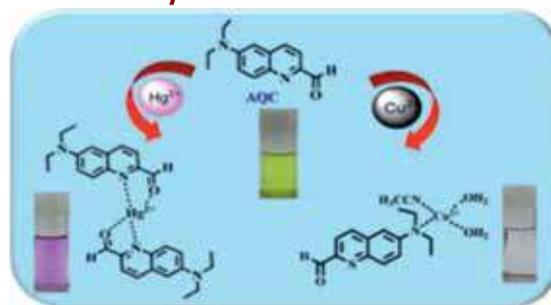
With an objective to develop optical probes for biologically important anions and neutral molecules, three novel NIR absorbing aza-BODIPY derivatives were synthesized, and have systematically tuned their photophysical properties by changing the peripheral substitution. A profound red-shift was observed in the absorption and fluorescence spectra of the aza-BODIPY dyes with the change in substitution from azido (3a) to amino (3b) to dimethylamino (3c) groups. Theoretical calculations of 3a-3c showed a consistent decrease in bandgap, which supported the observed spectral changes. The study of their interactions with various analytes revealed that the aza-

do-aza-BODIPY 3a selectively interacts with hydrogen sulfide ( $\text{H}_2\text{S}$ ) when compared to other molecules. Uniquely, the detection of  $\text{H}_2\text{S}$  can be visualized through a change in colour from bright blue to purple with a detection limit of 0.5 ppm. The sensitivity of the probe was observed to be 20-fold higher than the allowed exposure limits of  $\text{H}_2\text{S}$  as defined by EPA (10 ppm). The aza-BODIPY derivative 3b, on the other hand, exhibited selective interactions with nitrite ions ( $\text{NO}_2^-$ ) and nitric oxide (NO) in aqueous medium through a visible colour change from blue to green with a sensitivity of 20 and 0.15 ppb, respectively.



In contrast, the dimethylamino-aza-BODIPY derivative, 3c, showed negligible affinity for the anions and neutral molecules tested. By tuning the photophysical properties through the judicious functionalization, the aza-BODIPY dyes thus synthesized can be utilized for the sensitive on-site detection and analysis of various toxic species in the aqueous medium. (Ramaiah *et al. Anal. Chem.* **2014**, *86*, 9335–42).

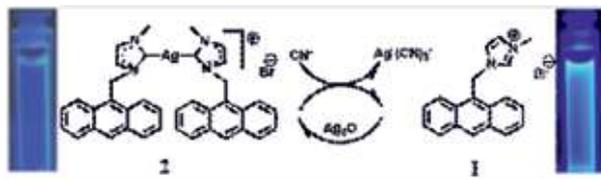
### Selective and dual naked eye detection of $\text{Cu}^{2+}$ and $\text{Hg}^{2+}$ ions using a simple quinoline-carbaldehyde chemosensor





A new colorimetric chemosensor based on diethylaminoquinolinecarbaldehyde was designed and its sensing behaviour towards various metal ions has been investigated through photophysical, IR and NMR techniques. Interestingly, this probe can selectively detect both  $\text{Cu}^{2+}$  and  $\text{Hg}^{2+}$  ions with an easy, well-defined naked-eye visible colour changes from yellow to colourless and pink, respectively. The uniqueness of this system is that it forms stable 1:1 stoichiometric complexes involving diethylamino moiety for the selective recognition of  $\text{Cu}^{2+}$  ions with detection limit of 25 ppb. For the selective recognition of  $\text{Hg}^{2+}$  ions, it forms a 2:1 stoichiometric complex involving quinoline nitrogen and aldehyde functionality and shows a detection limit of 360 ppb. The association constants for both  $\text{Cu}^{2+}$  and  $\text{Hg}^{2+}$  complexes were determined and are found to be  $ca. 2.1 \pm 0.1 \times 10^4 \text{ M}^{-1}$  and  $1.29 \pm 0.2 \times 10^8 \text{ M}^{-2}$ , respectively. Uniquely, this probe can be coated on a glass surface to fabricate a simple solid-state dipstick device that can be used for the easy visual detection and analysis of  $\text{Cu}^{2+}$  and  $\text{Hg}^{2+}$  ions in the aqueous medium (Ramaiah *et al. Sensors and Actuators*, **2014**, 204, 480–88).

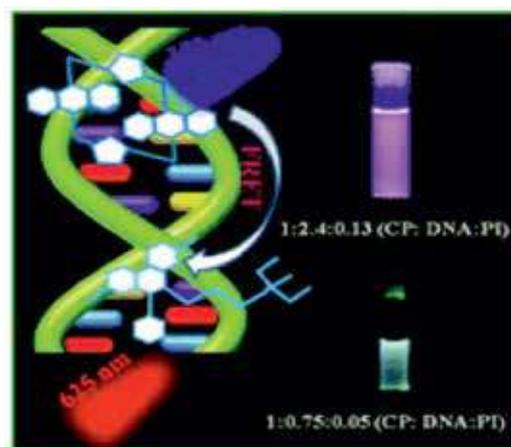
### Fluorescent chemodosimeter based on NHC complex for selective recognition of cyanide ions in aqueous medium



The hazardous impact of the cyanide ions on both physiological and environmental conditions, has led to an intensive research efforts for the design and development of efficient probes for their detection. The probes involving the displacement approach utilize the affinity of the  $\text{CN}^-$  ions towards various metal ions to form stable  $[\text{M}(\text{CN})_x]^{n-}$  complexes. In this context, two novel N-heterocyclic carbene (NHC) based mono-

and dinuclear silver complexes bearing optically active anthracene chromophore were synthesized for the selective and sensitive detection of the cyanide ions in aqueous medium. The uniqueness of these probes is that they recognize the cyanide ions through visible changes in fluorescence intensity with a sensitivity of *ca.* 50 ppb, which is far more sensitive than the maximum contaminant level as prescribed by the US-EPA. Interestingly, this NHC probe can be used for the accurate quantification of cyanide ions in aqueous medium (Ramaiah *et al. RSC Adv.*, **2014**, 4, 47982–86).

### Simultaneous binding of a cyclophane and classical intercalators to DNA: Observation of FRET-mediated white light emission

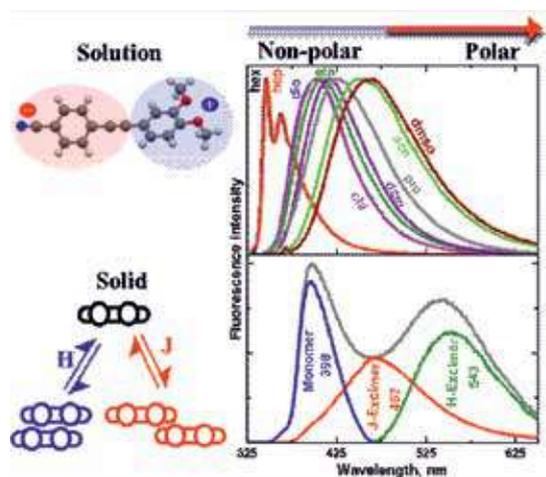


DNA-assisted Förster resonance energy transfer (FRET) between an anthracene-based cyclophane (CP) and mono- and bis-intercalators such as propidium iodide (PI) and ethidium homodimer-1 (EHD), respectively, has been studied using various photophysical and biophysical techniques. The cyclophane and PI exhibited simultaneous binding to DNA at all concentrations studied and showed DNA-assisted FRET from the excimer of cyclophane with a FRET efficiency of *ca.* 71%. On the other hand, the bis-intercalator EHD, only at lower concentrations, could act as an acceptor for the energy transfer process with a lower



efficiency of *ca.* 44%. At higher concentrations (415 mM), EHD, on account of its higher binding affinity, displaced cyclophane from the DNA scaffold. Employing the ternary system comprising of the cyclophane, DNA and PI and fine-tuning the concentrations of the components in a molar ratio of 1: 0.75: 0.05 (CP:DNA: PI), the white light emission with CIE coordinates (0.35, 0.37) was demonstrated. These studies further confirmed that both efficiency and nature of DNA binding, and the spectral overlap between donor and acceptor systems play a significant role in the generation of DNA-assisted white light emission (Ramaiah *et al. Phys. Chem. Chem. Phys.*, **2015**, *17*, 13495-500).

### Transformation of photophysical properties from solution to solid state in alkoxy-cyano-diphenylacetylene molecules



Detailed photophysical properties of cyano and mono (MA)/ bis alkoxy(DA) substituted diphenylacetylene moiety with different alkyl chain lengths (methyl (1), octyl (8) and dodecyl (12)) were investigated in solution and solid state in an effort to determine the role of self-aggregation on these properties. The solvated molecules showed minimal bathochromic shift with increase of solvent polarity in their absorption spectra, whereas significant shift was observed in the emission spectra. This could be attributed to

relatively low change in dipole moment between ground and Franck Condon excited state and luminescence arising from the intramolecular charge transfer state with dipole moment significantly higher than the ground state. In solid state the emission quantum yields of these materials were significantly higher than in solution. For DA1, polymorphic materials with distinct photophysical properties were obtained. The DA1 materials obtained by fast precipitation (DA1) showed broad fluorescence with peaks at 398, 467 and 535 nm by exciting at different wavelength. Detailed analysis of absorption, emission and excitation spectra and lifetime experiments indicated that these peaks could be attributed to the monomer, J- and H-type aggregates respectively. Whereas, the crystals obtained by slow crystallization (DA1C) showed only one emission peak around 396 nm attributed to the monomer. This was supported by the single crystal X-ray structure which consists of monomer molecule having minimal interaction with nearest neighbour molecules. (Karunakaran *et al.*, *Phys. Chem. Chem. Phys.*, **2015**, DOI: 10.1039/c5cp02762d).

### p/n-Polarity of thiophene oligomers in photovoltaic cells: Role of molecular vs supramolecular properties

Molecular and supramolecular properties play key roles on the optoelectronic properties and photovoltaic performances of organic materials. Two acceptor-donor-acceptor type semiconducting thiophene oligomers end-functionalized with oxazolone/isoxazolone derivatives (OT1 and OT2 respectively) were designed and synthesized. The HOMO - LUMO energy levels of both derivatives were found to be positioned in such a way, that they can act as electron acceptors to P3HT and electron donors to PCBM. However, OT1 functions as a donor (with PCBM) and OT2 as an acceptor (with P3HT) in BHJ photovoltaic cells, and the reverse roles either results no or poor performance of



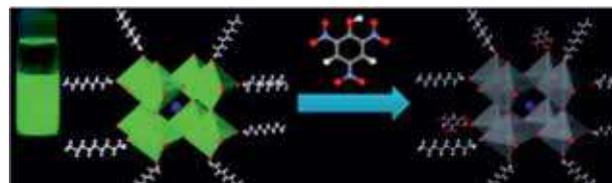
the cell. Detailed studies using UV-vis absorption and fluorescence spectroscopy, time-correlated single photon counting, UV-photoelectron spectroscopy, density functional theory calculations, X-ray diffraction, and thermal gravimetric analysis proved that both molecular and supramolecular properties were contributing equally but in a contrasting manner to the above mentioned observation. The obtained results were further validated by flash-photolysis time-resolved microwave conductivity studies which showed excellent correlation between the structure, property, and device performances of the materials. The results showed that a small change in the molecular structure affects the molecular properties, which in turn control the intrinsic and fundamental property such as the p/n-polarity of organic semiconductors in bulk-heterojunction solar cells. (Vijayakumar *et al. Phys. Chem. Chem. Phys.* **2015**, *17*, 10630–39).

#### Supramolecular and Molecular Chemistry



### Luminescent hybrid perovskite nanoparticles as a new platform for selective detection of 2,4,6-trinitrophenol

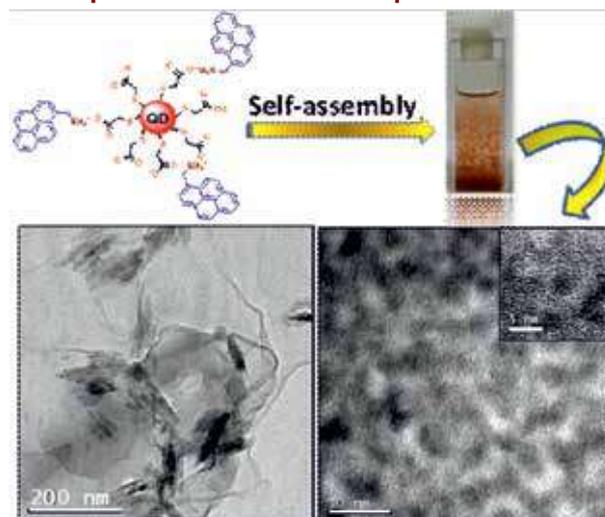
Luminescent organic – inorganic perovskite ( $\text{CH}_3\text{N}_2\text{H}_3\text{PbBr}_2$ ) nanoparticles were used for the detection of 2,4,6-trinitrophenol (TNP, picric acid) in solution and vapour state. TNP is a highly potent explosive



as that of dinitrotoluene (DNT) and trinitrotoluene (TNT), and it is present in several industrial wastes. It

contaminates soil, groundwater and plant foods, and is dangerous to wild life and human health because of its biological persistence and toxicity. However, selective detection of TNP from other nitro aromatic explosives such as DNT and TNT is difficult. Unlike most fluorescence based sensors, hybrid perovskite nanoparticles showed high selectivity and good sensitivity towards TNP, particularly in the solution state. Hydrogen bonding ability and electron accepting strength of TNP were found to play key roles on the detection mechanism (Vijayakumar *et al. RSC Adv.* **2014**, *4*, 55908–11).

### 2D Superstructures of CdTe quantum dots



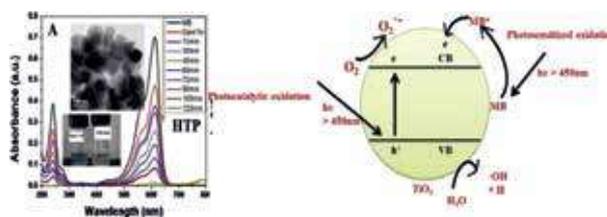
Organization of quantum dot (QD) based nano-materials with organic molecules into higher order macro-scale assemblies is highly essential for their practical utilization in opto-electronic devices such as solar cells and light emitting devices. Self-assembly is one of the efficient bottom-up methodologies to produce such hybrid materials with newer and modified properties. However, attempts to produce such assemblies often results in the fusing of the nanocrystals destroying their quantum confinement and hence the unique properties. In this context it was envisaged that electro-statically driven self-assembly



of QDs with organic chromophores could be a viable methodology for producing 2D assemblies of QDs, but without losing their desirable properties. Studies revealed that Coulombic interaction of negatively charged QDs with positively charged organic chromophore (pyrenemethylamine hydrochloride) resulted in neutralization of their charges. This in turn caused the diminishing of the electrostatic repulsion between the QDs and increase in hydrophobicity of both QDs and organic chromophores. These two factors induce the self-assembly of QDs and the attractive dipole-dipole interaction between the nanocrystals organizes them into 2D sheet like structures spanning over several micrometers. (Yoosaf *et al.* *RSC Adv.* **2015**, *5*, 47813; DOI: 10.1039/c5ra08334f).

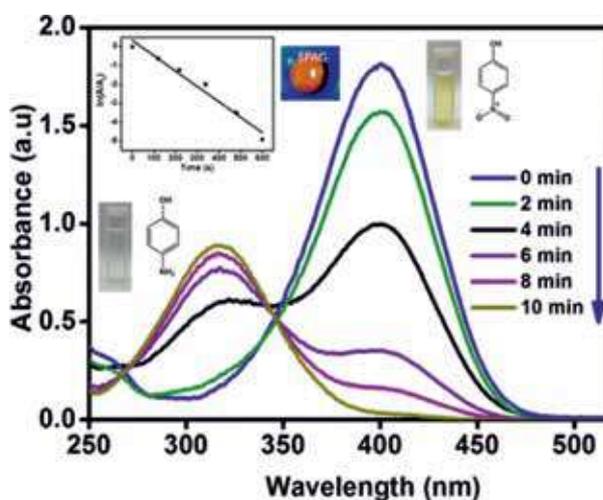
### Nanocubes of rutile titania for enhanced visible light photocatalytic applications

Preparation of rutile nanotitania using low cost bio-capping strategies was demonstrated. It was characterized for its particle size, zeta potential, photo-physical properties such as UV-vis absorption and emission, crystalline phase by XRD, surface area by BET analysis, morphology by SEM and TEM. Results revealed the formation of nanocubes of rutile titania having band gap of ~2.5 eV. Photocatalytic efficiency of nanotitania was envisaged by conducting visible light induced photodegradation of methylene blue (MB). Superior visible light photodegradation efficiency exhibited by nanotitania is attributed to the photo-catalytic and photo-sensitized oxidation mechanisms. From the various results, a plausible mechanism for the superior photodegradation efficiency exhibited by nanotitania is suggested. Total organic carbon (TOC) analysis further supported the photodegradation of MB (Sudha *et al.*, *Materials Chemistry and Physics*, **2015**, *157*, 31-38).



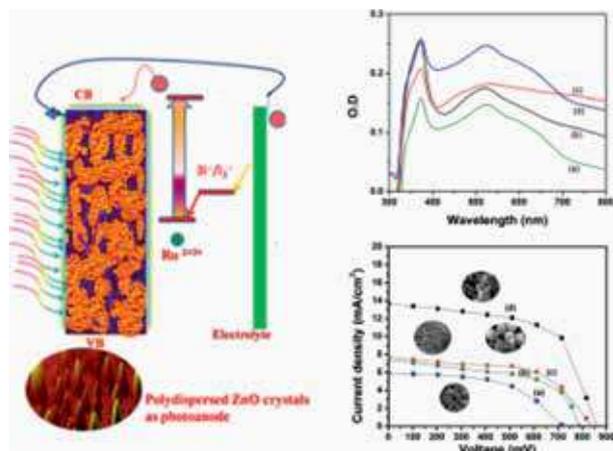
### Brawny silver-hydrogel based nanocatalyst for reduction of nitrophenols: Studies on kinetics and mechanism

Preparation and characterization of silver nanoparticles-ensnared hydrogel capable of acting as catalyst in the reduction of a series of nitrophenols were undertaken. Silver containing polyacrylic acid gel (SPAG) was synthesized via simultaneous polymerization of acrylic acid and in situ reduction of silver nitrate in the presence of amidodiols. Reduction process in the presence of SPAG exhibited a first-order reaction with a lower activation energy path (28.0, 30.7, and 33.8 kJ/mol for *p*-nitrophenol, *o*-nitrophenol, and *m*-nitrophenol, respectively) and the reduction mechanism was found to be obeying the Langmuir-Hinshelwood model (Sudha *et al.*, *Ind. Eng. Chem. Res.*, **2015**, *54*, 1197-203).





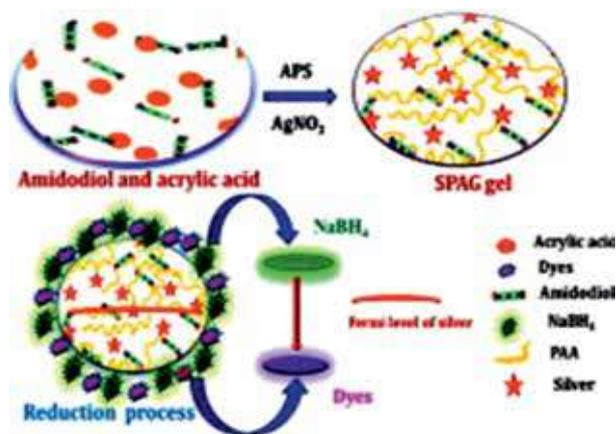
## Facile bioanchoring strategy for the preparation of hierarchical multiple structured ZnO crystals and its application as a photoanode in dye sensitized solar cells



A facile bioanchoring strategy for controlling the crystal growth process of ZnO crystals during calcination to form hierarchical multiple structures was demonstrated. Crystalline phase and morphology of ZnO was investigated using X-ray diffraction, scanning electron microscopy, transmission electron microscopy, and atomic force microscopy. Results revealed the evolution of ZnO nanocrystallites from nanosize to hierarchical self-assembly of polydispersed microstructures of bars/sheets/spheres/hollow spheres in wurzite hexagonal phase. ZnO exhibited photoluminescence attributed to the presence of various defects which was further supported by Raman spectroscopy and energy-dispersive X-ray spectroscopy. On the basis of the various experimental results, a plausible growth mechanism for the formation of multiple structures of ZnO crystals was proposed. The application of the polydispersed sub-micrometer sized ZnO crystals as photoanode in dye sensitized solar cells for improving the power conversion efficiency (5.3%) was demonstrated through high dye loading and enhanced light absorption edge via inherent light reflection mechanism (Sudha *et al.* *J. Phys. Chem. C*, **2014**, *118* (34), 19529–39).

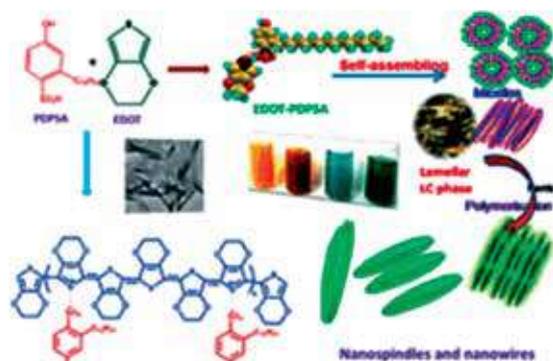
## Robust fibrillar nanocatalyst based on silver nanoparticles entrapped polymeric hydrogel

Robust fibrillar network of hydrogels entrapped with silver nanoparticles were prepared by *in situ* polymerization of acrylic acid and reduction of silver nitrate using amidodiol as cross-linking cum reducing agent under ambient conditions. Further, catalytic activities of SPAGs were studied using dyes such as methylene blue, rhodamine 6G and crystal violet. Effects of temperature and pH on the reduction process were studied. The activation energy for the reduction process was calculated and found to be decreased by 10 kJ/mol in the SPAG-catalysed reaction. In addition, SPAGs showed excellent reusability, easy separation, high rate constant and absence of induction period. All these results suggested SPAGs as a promising catalyst for the reduction of organic molecules (Rao *et al.*, *Applied Catalysis A: General*, **2014**, *483*, 31–40).



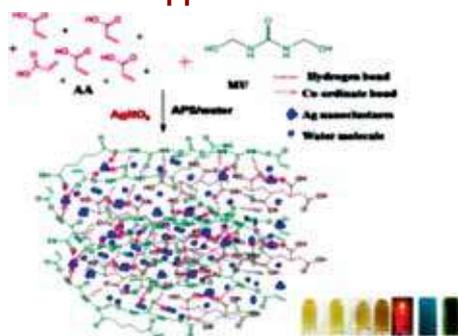
## Water dispersible electrically conductive poly(3,4-ethylenedioxythiophene) nanospindles by liquid crystalline template assisted polymerization

An inimitable liquid crystalline template strategy for the preparation of water dispersible electrically conducting poly(3,4-ethylenedioxythiophene) nanospindles (PEDOTs) has been attempted. PEDOTs



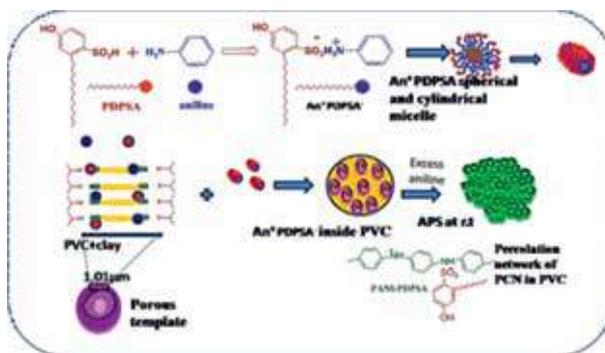
were formed during the polymerization of the spindle shaped liquid crystalline phase of "EDOT-PDPSA" which was formed by the specific interactions of 3,4-ethylene-dioxythiophene (EDOT) with 3-pentadecyl phenol-4-sulphonic acid (PDPSA). Liquid crystalline phases were characterized by polarized light microscopic analyses, rheology and XRD. Morphology and solid state ordering of conducting nanospindles were characterized by SEM, TEM and XRD. PEDOTs exhibited an electrical conductivity of  $\approx 2.79 \text{ S cm}^{-1}$  and a good thermal stability ( $\approx 300^\circ \text{C}$ ), which suggests their applicability in fabricating high temperature electronic devices. Furthermore, electrochemical studies of PEDOTS modified glassy carbon electrodes (GCEs) showed an oxidation peak of ascorbic acid at a lower potential of 0.046 V with a peak current about 10 times (91.68  $\mu\text{A}$ ) higher than that of the bare GCE with excellent electrode stability, proposing that it can be used as a steady electrode for the electro-catalytic oxidation of similar molecules (Sudha *et al.*, *J. Mater. Chem. C*, **2014**, 2, 6991-7000).

### Electrically conducting silver-polyacrylic acid hydrogel by *in situ* reduction and polymerisation approach



Electrically conducting hydrogel nanocomposite based on silver nanoparticles-polyacrylic acid has been prepared by *in situ* polymerization of acrylic acid and reduction of silver ions using methylol urea as a gelling cum reducing agent at room temperature. Effect of silver ion concentration on the optical properties, morphology and conductivity was studied. Swelling dependent electrical conductivity results suggested that these hydrogels can be considered as a promising candidate in many advanced technological applications such as nanoelectronic devices, electric field controlled artificial muscles and so forth (Sudha *et al.*, *Materials Letters*, **2014**, 116, 135-38).

### Percolated conductive polyaniline-clay nanocomposite in polyvinyl chloride through the combined approach porous template and self-assembly



Demonstrated a novel strategy for the preparation of conductive polyaniline-clay nanocomposite in polyvinylchloride (PVC) matrix by admicellar emulsion polymerization using a low cost renewable resource based surfactant cum dopant. The highly oriented percolated network of polyaniline-clay nanocomposite in PVC matrix was revealed from the studies made by scanning electron microscopy (SEM) and atomic force microscopy (AFM). Fourier transform infrared spectroscopy (FTIR) results suggested that porous template was formed by the noncovalent interactions among the hydroxyl groups present in the nano-clay



edges and the chloride ions present in PVC matrix. Here, the bio-based surfactant, 4-hydroxy-2-pentadecylbenzene-1-sulphonic acid (PDPSA) performed multiple roles of dopant, emulsifier and soft template during the polymerization of anilinium<sup>+</sup>PDPSA<sup>-</sup> in PVC-clay matrix. The prepared composite exhibited electrical conductivity ( $\sigma$ ) of  $4.8 \cdot 10^{-2}$  S/cm and electromagnetic interference shielding efficiency (EMI SE) of 55.2 dB suggesting it as a prospectable candidate for the encapsulation of electronic devices in high technological applications (Sudha *et al.* *EXPRESS Polymer Letters*, **2014**, 8(2), 107-15).

### Pragmatic approach to methyl methacrylate based solid polymer electrolyte processing: A case study for electrochromism

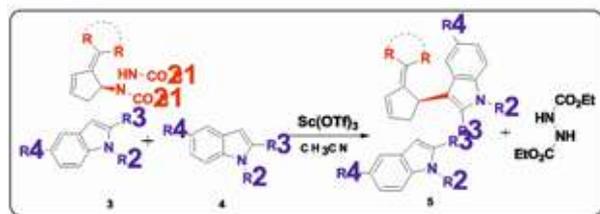
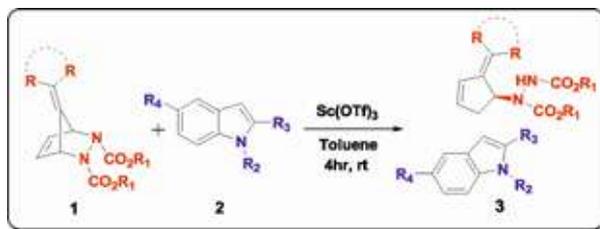


Development of inexpensive and flexible solid polymer electrolytes (SPEs) is critically important for the cost-effective electrochromic device (ECD) fabrication. The SPEs are also an integral part of the flexible ECDs which are projected to boost up the ECD's usability in several unexplored areas. Polymethyl methacrylate (PMMA) based aprotic salt (LiClO<sub>4</sub>) containing SPEs were synthesized, which were more or less electrochemically benign in the normal ECD operational voltage window. Experiments verified that the developed SPEs have good luminous clarity (transmittance > 92%), high ionic conductivity of the order of  $10^{-4}$  S/cm and excellent dimensional stability, all of which are required for the ideal ECD operations. Impedance spectroscopy showed an enhancement in the ionic conductivity and decrease in the solid elec-

trolyte interface (SEI) resistance with increasing salt loading. Two different device configurations using these SPEs were fabricated and then subjected to detailed electrochemical studies. Comprehensive analysis established long term cyclic durability of the SPEs. Prototype ECDs fabricated using these SPEs rendered excellent optical modulation and coloration reversibility (Deb *et al.*, *Solar Energy Materials and Solar Cells*, **2015**, 140, 17-24).

### Lewis acid catalyzed C-3 alkylidenecyclopentenylolation of indoles: An easy access to functionalized indoles and bisindoles

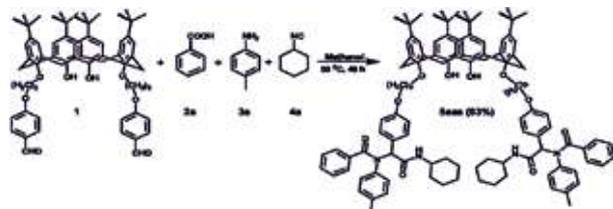
Production of trans 3,4-disubstituted alkylidenecyclopentene<sub>3</sub> by Lewis acid catalyzed stereoselective ring-opening of pentafulvene derived diazabicyclic olefins **1** with various substituted indoles **2** was in accordance with the previous results. Because of the high demand of bis-indoles and its derivatives in multiple therapeutic areas, the reaction condition was tuned by changing the equivalence of the substrates to obtain a general protocol for the synthesis of bis-indoles and succeeded in complete conversion of the starting material to bis-indole<sub>5</sub> (Radhakrishnan *et al.* *RSC Advances*, **2015**, 5, 38075).





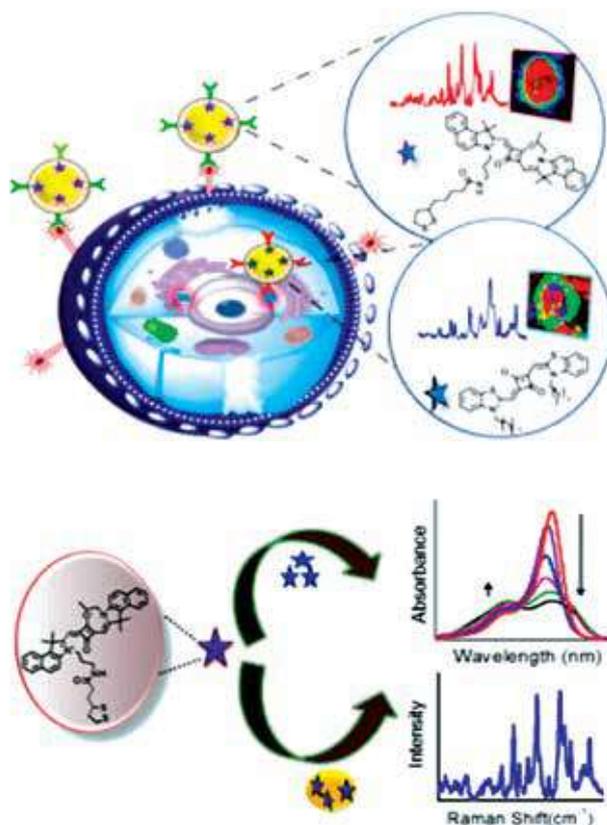
## Narrow-rim functionalization of calix[4]arenes through Ugi-4CR: Synthesis of a series of calix[4]arene peptoids

Calix[n]arenes are the most readily available synthetic molecular baskets that enjoy a considerable reputation for being applied in diverse areas. Among the various calix[4]arene derivatives, those adorned with multivalent groups such as peptides or peptide-like motifs are attractive in host-guest chemistry since they provide a variety of functional groups that can interact with guest molecules through hydrogen-bonding, electrostatic and van der Waals interactions. An operationally simple multi component synthetic route was demonstrated for the lower rim functionalization of calix[4]arene towards a new series of peptoid derivatives which accommodate rich multivalent groups that could find potential applications in supramolecular chemistry. Usage of Ugi-4 component reaction for the one-pot synthesis of these calixarene derivatives was demonstrated successfully. (Luxmi Varma *et al. J. Org. Chem.*, **2014**,79, 1683-89).



## Aggregation induced Raman scattering of squaraine dye: Implementation in diagnosis of cervical cancer dysplasia by SERS imaging

Squaraine dye aggregation that reflects on surface enhanced Raman signal scattering (SERS) intensity upon adsorption on nano-roughened gold surface has been investigated. Series of six squaraine dyes were synthesized consisting of two different electron donating moieties *i.e.* 1,1,2-trimethyl-1H-benzo[e]indole

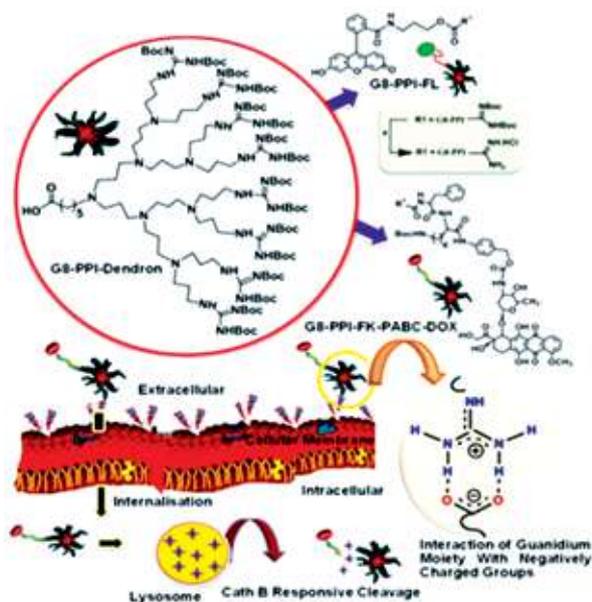


and 2-methylbenzo[d]thiazole which modulates the chemisorptions and hydrophobicity being designated as SQ1, SQ2, SQ3, SQ4, SQ5 and SQ6. Interestingly, SQ2 (monolipoic acid appended), SQ5 and SQ6 (conjugated with hexyl and dodecyl side chain) squaraine derivatives having more tendency of aggregation in DMSO-water mixed solvents showed significant increase of Raman scattering in the fingerprint region when chemisorbed on spherical gold nanoparticles. Two sets of SERS nanotags were prepared with colloidal gold nanoparticle (Au-NPs size: 40nm) by incorporating Raman reporters SQ2 and SQ5 followed by thiolated PEG encapsulation (SH-PEG, SH-PEG-COOH) denoted as AuNPs-SQ2-PEG and AuNPs-SQ5-PEG. Further conjugation of these nanotag with monoclonal antibodies specific to over expressed receptors, EGFR and p16/Ki-67 in cervical cancer cell, HeLa showed prominent SERS mapping intensity and selec-



tivity towards cell surface and nucleus. The fast and accurate recognition obtained by antibody triggered SERS-nanotag has been compared with conventional time consuming immuno-cytochemistry technique which prompted to extend further investigation using real patient cervical smear sample for a non-invasive, ultrafast and accurate diagnosis (Maiti *et al.*, *Biosensors and Bioelectronics*, **2015**,70,145-52).

### Novel lysosome targeted molecular transporter built on guanidinium-poly-(propenyl)imide hybrid dendron for efficient delivery of doxorubicin into cancer cells



An efficient synthetic approach to construct new dendron-based octa-guanidine appended molecular transporter with lysosomal targeted peptide-doxorubicin conjugate was introduced. Transporter alone (G8-PPI-FL) was found to be non-toxic, showed higher cellular uptake compared to Arg-8-mer, exhibited excellent selectivity towards lysosome in cathepsin B expressing HeLa cells, while DOX-conjugate showed significant cytotoxicity (Maiti *et.al.*, *Chem. Commun.* **2015**, 51, 2403-06).

### Bioactives & Natural Products Research

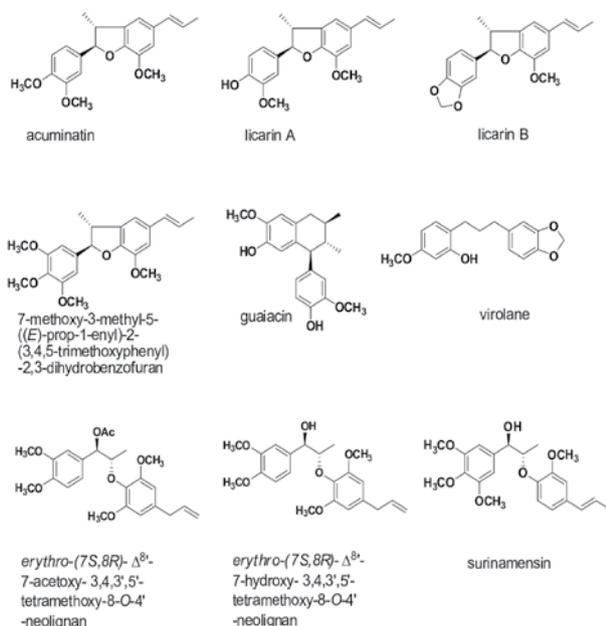
Plants have been the source of food, medicine and fuel, since time immemorial. They constitute the most inevitable part of human life and form the basis of various traditional systems of medicine as well as that of modern medicine all around the world. Phytochemical investigation of plants which are used in traditional systems of medicine has gained great interest in recent years since they are already proven to contain bio active compounds in them. Accordingly, CSIR-NIIST has a very active programme in this area.

*Myristica fragrans* Houtt, belonging to Myristicaceae family, is a well-known spice and is commonly used in traditional systems of medicine in almost all countries around the world. Known as "nutmeg", it includes the two spices, viz., *mace* and *nutmeg*. Nutmeg is the seed kernel inside the fruit and mace is the red lacy covering (aril) on the kernel. Nutmeg has been shown to possess analgesic, antifungal, antimicrobial, anti-inflammatory as well as hepatoprotective activities in various *in vitro* and *in vivo* studies.

About 30 nonvolatile compounds have been reported from seed and mace of *M. fragrans* so far. Among these, licarin A has been found to have anti-tuberculosis activity while guaiacin has been found to have anti-cancer activity. Several neolignans isolated from the seeds and maces have shown antibacterial activity too. Even though mace and seed of *M. fragrans* have been studied for their bioactive compounds, the fruit pericarp has not been investigated earlier in terms of their phytochemical constituents. Ten compounds have now been isolated from the fruit pericarp of *M. fragrans* whose structures are given below. Of these, virolane and surinamensin are being isolated for the first time from *M. Fragrans* (Mangalam S. Nair, *Nat. Prod. Res.* 2014, 28, 1664-68).

*M. fragrans* fruit showing pericarp

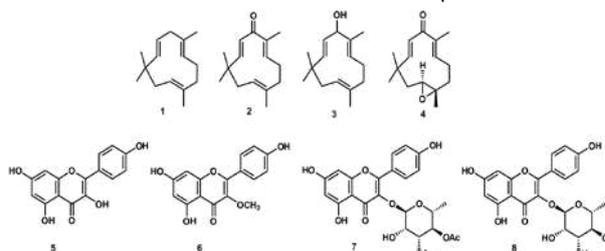
Seed and mace

Structures of compounds isolated from *M. fragrans*

### Studies on $\alpha$ -glucosidase, aldose reductase and glycation inhibitory properties of sesquiterpenes and flavonoids of *Zingiber zerumbet* Smith

Eight known phytochemicals, four sesquiterpenes and four flavonoids of *Zingiber zerumbet* were screened against  $\alpha$ -glucosidase enzyme, aldose reductase enzyme and antiglycation property under *in vitro* conditions. The results established kaempferol-3-*O*-methyl ether as a potent inhibitor of  $\alpha$ -glucosidase enzyme with an  $IC_{50}$  value of 7.88  $\mu$ M. In aldose reductase enzyme inhibition assay, all the compounds except zerumbone epoxide showed good to excellent inhi-

bition properties. Among these, the flavonoid compounds were found to be potent aldose reductase inhibitors compared to the four sesquiterpenes. On the other hand compounds such as  $\alpha$ -humulene, kaempferol, kaempferol-3-*O*-methylether and 3'',4''-*O*-diacetylafzelin displayed potent antiglycation properties. From overall results, it was found that kaempferol and kaempferol-3-*O*-methylether were potent inhibitors of  $\alpha$ -glucosidase enzyme, aldose reductase enzyme and glycation reaction, the three main targets of drugs for the treatment of diabetes and its complications.



Structures of isolated compounds 1-8

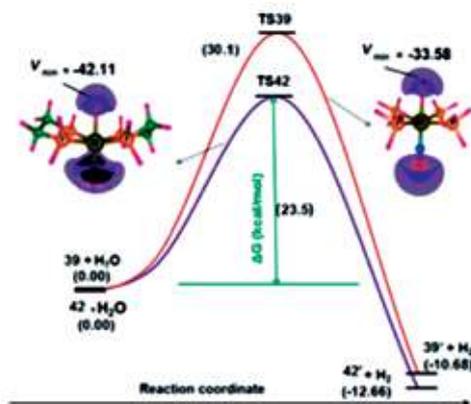
### CeO<sub>2</sub>-MWCNT nanocomposite based electrochemical sensor for acetaldehyde

A new, highly sensitive and selective electrochemical sensor with CeO<sub>2</sub>-MWCNT nanocomposite film, which enhances the sensing platform to detect acetaldehyde was developed. The chemically synthesised CeO<sub>2</sub> nanoparticles were subjected to adsorb on MWCNT. Thus prepared nanocomposite was characterized by XRD, SEM and impedance spectroscopy. Drop cast method was employed in the preparation of CeO<sub>2</sub>-MWCNT modified glassy carbon electrode by cyclic voltammetry. Under optimal conditions, the developed sensor detected acetaldehyde in the concentration range of 10<sup>-8</sup> – 10<sup>-5</sup> M with a detection limit of 7.4 × 10<sup>-9</sup> M accompanied with a good precision of 1.6% at 10<sup>-6</sup> M of acetaldehyde. Moreover, it exhibited reasonably good selectivity towards acetaldehyde in conjunction with different co-existing organic species and was successfully applied to synthetic fruit juice samples (Rao *et al.*, *Anal. Methods*, **2015**,7, 4912-18).

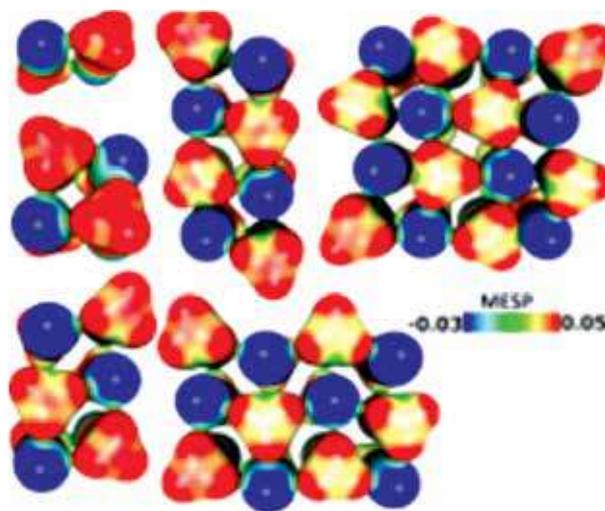


## Designing metal hydride complexes for water splitting reactions: A molecular electrostatic potential approach

The hydridic character of octahedral metal hydride complexes of group VI, VII and VIII has been systematically studied using molecular electrostatic potential (MESP) topography. The absolute minimum of MESP at the hydride ligand ( $V_{\min}$ ) and MESP value at the hydride nucleus ( $V_H$ ) were found to be very good measures of the hydridic character of the hydride ligand. The increasing/decreasing electron donating feature of the ligand environment was clearly reflected on the increasing/decreasing negative character of  $V_{\min}$  and  $V_H$ . The formation of an outer sphere metal hydride-water complex showing H...H dihydrogen interaction was supported by the location and value of  $V_{\min}$  near the hydride ligand. A higher negative MESP suggested lower activation energy for  $H_2$  elimination. Thus, MESP features provided a way to fine tune the ligand environment of a metal-hydride complex to achieve high hydricity for the hydride ligand. The applicability of MESP based hydridic descriptor in designing water splitting reactions was tested for group VI metal hydride model complexes of tungsten (Suresh, *et al. Dalton Trans.*, **2014**, 43, 12279–87).



## Cooperativity and cluster growth patterns in acetonitrile: A DFT study



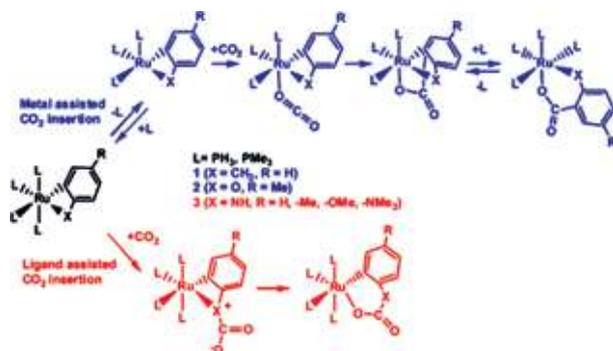
Cooperativity in intermolecular interactions and cluster growth patterns of acetonitrile has been studied using M06L density functional theory. Cyclic, ladder-type, stacked, cross-stacked, and mixed patterns were studied. Total interaction energy ( $E_{\text{int}}$ ) and interaction energy per monomer ( $E_m$ ) showed maximum stability and cooperativity in stacked clusters followed by cross-stacked ones. As cluster size increased, magnitude of  $E_m$  showed significant increase. Compared to  $E_m$  of dimer ( $-2.97$  kcal/mol), the increase is 2.6-fold for 27mer. Higher stabilization in larger clusters was attributed to strong cooperativity in intermolecular C—H...N and dipolar interactions. Enhanced cooperativity in stacked structures is supported by atoms-in-molecule electron density ( $\rho$ ) data. Sum of  $\rho$  at intermolecular bond critical points was the highest for stacked clusters. Further, area of negative-valued molecular electrostatic potential was linearly related with  $E_{\text{int}}$  and showed the lowest value in stacked followed by cross-stacked clusters, indicating maximum utilization of lone pair density and maximum cooperativity in such growth patterns. A red shift in



the average C—N stretching frequencies with increase in the number of monomers and its direct correlation with  $E_{\text{int}}$  in stacked clusters also supported their stability. Further, two known crystal patterns of acetonitrile ( $\alpha$  and  $\beta$ ) with 16 monomers were optimized and compared with the most stable hexadecamer pattern and were found to show lower values for  $E_{\text{int}}$  and  $E_m$  compared to the latter. Based on this result, the existence of a third crystal pattern for acetonitrile was predicted which will be more ordered and more stable than  $\alpha$  and  $\beta$  forms (Suresh *et al. J. Comput. Chem.* **2014**, *35*, 910–22).

### Metal and ligand assisted CO<sub>2</sub> insertion into Ru–C, Ru–N, and Ru–O bonds of ruthenium(II) phosphine complexes: A density functional theory study

The CO<sub>2</sub> insertion reactions of [L<sub>4</sub>Ru( $\eta^2$ -CH<sub>2</sub>C<sub>6</sub>H<sub>4</sub>)] (1), [L<sub>4</sub>Ru( $\eta^2$ -OC<sub>6</sub>H<sub>3</sub>Me)] (2), and [L<sub>4</sub>Ru( $\eta^2$ -NHC<sub>6</sub>H<sub>4</sub>)] (3), where L = PH<sub>3</sub> and PMe<sub>3</sub>, were modelled using density functional theory methods. In 1 and 2, the metal-assisted CO<sub>2</sub> insertion occurred because of the favourable initial axial phosphine dissociation mechanism, whereas in 3, the ligand (NHC<sub>6</sub>H<sub>4</sub>)-assisted mechanism operated ( $\Delta G = +19.0$  kcal/mol), wherein



the nucleophilic affinity of the –NHC<sub>6</sub>H<sub>4</sub> moiety aided the CO<sub>2</sub> insertion process. The modelled mechanisms were consistent with the experimental findings by Hartwig *et al. (J. Am. Chem. Soc.* **1991**,

113, 6499), in which the rate of the reactions of 1 and 2 depended on the added phosphine concentration, whereas the rate of the reaction of 3 was independent of the added phosphine concentration. In 1 and 2, CO<sub>2</sub> was preferably inserted into the Ru–C<sub>aryl</sub> bond rather than the competitive Ru–CH<sub>2</sub> and Ru–O bonds, respectively. In 1, the  $\pi$ -type orbital interaction of the aryl ring with the metal center was found to stabilize the transition state for Ru–C<sub>aryl</sub> bond insertion ( $\Delta G^\ddagger = +25.7$  kcal/mol). In 2, the Ru–C<sub>aryl</sub> insertion ( $\Delta G^\ddagger = +23.0$  kcal/mol) was thermodynamically preferred, while the kinetically preferred Ru–O bond insertion ( $\Delta G^\ddagger = +17.4$  kcal/mol) was highly reversible. The more electron-donating and sterically bulky PMe<sub>3</sub> facilitated the CO<sub>2</sub> insertion of 1 and 2 because the initial dissociation of axial PMe<sub>3</sub> was easier than that of PH<sub>3</sub> by ca. +11.0 kcal/mol, whereas in the case of 3, the effect of PMe<sub>3</sub> slightly increased the  $\Delta G^\ddagger$  value of 3. The increase in the nucleophilic affinity of amido nitrogen in 3 and the increase in the polarity of the solvent decreased the  $\Delta G^\ddagger$  value of 3 by 48%. The inclusion of the chelating dimethylphosphinoethane ligand in 3 along with the electron-donating substituent at the –NHC<sub>6</sub>H<sub>4</sub> moiety and the polar solvent further reduced the  $\Delta G^\ddagger$  value of 3 by 62%, which demonstrated the role of the chelating ligand, electron-donating substituent, and polar solvent in the ligand-assisted CO<sub>2</sub> insertion reactions (Suresh *et al. Inorg. Chem.* **2015**, *54*, 502–12).

### Equivalence of ethylene and azo-bridges in the modular design of molecular complexes: Role of weak interactions

Structural equivalence is a general tool applied in crystal engineering for the predictable construction of molecular assemblies. The equivalence of azo (–N=N–) and ethylene (–C=C–) bridges in the



modular design of organic assemblies was analysed by studying 22 molecular complexes of 4,4'-azopyridine and 1,2-bis(4-pyridyl)ethene. Unit cell similarity index ( $\Pi$ ), as a numerical descriptor, was used to rationalize the observed equivalence/variance in the crystal packing of related complexes. A combined structural chemistry, database analysis and computational methods unveiled the fact that the identity of the primary synthons alone does not ensure iso-structurality; instead a concurrent effect of the contributions from both strong and weak/dispersive forces determined the structural equivalence. A statistical analysis based on a Cambridge Structural Database survey features an apparent inverse correlation that exist between N...I and I-I bond distances; a group of data points, however, deviate from this linear relation and was accounted on the basis of electrostatic potential distribution and interaction types (Sunil Varghese, *Cryst. Growth Des.* **2015**, *15*, 2389).



## MATERIAL SCIENCE AND TECHNOLOGY DIVISION

The R&D programmes of Material Science and Technology Division has mainly focused on the development of advanced functional materials and components for strategic, automobile, energy and societal applications. The major research areas during the period 2014-15 were (i) Inorganic colorants with high NIR reflectance for energy saving applications, (ii) Photoluminescent materials for white light emitting diode and bio- medical applications, (iii) Porous ceramic materials for CO<sub>2</sub> adsorption, (iv) Non-wetting ceramic materials, (v) Nano photo catalysts for dye-degradation, (vi) New low temperature co-fired ceramics substrates through tape casting, (vii) Magnetic and magneto refrigeration materials, (viii) Polymers and polymer nano-composites, (ix) Beneficiation of minerals and value addition to the industrial slag and (x) Aluminium and magnesium alloys and composites for strategic and automobile applications.

The members of the division have published 68 papers in SCI Journals, one book chapter and were granted 3 foreign patents. Some of the research highlights of the division during the period are given below:

### Highlights

- A new series of environment friendly intense yellow, blue, red and green inorganic pigments with high infrared reflectance for cool roof and surface coating applications.
- Rare-earth activated phosphor materials for white light emitting diode applications
- Developed a promising green packaging material - biodegradable ZnO / gelatin hybrids
- Developed a lanthanum phosphate coatings and monoliths for non-wetting surfaces for water and molten metals
- Development of hydrogen titanate nanotubes based nanocomposite as magnetically recyclable catalyst for dye-removal application
- Designed a new microelectronic substrate material through tape casting
- Development of porous ceramics based on alkali silicates for CO<sub>2</sub> adsorption
- Developed a green approach for the growth of silver nanoflowers for efficient plasmonic resonance catalyst platforms
- Development of thermally stable flame retardant materials based on LDH incorporated isotactic polypropylene nano composites
- A facile method for preparation of mesocrystals of superparamagnetic magnetite nanoparticle assembly was developed
- Beneficiations of Orissa grade ilmenite for high grade synthetic rutile
- Pyro and hydro treatment on waste iron oxide from titanium mineral industries through de-acidification and de-chloridisation for pigment applications
- Studies on the effect of addition of magnesium on modifying efficiency of strontium in A356 alloy
- Development of functionally graded aluminium composites for automotive pistons
- Adduct modified nano-clay dispersed polystyrene nanocomposites as advanced anticorrosive coatings for aluminium alloys



## पदार्थ विज्ञान तथा प्रौद्योगिकी प्रभाग

पदार्थ विज्ञान तथा प्रौद्योगिकी प्रभाग के अनुसंधान एवं विकास कार्यक्रम, मुख्य रूप से, सामरिक, ऑटोमोबाइल, ऊर्जा और सामाजिक अनुप्रयोगों के लिए उन्नत कार्यात्मक सामग्री और उपकरणों के विकास पर केंद्रित हैं। वर्ष 2014-15 की अवधि के दौरान अनुसंधान के प्रमुख क्षेत्र थे- (i) ऊर्जा की बचत अनुप्रयोगों के लिए उच्च एनआईआर परावर्तकता के साथ अकार्बनिक कोलोरेन्ट्स (ii) सफेद प्रकाश उत्सर्जक डायोड और जैव चिकित्सा अनुप्रयोगों के लिए प्रकाश संदीप्तिशील सामग्री, (iii) कार्बन डाइ ऑक्साइड अवशोषण के लिए पोरस चीनी मिट्टी सामग्री (iv) गैर आर्द्र सिरैमिक सामग्री (v) डार्ड-क्षरण के लिए नैनो फोटो उत्प्रेरक (vi) टेप कास्टिंग के माध्यम से नए कम तापमान को-फायेर्ड सिरैमिक्स क्रियाधार (vii) मैग्नेटिक और मैग्नेटो प्रशीतन सामग्री (viii) पॉलिमर और पॉलिमर नैनो कंपोजिट (ix) खनिजों का इष्टतमीकरण और औद्योगिक लावा के लिए मूल्य संवर्धन और (x) सामरिक और ऑटोमोबाइल अनुप्रयोगों के लिए एल्यूमिनियम और मैग्नीशियम मिश्र धातु और कंपोजिट।

प्रभाग के सदस्यों ने एससीआई पत्रिकाओं में 68 शोध पत्रों और पुस्तक के एक अध्याय का प्रकाशन किया है और उन्हें 3 विदेशी पेटेंट प्रदान किये गये हैं। इस अवधि के दौरान प्रभाग की गतिविधियों की कुछ मुख्य विशेषताएं निम्न हैं:-

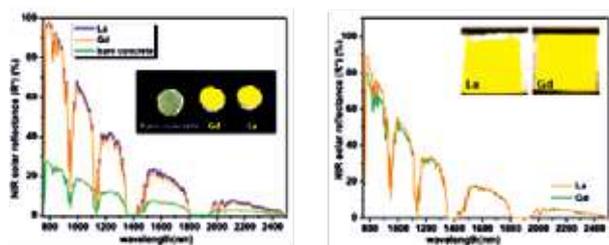
### मुख्य विशेषताएं

- शीतल छत और सतह कोटिंग अनुप्रयोग के लिए उच्च अवरक्त परावर्तन के साथ पर्यावरण के अनुकूल तीव्र पीले, नीले, लाल और हरे रंग के अकार्बनिक पिगमेंट्स की एक नई श्रृंखला
- सफेद प्रकाश उत्सर्जक डायोड अनुप्रयोग के लिए दुर्लभ पृथ्वी सक्रिय फॉस्फोर सामग्री
- एक होनहार ग्रीन पैकेजिंग सामग्री- जैव-निम्नीकरणीय जिंक ऑक्साइड / जिलेटिन संकर का विकास किया
- पानी और पिघले हुये धातुओं के लिए गैर आर्द्र सतहों के लिए लेण्टेनियम फॉस्फेट कोटिंग्स और मॉनोलिथ्स विकसित किया
- डार्ड हटाने के अनुप्रयोग के लिए मैग्नेटिक रूप से पुनः चक्रण योग्य उत्प्रेरक के रूप में नैनो कम्पोजिट आधारित हाइड्रोजन टाइटेनेट नैनोट्यूब का विकास
- टेप कास्टिंग के माध्यम से एक नई माइक्रोइलेक्ट्रॉनिक सबस्ट्रेट सामग्री का डिज़ाइन किया
- कार्बन डाइ ऑक्साइड अवशोषण के लिए अल्कली सिलिकेट पर आधारित पोरस सिरैमिक्स का विकास
- कुशल प्लेजमॉनिक अनुनाद उत्प्रेरक प्लेटफार्मों के लिए सिल्वर नैनोफ्लवर्स के विकास के लिए एक हरी दृष्टिकोण विकसित किया
- एलडीएच शामिल एसोटेक्टिक पॉलीप्रोपाइलिन नैनो कंपोजिट्स पर आधारित तापीय स्थिर ज्वाला मंदक सामग्रियों विकसित की
- सुपरपैरामैग्नेटिक मैग्नेटाइट नैनोकण समुच्चय के मेसोक्रीस्टल की तैयारी के लिए एक सरल विधि विकसित की गयी
- उच्च ग्रेड सिंथेटिक रूटाइल के लिए उड़ीसा ग्रेड इल्मेनाइट का इष्टतमीकरण
- डी-अम्लीकरण के माध्यम से टाइटेनियम खनिज उद्योगों से बेकार लोहे आक्साइड पर पाइरो और जल उपचार और पिगमेंट अनुप्रयोग के लिए डी-क्लोरीडाइजेशन
- A356 मिश्र धातु में स्ट्रॉटियम की संशोधित दक्षता पर मैग्नीशियम के संयोजन के प्रभाव पर अध्ययन
- मोटर वाहन पिस्टन के लिए कार्यात्मक वर्गीकृत एल्यूमिनियम कंपोजिट का विकास
- एल्यूमिनियम मिश्र धातु के लिए उन्नत एंटी संक्षारक कोटिंग्स के रूप में योगोत्पाद संशोधित नैनो मिट्टी परिक्षिप्त पॉलिस्टाइरीन नैनो कंपोजिट



## MULTIFUNCTIONAL INORGANIC PIGMENTS

### Brilliant IR reflecting yellow colorants in rare earth double molybdate substituted $\text{BiVO}_4$ solid solutions



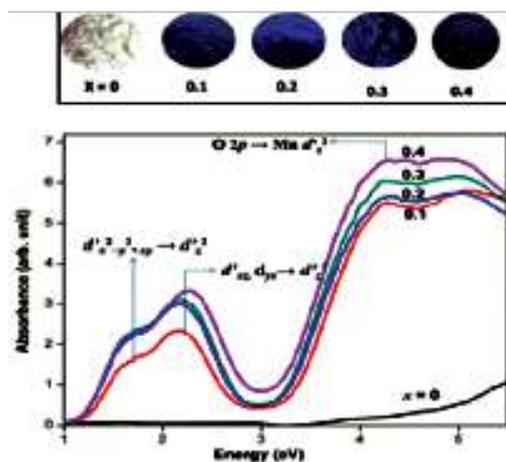
IR solar reflectance spectra of  $\text{Li}_{0.10}\text{RE}_{0.10}\text{Bi}_{0.8}\text{Mo}_{0.2}\text{V}_{0.8}\text{O}_4$  pigments; RE = La,

Gd coated over (a) concrete cement surface and (b) metal panel.

Brilliant IR reflecting yellow colorants are developed in rare earth double molybdate substituted  $\text{BiVO}_4$  solid solutions.  $\text{Li}_{0.10}\text{RE}_{0.10}\text{Bi}_{0.8}\text{Mo}_{0.2}\text{V}_{0.8}\text{O}_4$  (RE = La, Pr, Sm, Gd, Tb, Dy, Y, Yb and Lu) pigments were prepared by a conventional solid-state reaction route and their optical, structural and morphological properties were analyzed. X-ray diffraction analysis confirmed the tetragonal scheelite phase formation in the series. These pigments have a strong optical absorption in the UV-blue light wavelength region. CIE LAB color analysis showed different hues of yellow shades. The color characteristics were comparable to commercial  $\text{BiVO}_4$  pigment. Incorporation of double rare earth molybdates of La, Gd, Tb, Y and Lu into  $\text{BiVO}_4$  resulted in non toxic IR reflecting cool pigments. The applicability of the developed pigment was tested on a concrete cement surface as well as on a metal panel. These pigments comprise of less toxic elements that make them favorable for energy saving surface coating formulations for buildings and automobiles (P Prabhakar Rao et al. *ACS Sustainable Chemistry & Engineering* 2015, 3, 1227-33).

### Monoclinic $\text{LaGa}_{1-x}\text{Mn}_x\text{Ge}_2\text{O}_7$ : A new blue chromophore based on $\text{Mn}^{3+}$ in trigonal bipyramidal coordination with longer apical bond lengths

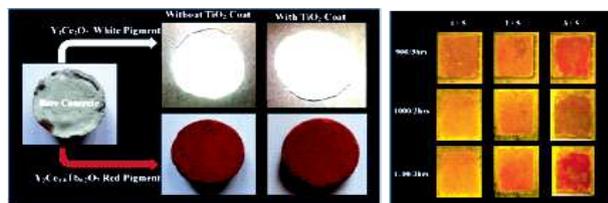
New blue inorganic oxide materials  $\text{LaGa}_{1-x}\text{Mn}_x\text{Ge}_2\text{O}_7$  were developed by a solid state reaction method. Substitution of  $\text{Mn}^{3+}$  in  $\text{LaGaGe}_2\text{O}_7$  changes the color from white ( $x = 0$ ) to blue ( $x = 0.1 - 0.4$ ). The blue color is due to the absorption in the energy region of 1.7- 2.5 eV. To understand the origin of this blue color, diffuse reflectance spectra was measured using UV-vis spectrometer. Coloring performance of  $\text{Mn}^{3+}$  bearing pigments depended on its co-ordination environment. Band gap of undoped  $\text{LaGaGe}_2\text{O}_7$  lies in the range of 3.3eV. When  $\text{Mn}^{3+}$  was introduced in the gallium site of  $\text{LaGaGe}_2\text{O}_7$ , two new absorption bands were observed in all doped samples. This absorption arises due to the symmetry-allowed optical transitions from  $d'_{(x-y,xy)} \rightarrow d'_z$  and  $d'_{(xz,yz)} \rightarrow d'_z$ , (symmetry forbidden transition) and the corresponding d-states hybridized with  $\text{O}_{2p}$  orbital. Usually the absorption spectra of  $\text{Mn}^{3+}$  in TBP site will give an intense absorption band in the 1.7eV region and a weak one around 2.1eV region. It was proposed that this effect is due to the presence of longer Mn-O apical bond length in  $\text{LaGa}_{1-x}\text{Mn}_x\text{Ge}_2\text{O}_7$  ( $x = 0.1$  to 0.4) (P Prabhakar Rao et al. *RSC Advances*, 2015, 5, 27278-81).





## Pigments based on terbium-doped yttrium cerate with high NIR reflectance for cool roof and surface coating applications

New class of intense red pigments with enhanced near infrared (NIR) reflectance of cubic yttrium cerate were obtained by the substitution of terbium ions into the cerium site of  $Y_2Ce_2O_7$  without any toxic metal ions like cadmium, lead, cobalt etc. Pigments of stoichiometric compositions:  $Y_2Ce_{2-x}Tb_xO_7$  ( $x = 0, 0.2, 0.4, 0.6, 0.8,$  and  $1.0$ ) were synthesized by a conventional solid state route. The Tb substitution extends the absorption edge to longer wavelengths by introducing an additional electronic level between the valence band and conduction band and exhibit various red colors by fine tuning the band gap from 3.11 eV (ivory white) to 1.87 eV (red). The applicability studies of these pigments in cement slab, and ceramic glazes exhibited good coloring performance with high near infrared reflectance. The exhibition of high NIR reflectance (80%) with comparable color properties of these pigments make them as potential NIR reflective red colorants for cool roof and surface coating applications (P Prabhakar Rao *et al.* *Dyes Pigments*, **2015**, 122, 116–25).

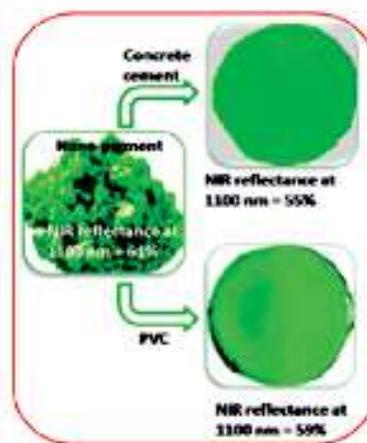


Photographs of a) pigment coated [white ( $x = 0$ ) and red ( $x = 0.2$ )] cement slab without and with  $TiO_2$  base coat in sequence b) glazed tile substrates for different amounts of  $Y_2Ce_{1.8}Tb_{0.2}O_7$  pigment powder calcined at different temperatures.

## Green colored nano-pigments derived from $Y_2BaCuO_5$ : NIR reflective coatings

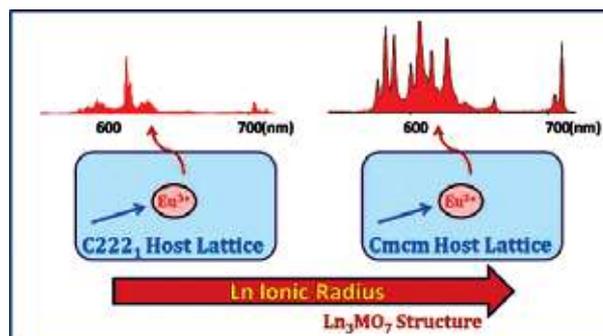
A green colored nano-pigment  $Y_2BaCuO_5$  with impressive near infra-red (NIR) reflectance (61% at 1100 nm) was synthesized by a nano-emulsion method. The XRD and Rietveld analyses of the designed pigment powders revealed the orthorhombic crystal structure for  $Y_2BaCuO_5$ , where yttrium was coordinated by seven

oxygen atoms with the local symmetry of a distorted trigonal prism, barium was coordinated by eleven oxygen atoms, and the coordination polyhedron of copper was a distorted square pyramid  $[CuO_5]$ . The UV-vis spectrum of the nano-pigment exhibited an intense d-d transition associated with  $CuO_5$  chromophore between 2.1 and 2.5 eV in the visible domain. Therefore, a green color has been displayed by the developed nano-pigment. The potential utility of the nano-pigments as "Cool Pigments" was demonstrated by coating on to a building roofing material like cement slab and PVC coatings. (Reddy *et al.*, *Dyes and Pigments*, **2014**, 107, 118-26).



## LUMINESCENT MATERIALS

### Effect of host structure on the photoluminescence properties of $Eu^{3+}$ doped $Ln_3TaO_7$ ( $Ln = La, Gd, Y, Lu$ ) red phosphors

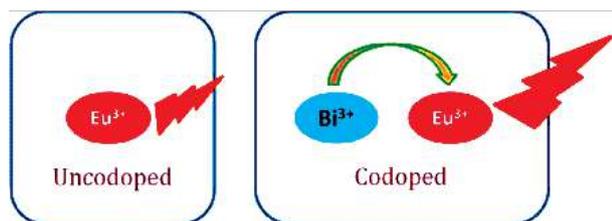


$Eu^{3+}$  doped  $Ln_3TaO_7$  ( $Ln = La, Gd, Y, Lu$ ) red phosphors were prepared using a solid state route. The  $Ln^{3+}$  substitution induces variation of crystalline struc-



ture from a defect fluorite to weberite types with increased ordering of the cations from Lu to La. These phosphors showed strong absorptions at near UV wavelength and emitted orange-red luminescence. The luminescence intensity and quantum efficiency were closely related to the degree of ordering of the cations in the lattice. The  $\text{Eu}^{3+}$  luminescence in  $\text{La}_3\text{TaO}_7$  embodied the structural variation through intense multiband  ${}^5\text{D}_0\text{-}{}^7\text{F}_{0,1,2,4}$  transitions to only dominant hypersensitive electric dipole  ${}^5\text{D}_0\text{-}{}^7\text{F}_2$  transition. All the  $\text{Eu}^{3+}$  emission transitions ( ${}^5\text{D}_0\text{-}{}^7\text{F}_{0,1,2,4}$ ) were more intense in  $\text{La}_3\text{TaO}_7$  host due to increased polarizability and covalent nature of  $\text{Eu}^{3+}$  bonding environment with the surrounding.

### Novel red phosphors $\text{Gd}_2\text{GaTaO}_7:\text{Eu}^{3+}$ , $\text{Bi}^{3+}$ for white LED applications

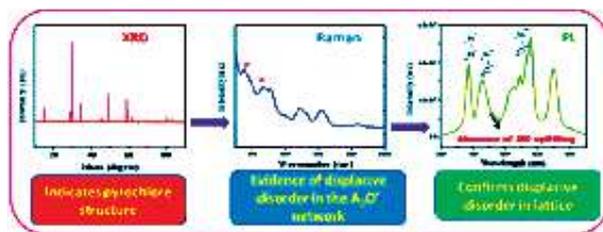


Novel red phosphor materials  $\text{Gd}_{2-x-y}\text{GaTaO}_7:\text{xEu}^{3+}$ ,  $\text{yBi}^{3+}$  were prepared using a high temperature solid state reaction route. Red shift in the charge transfer band coupled with increased emission intensity in the red region ~ 612 nm was observed with  $\text{Bi}^{3+}$  codoping. The prepared samples exhibited higher emission intensities than the standard  $\text{Y}_2\text{O}_3:\text{Eu}^{3+}$  red phosphors and thus these could be promising phosphors for White LED applications (P Prabhakar Rao *et al. J Mater Sci: Mater Electron*, **2015**, 26, 5743-47).

### Structural and photoluminescence properties of stannate based displaced pyrochlore-type red phosphors: $\text{Ca}_{3-x}\text{Sn}_3\text{Nb}_2\text{O}_{14}:\text{xEu}^{3+}$

A series of stannate based displaced pyrochlore type red emitting phosphors  $\text{Ca}_{3-x}\text{Sn}_3\text{Nb}_2\text{O}_{14}:\text{xEu}^{3+}$  were prepared by the conventional solid state reaction method. The influence of the partial substitution of Sn in both A and B sites of the pyrochlore-type oxides on the photoluminescence properties was studied in detail. The results demonstrated that displacive disorder

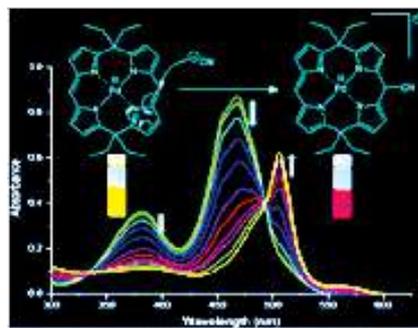
was not well evidenced by powder X-ray diffraction studies whereas Raman spectral studies indicate some amount of disorder in the lattice. Conversely photoluminescence studies exhibit intense multiband emissions due to  $\text{Eu}^{3+}{}^5\text{D}_0\text{-}{}^7\text{F}_{0,1,2}$  transitions. The absence of characteristic MD transition splitting confirms the local cation disorder in this type of displaced pyrochlores (P Prabhakar Rao *et al. Dalton Transactions* **2015**, 44, 8718-28).



### Photoluminescence studies of $\text{CaLaNbMoO}_8$ : $\text{Dy}^{3+}$ for full color emission phosphors

$\text{Dy}^{3+}$  doped  $\text{CaMoO}_4$  and  $\text{CaLaNbMoO}_8$  were synthesized using a high temperature solid state route. The photoluminescence properties of dysprosium activated  $\text{CaLaNbMoO}_8$  indicated two sharp emission peaks in the visible region. The yellow and blue emissions at 489 nm and 576 nm upon UV excitation resulted from the forced electric dipole transition of  ${}^4\text{F}_{9/2}\text{-}{}^6\text{H}_{13/2}$  and the magnetic dipole transition of  ${}^4\text{F}_{9/2}\text{-}{}^6\text{H}_{15/2}$  respectively.  $\text{Dy}^{3+}$  doped  $\text{CaLaNbMoO}_8$  under the excitation of near UV region could serve as a promising candidate for single-phase white-light emitting phosphor for application in WLEDs.

### Chemodosimetric cyanide sensing in a 5,15-porphodimethene Pd(II) complex

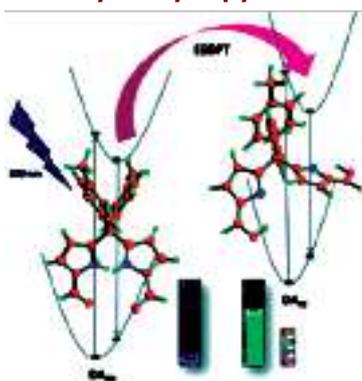


The Pd(II) complex of 5,15-porphodimethene has shown as a chemodosimetric sensor where it selectively senses cyanide ions,



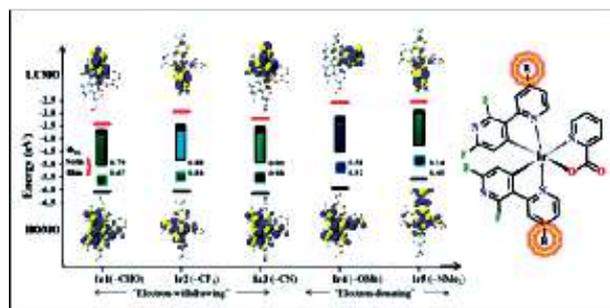
monitored through electronic spectral analysis and identified by the naked eye. The possible binding mechanism was also proposed based on the  $^1\text{H}$  NMR analyses. Two polymorphs of the mentioned complex were obtained by using different polar solvents and further confirmed by single crystal X-ray analyses. (Reddy *et al.*, *Chem. Commun.*, **2014**, 50, 10834-36).

### Photoenolization via excited state double proton transfer induces "turn on" fluorescence in diformyl diaryldipyrromethane



A light triggered enolization in diformyl diaryldipyrromethane by excited state dual proton transfer (ES-DPT) induces "turn on" fluorescence. The role of diaryl and diformyl groups in the enolization process was confirmed by photophysical and theoretical studies. (Reddy *et al.*, *Chem. Commun.*, **2014**, 50, 8667-69).

### Substituent effects on the photophysical and electroluminescent properties of bis(2',6'-difluoro-2,3'-bipyridinato-N,C4') iridium (picolinate) complexes



Series of 2',6'-difluoro-2,3'-bipyridine cyclometalating ligands were synthesized by substituting electron-withdrawing ( $-\text{CHO}$ ,  $-\text{CF}_3$ ,  $-\text{CN}$ ) and elec-

tron-donating ( $-\text{OMe}$ ,  $-\text{NMe}_2$ ) groups at the 4' position of the pyridyl moiety and utilized for the construction of five new iridium(III) complexes (Ir1-Ir5) in the presence of picolinate as an ancillary ligand. The photophysical properties of the developed iridium(III) compounds were investigated with a view to understand the substituent effects. The strong electron-withdrawing ( $-\text{CN}$ ) group containing iridium(III) compound (Ir3) exhibited highly efficient genuine green phosphorescence ( $\lambda_{\text{max}} = 508 \text{ nm}$ ) at room temperature in solution and in thin film, with an excellent quantum efficiency ( $\Phi_{\text{PL}}$ ) of 0.90 and 0.98, respectively. On the other hand, the  $-\text{CF}_3$  group substituted iridium(III) compound (Ir2) displayed a sky-blue emission ( $\lambda_{\text{max}} = 468 \text{ nm}$ ) with a promising quantum efficiency ( $\Phi_{\text{PL}} = 0.88$  and 0.84 in solution and in thin film, respectively). The  $-\text{CHO}$  substituted iridium(III) complex (Ir1) showed greenish-yellow emission ( $\lambda_{\text{max}} = 542 \text{ nm}$ ). Most importantly, the strong electron-donating  $-\text{NMe}_2$  substituted iridium(III) complex (Ir5) gave a structure less and a broad emission profile in the wavelength region 450 to 700 nm ( $\lambda_{\text{max}} = 520 \text{ nm}$ ) with a poor quantum efficiency. An intense blue phosphorescence with impressive quantum efficiency, especially in thin-film noted in the case of  $-\text{OMe}$  substituted iridium(III) complex (Ir4). Comprehensive density functional theory (DFT) and time-dependent DFT (TD-DFT) approaches have been performed on the ground and excited states of the synthesized iridium(III) complexes, in order to obtain information about the absorption and emission processes and to gain deeper insights into the photophysical properties. The combinations of a smaller  $\Delta E_{\text{S}_1\text{-T}_1}$  and higher contribution of  $^3\text{MLCT}$  in the emission process resulted in the higher quantum yields and lifetime values for complexes Ir1-Ir3. Multi-layered Phosphorescence organic light emitting diodes (PhOLEDs) were designed using the phosphorescent dopants Ir2, Ir3 and Ir4 and evaluated their electro luminescence properties. The compound Ir4 at a doping level of 5 wt% showed the best performance with an external quantum efficiency of 4.7%, in non-optimized device, and power efficiency of  $5.8 \text{ lm W}^{-1}$ , together with a true-blue chromacity  $\text{CIE}_{\text{x,y}} = 0.15, 0.17$  recorded at maximum brightness of  $33,180 \text{ cd/m}^2$ . (Reddy *et al.*, *J. Mater.Chem C*, **2015**, 3, 7405-20)



## POROUS CERAMIC MATERIALS: ENVIRONMENTAL APPLICATIONS

### Biodegradable ZnO / gelatin hybrids: - A promising green packaging material

Gelatin is a renewable biopolymer traditionally known for its excellent biocompatibility and biodegradability. Its poor antibacterial/antifungal/mechanical properties, and also inherent hydrophilic nature limit the industrial potential. In this work, functionally engineered gelatin bio hybrid was successfully designed that exhibited excellent resistance against swelling, bacterial and fungal attack. Incorporation of silane modified ZnO nanostructure in gelatin matrix produced a biodegradable, moisture repellent ZnO/gelatin biohybrid which in-turn offered mechanical flexibility resulting in a new green packaging material to get rid-off environmentally unsafe polyethylene polymer packaging material.



ZnO/Si/gelatin biohybrid film & antibacterial activity against chromo bacterium violacin

### Materials for CO<sub>2</sub> adsorption

Selective CO<sub>2</sub> capture followed by its sequestration is an effective approach to minimize CO<sub>2</sub> emission to the atmosphere. Lithium orthosilicate has capacity to absorb CO<sub>2</sub> in a wide range of temperatures (400-700°C) and have low regeneration temperature (~750°C). In the present work, lithium silicate containing eutectic orthosilicate mixtures were developed by a solid-state route. It displayed CO<sub>2</sub> adsorption capacity of 256 mgg<sup>-1</sup>. Incorporation of second phase materials

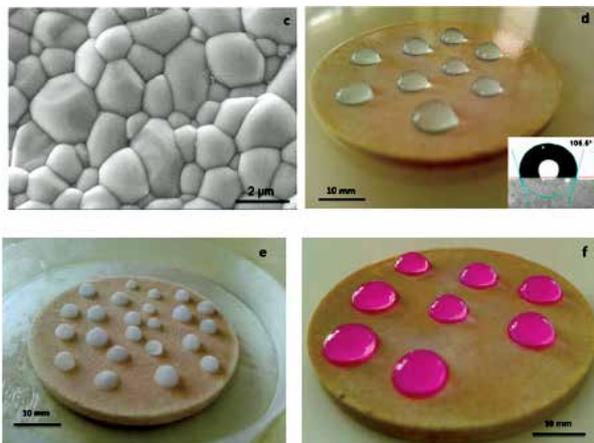
was investigated as a strategy to enhance the stability of the absorbent materials against agglomeration and sintering during powder processing and high temperature cyclic absorption/desorption loading. Yttrium oxide, gadolinium oxide and lanthanum phosphate were added as second phases to the absorbent. It was found that when the composites were rich in absorbents (10:1 and 20:1 absorbent: second phase), the absorption performance was hardly influenced by the type of the second phase material present. On the other hand yttrium oxide or gadolinium oxide additions in large quantities were found to enhance the absorption capacity of the orthosilicate phase. 2:1 sample containing yttrium oxide gave absorption capacity of 315 mgg<sup>-1</sup> of orthosilicate absorbent present in the composite sample. Based on the structural and morphological studies it is believed that the non-reactive second phase components formed a virtual shell against the segregation of absorbent phase thereby helping to improve their absorption performance. Cyclic studies have supported the superior stability and performance of such composite absorbent materials (Hareesh *et al.*, *Journal of Physical Chemistry C*, 2015, 119, 5319–26).

### Lanthanum phosphate (LaPO<sub>4</sub>) coatings and monoliths for non-wetting surfaces for water and molten metals

Ceramic materials composing of metal and oxygen, in general, are known to exhibit significant wet ability towards water molecules because of the high feasibility of synergetic hydrogen-bonding interactions possible at the solid-H<sub>2</sub>O interface. It was shown that the phosphates of rare earth materials (REPs), LaPO<sub>4</sub> in particular, exhibited without any chemical modification, unique combination of intrinsic properties including remarkable hydrophobicity that could be retained even after exposure to extreme temperatures and harsh hydrothermal conditions. Transparent thin films of LaPO<sub>4</sub> as well as mixture of other REPs on glass surfaces were shown to display notable hydrophobicity with water contact angle (WCA) values of 115-120° while sintered and polished monoliths manifested WCA greater than 105°. Significantly, these materials



in the form of coatings and monoliths also exhibited complete non-wetability and inertness towards molten metals like Ag, Zn, and Al well above their melting points. These properties, coupled with their excellent chemical and thermal stability, ease of processing and machinability as well as their versatile photo-physical and emission properties, make  $\text{LaPO}_4$  and other REP ceramics candidates for diverse applications.

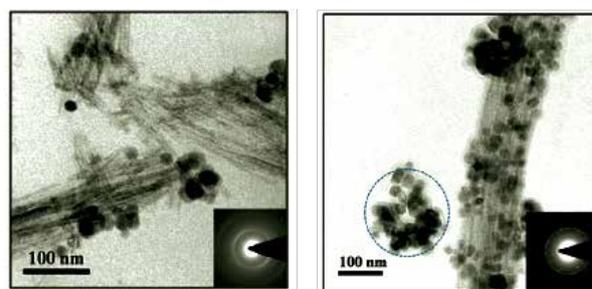


*Sintered Lanthanum Phosphate Ceramics. Photographs of  $\text{LaPO}_4$  surfaces showing hydrophobic and icephobic properties. Surfaces after extreme hydrothermal conditions indicating high stability of  $\text{LaPO}_4$*

### Development of hydrogen titanate ( $\text{H}_2\text{Ti}_3\text{O}_7$ ) nanotubes based nanocomposite as magnetically recyclable catalyst for dye-removal application.

Maghemite ( $\gamma\text{-Fe}_2\text{O}_3$ ) nanoparticles integrated  $\text{H}_2\text{Ti}_3\text{O}_7$  nanotubes based nanocomposite has been processed *via* the combination of hydrothermal and ion-exchange mechanisms. The different magnetic nanocomposites were designated as HTNF-X where X represents the weight-percentage of  $\gamma\text{-Fe}_2\text{O}_3$  in the magnetic nanocomposite. The transmission electron microscope images of different samples suggested that the  $\gamma\text{-Fe}_2\text{O}_3$  nanoparticles were typically attached to the ends of nanotubes which appears to be a characteristic feature of the ion-exchange process. The MB adsorption capacity ( $q_m$ ) was estimated to be 113, 99, 75, and 66  $\text{mg g}^{-1}$  for the pure-HTN, HTNF-5, HTNF-10, and HTNF-25 samples respectively. The HTNF-5 magnetic nanocomposite was used to demonstrate

its recyclability in the dye removal application. The cationic methylene blue (MB) dye was first adsorbed on the surface of HTNF-5 sample *via* three successive dye-adsorption cycles, which was then subjected to the surface-cleaning treatment using 30 wt% hydrogen peroxide solution. This was followed by the fourth cycle of dye-adsorption. The surface-cleaning treatment conducted after the cycle-3 was successful in decomposing the MB on the surface of HTNF-5 sample. As a result, the surface of nanotubes was free of MB dye after the surface-cleaning treatment and could be recycled for the next successive cycle of dye-adsorption. The original amount of dye-adsorption was restored in the fourth cycle of dye-adsorption. The variation in the color of HTNF-5 sample as observed at the different stages of recycling process supported the adsorption and decomposition of MB dye before and after the surface-cleaning treatment (Shukla *et al.*, RSC Adv. **2015**, 5, 30354-62).



### Synthesis of nanotubes and nanoplates of anatase-titania ( $\text{TiO}_2$ ) *via* hydrothermal method

Pure as well as silver (Ag)-doped and Ag nanoparticles deposited nanotubes and nanoplates of anatase- $\text{TiO}_2$  have been synthesized *via* the hydrothermal method involving the double ion-exchange mechanism. The synthesized anatase- $\text{TiO}_2$  nanotubes can be used for the removal of organic synthetic dyes from the industry effluents and aqueous solutions *via* the dark-catalysis process involving the two-step and one-step methods. In the two-step method, the dye is adsorbed on the surface of catalyst in an aqueous solution and decomposed on the surface of catalyst in another aqueous solution containing a strong oxidizer such as  $\text{H}_2\text{O}_2$ . In the one-step method, the dye-ad-



sorption and dye-decomposition take place in an aqueous solution containing both the catalyst and  $H_2O_2$  (Shukla *et al.*, J. Sol-Gel. Sci. Technol., **2015**, 73, 38-47).

### Predicting dye-adsorption capacity of $H_2Ti_3O_7$ nanotubes via one-step dye-removal method of novel dark-catalysis process.

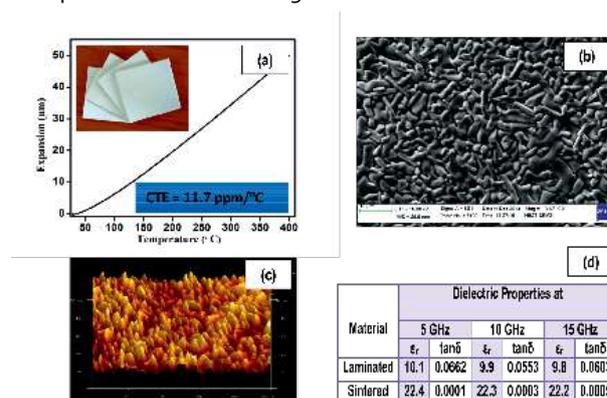
The dye-adsorption capacity of adsorbents has been traditionally determined via the equilibrium dye-adsorption/desorption experiments. A new method for predicting the dye-adsorption capacity of hydrothermally synthesized semiconductor-oxide nanotubes, such as the  $H_2Ti_3O_7$ , has been demonstrated which involves the use of one-step dye-removal method of novel dark-catalysis process. The MB dye-adsorption capacity of  $H_2Ti_3O_7$  nanotubes has been determined to be  $121 \text{ mg g}^{-1}$  via the conventional method which is comparable with that ( $114 \text{ mg g}^{-1}$ ) predicted via the one-step dye-removal method of novel dark-catalysis process (Shukla *et al.*, J. Environ. Chem. Eng., **2014**, 2, 1980-88).

## ELECTRO-CERAMIC MATERIALS

### Lithium zinc titanate ( $Li_2ZnTi_3O_8$ ): A new microelectronic substrate through tape casting

Developing a cost effective and crack-free microelectronic ceramic substrate is still regarded as a challenging problem. A novel microelectronic substrate based on  $Li_2ZnTi_3O_8$  (LZT) was developed through solid state synthesis and non-aqueous tape casting technique. The currently developed method was found to be ideal for producing electronic ceramics. Detailed investigation has been made in this direction, in which the entire process chain has been evaluated with regard to rheological properties, drying, binder removal, sintering and, finally, microstructure. The average particle size of LZT was 720 nm and average surface area of the powder measured was about  $0.7930 \text{ m}^2\text{g}^{-1}$ . Tape casting

slurry with good flow properties preparation was done using meticulously controlled ingredients such as solvents, dispersants, homogenizers and binders and plasticizers. In the present research, a mixture of xylene and ethanol in the ratio 1:1 was used as the solvent for the slurry. Fish oil was used as the dispersant due to its high deflocculating ability. Powder loading was optimized to 63% using viscosity measurements. Butyl benzyl phthalate, polyethylene glycol, polyvinyl butyral and cyclohexanone were respectively used as type I plasticizer, type II plasticizer, binder and homogenizer respectively. The tape casting was carried out on Mylar® film using a doctor blade system. The tape was then allowed to dry at room temperature. The casted tapes were thermo-laminated and sintered at  $1050^\circ\text{C}$  with a strictly controlled heating schedule to enable the complete burnout of organics.



(a) Thermal expansivity, (b) and (c) SEM and AFM microstructure and (d) microwave dielectric properties of LZT substrate

The coefficient of linear expansivity of LZT was measured to be  $11.7 \text{ ppm}/^\circ\text{C}$  which was in the same range as that of several microwave substrates like alumina. The scanning electron microscopy showed a dense and homogeneous microstructure without much porosity at a sintering temperature of  $1050^\circ\text{C}$ . The sintered tape had an average surface roughness of 246 nm. More importantly, the well densified microwave substrate based on LZT showed a higher dielectric permittivity of around 22.2 and a loss tangent of 0.0001 at 5GHz. The values of high permittivity  $>20$  and low loss



tangent are interesting for microwave substrates, since most of the commercial dielectric substrates have permittivity less than 10 and any higher permittivity substrate will enable better circuit miniaturization.

### Cation-dependent effects of substitution on structural and electrical properties of $Gd_2(Zr_{1-x}M_x)_2O_{7-8}$ (M = Sc, Y) system

Fluorite-type zirconate compositions of the form  $Gd_2(Zr_{1-x}M_x)_2O_{7-8}$  (M= Sc and Y; x = 0, 0.1, 0.2, 0.3, 0.4) were prepared and the influence of substitutions on the structural and electrical properties were investigated. Despite being in the same group of elements, the two substituent cations differed in their influence on the parent lattice. Both aliovalent substitutions introduced oxygen vacancies. Larger ionic radius of  $Y^{3+}$  forced the lattice to expand which along with the increased anion defects lowered the energy barrier for charge transport. Whereas, in Sc-substituted compositions, oxygen vacancies dominated over ionic size causing the lattice to contract and their cooperative behavior turned out to be disadvantageous for long range conduction process. The changes in rigidity of the inter-ionic bonds and the lattice volume introduced by the substituent cations also influenced the thermal expansion behavior of the materials.

### Electrical properties of $(1-x)Gd_2Zr_2O_7-xCaTiO_3$ solid solutions for fuel cell applications

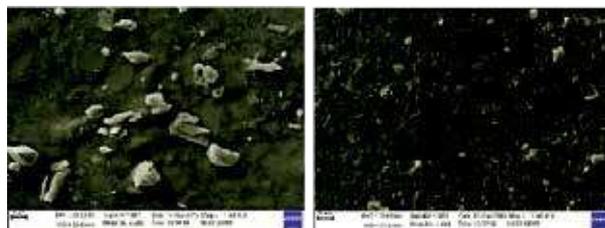
One interesting property of pyrochlore type compounds is the structural transformation from ordered pyrochlore structure to a disordered fluorite structure with variation in chemical composition, temperature, and pressure. Gadolinium zirconates ( $Gd_2Zr_2O_7$ ) is considered as a good candidate for the study of such a phase transition because of the fact that the radius ratio ( $r_A/r_B$ ) is 1.46 and so is at the phase boundary between the pyrochlore and the fluorite type.  $Gd_2Zr_2O_7-xCaTiO_3$  (x=0.05, 0.1, 0.3, 0.4, 0.5) solid solutions were prepared via solid state reaction route. Electrical characterization

of the sintered pellets was carried out using an impedance spectrometer with a dielectric interface. Addition of  $CaTiO_3$  favoured ionic conductivity up to x=0.3 after which formation of secondary phase decreased the conductivity. From Arrhenius plot it was proved that the conduction mechanism was thermally activated. The Cole-Cole plot end up in short spikes at low frequency showed that accumulation of ions at the electrode-sample increased capacitive reactance which proved that the conduction mechanism was ionic in nature.

## POLYMERS AND POLYMER MATRIX NANOCOMPOSITES

### Phosphorylated cashew nut shell liquid prepolymer modified kaolin as a reinforcing filler for natural rubber

Low cost industrial byproducts/renewable natural resources such as cashew nut shell liquid (CNSL) or rubber seed oil (RSO) or their derivatives may be used as organo-modifiers for kaolin to impart excellent compatibility with non-polar rubbers along with desired physico-mechanical properties for various applications. Results of the present study as obtained from XRD, TEM, SEM, TGA, CLD (chemical crosslink density) and tensile properties showed that low dosages of kaolin modified with a solution of phosphorylated cashew nut shell liquid pre-polymer (PCNSL) in toluene could act as potential nano-reinforcing fillers for natural rubber (NR).



(a) (b)

SEM of NR vulcanizates containing (a) PCNSL modified precipitated silica (8 phr) and (b) PCNSL modified kaolin (8 phr)



### Kaolin modified with sodium salt of rubber seed oil as reinforcing filler for blends of natural rubber, polybutadiene rubber and acrylonitrile butadiene rubber

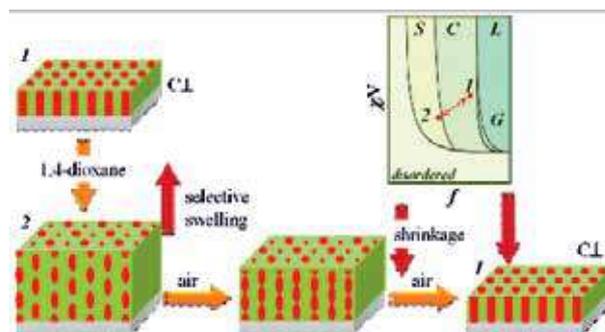
The emerging field of organo-modified clay- rubber nanocomposites could provide a host of novel materials having a unique combination of properties to meet various stringent service conditions. Previous studies have shown that at very low dosages, china clay (kaolin) modified with sodium salt of rubber seed oil (SRSO) improved the cure characteristics and physico-mechanical properties of natural rubber (NR). Results of the present study showed improved cure characteristics and physico-mechanical properties for blends of NR with butadiene rubber (BR) / nitrile rubber (NBR) containing 4 phr of SRSO modified kaolin as indicated by reduction in optimum cure time ( $t_{90}$ ) along with higher tensile strength, tensile modulus and elongation at break for their vulcanizates as compared to those containing unmodified kaolin. The SRSO modified kaolin – rubber nanocomposites showed improved flex resistance, reduced heat build-up, tan delta ( $\tan\delta$ ) and loss modulus and higher chemical crosslink density index indicating reinforcing effect of SRSO modified kaolin, enabling them for potential industrial applications. The results indicated possible cross linking between the double bonds of the aliphatic moiety of SRSO and that of NR, BR / NBR along with polar interaction with kaolin, thereby acting as a coupling agent between the filler and the rubber.

## SELF ASSEMBLY OF BLOCK COPOLYMERS AND NANOPATTERNING

### Pathways of cylindrical orientations in PS-*b*-P4VP diblock copolymer thin films upon solvent vapor annealing

The orientation changes of perpendicular cylindrical microdomains in polystyrene-*block*-poly(4-vinylpyridine) (PS-*b*-P4VP) thin films upon annealing

in different solvent vapors were investigated by *in situ* grazing incidence small-angle X-ray scattering (GISAXS) and *ex-situ* scanning force microscopy (SFM). The swelling of the P4VP perpendicular cylinders (C $\perp$ ) in chloroform, a non-selective solvent vapor lead to the reorientation to in-plane cylinders through a disordered state in a particular kinetic pathway in the phase diagram upon drying. On the other hand, the swelling of the P4VP perpendicular cylinders in a selective solvent vapor (i.e., 1,4-dioxane) induced a morphological transition from cylindrical to ellipsoidal as a transient structure to spherical microdomains; subsequent solvent evaporation resulted in shrinkage of the matrix in the vertical direction, merging the ellipsoidal domains into the perpendicularly aligned cylinders. (Bhoje Gowd *et al.* Soft Matter, **2014**, 10, 7753-61)



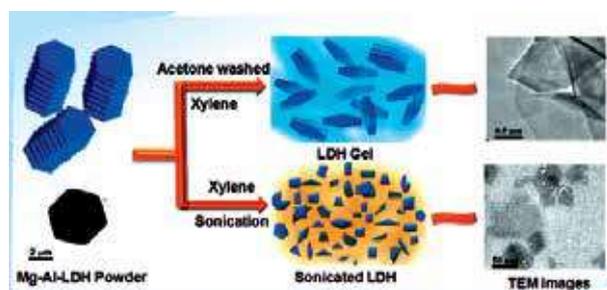
Schematic representation of structural changes upon swelling of PS-*b*-P4VP block copolymer thin film in the selective solvent (1,4-dioxane) vapors.

### Polypropylene/Layered Double Hydroxide (LDH) Nanocomposites: Influence of LDH Particle Size on the Crystallization Behavior of Polypropylene

Highly dispersed isotactic polypropylene (iPP) nanocomposites were prepared by incorporating two different sized Mg-Al LDH nanoparticles with different loadings from 1 to 10 wt % using a modified solvent mixing method. Larger sized LDH nanoparticles (~3-4  $\mu\text{m}$ ) were prepared from the gel form of Mg-Al LDH and the smaller sized nanoparticles (~50-200 nm) were prepared by sonication of as-synthesized LDH particles. Such



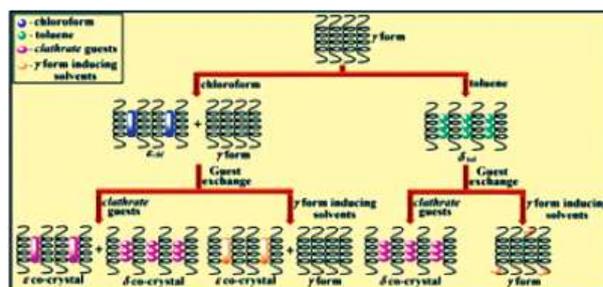
obtained LDH nanoparticles were carefully characterized using wide-angle X-ray diffraction (WAXD), transmission electron microscopy and scanning electron microscopy. WAXD and atomic force microscopy results indicated that the LDH nanoparticles were highly dispersed in iPP matrix. The influence of LDH nanoparticles size and concentration on the thermal stability, spherulitic morphology, melting behavior, isothermal crystallization kinetics and lamellar structure of iPP were investigated. Incorporation of low loadings of sonicated LDH particles (e.g. 1-2.5 wt %) showed substantial effect on thermal stability, spherulite size, crystallinity and crystallization half-time and lamellar morphology of iPP compared to the pure iPP and that of nanocomposites with larger LDH particles with same loadings. The better nucleation ability of iPP in presence of sonicated LDH can be attributed to the high surface area of LDH nanoparticles along with its better dispersibility within the polymer matrix. The incorporation of LDH nanoparticles doesn't change the crystallization growth mechanism and crystal structure of iPP. (Bhoje Gowd *et al*, ACS Applied Materials and Interfaces, **2015**, 7, 12399-410)



### Factors controlling the structure of syndiotactic polystyrene upon the guest exchange and guest extraction processes

Syndiotactic polystyrene (sPS) has a tendency to form polymer-solvent complexes (co-crystals) with a large number of guest molecules. The guest molecules used for the guest exchange process have a significant role in facilitating the phase transitions of the host structure. Chloroform and toluene treated  $\gamma$  form samples were used as starting materials for the guest exchange process with dif-

ferent kind of solvents. Solvents that are capable of crystallizing sPS into the delta ( $\delta$ ) co-crystal are termed as clathrate guests and the solvents which are crystallizing sPS directly into the  $\gamma$  form are termed as  $\gamma$  form inducing solvents. Upon guest exchange process (performed by dipping the samples in clathrate guests and  $\gamma$  form inducing solvents), chloroform treated of  $\gamma$  form ( $\epsilon$  clathrate) sample transformed into the mixture of  $\epsilon$  clathrate and  $\delta$  clathrate in the presence of clathrate guests, whereas the  $\epsilon$  co-crystal retained its structure in the presence of  $\gamma$  form inducing solvents. However, the toluene treated  $\gamma$  form (monoclinic  $\delta$ ) samples showed different structures upon guest exchange process depending on the kind of guest molecules. In the case of clathrate guests, upon the guest exchange, the monoclinic  $\delta$  retained its structure; however, the toluene treated  $\gamma$  form (monoclinic  $\delta$ ) transformed to the  $\gamma$  form in the presence of  $\gamma$  form inducing solvents. Apart from the guest exchange process, structural changes upon the guest extraction process were also investigated. ((Bhoje Gowd *et al.*, Polymer, **2015**, 56, 581-89).



### Growth of silver nanoflowers: a green approach

A green strategy was tried involving TEMPO oxidized nanocellulose fibers (TNCF) for designing silver nanoflowers. The method uses a salt of citric acid as reductant whose synergic action with TNCF in reduction of Ag (III) to form silver nanoparticles (Ag NP) which will be assembled into a flower-like structure. TNCF not only acted as a capping agent, but took a major role in directing Ag NP via its non-covalent interactions with co-reagents. The time dependent study on the growth mechanism by TEM suggested



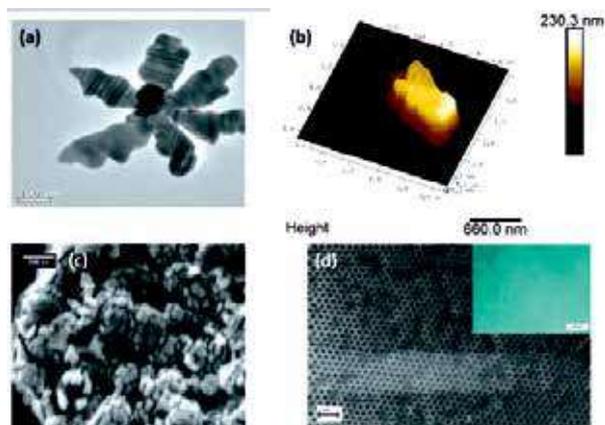
that primary Ag NP (2-5 nm) assembled into a centre core in the first stage and a regular outgrowth of as prepared plasmonic structures happened by the directed addition of Ag NP. Moreover, a stable aqueous colloidal suspension of Ag NPs could be prepared using this method.

### Cucurbit[n]uril-grafted electrospun cellulose acetate nanofibers via 'click' chemistry

Permanent grafting of cucurbituril[6] molecules on nonwoven cellulose acetate nanofibers was achieved via 'click' chemistry. Initially, azide-terminated cucurbituril[6] and electrospun CA nanofiber mat were prepared. The propargyl terminated cellulose fiber/paper was obtained upon chemical modifications. Later, 'click' reaction was used to graft cucurbituril[6] to CA nanofibers. Cucurbituril[6]-modified cellulose nanofiber is very attractive due to their unique characteristics and wide range of applications in the field of textiles, biomedical and agriculture and other industrial fields.

### A facile method for preparation of mesocrystals of super paramagnetic magnetite ( $\text{Fe}_3\text{O}_4$ ) nanoparticle assembly

Magnetic nanoparticles (MNPs) were synthesized using a modified co-precipitation method. The synergic effect of microwave-ultrasonic irradiation on MNPs morphology was investigated. The results showed that the MNPs were mono-disperse, single crystalline with spinal structure and super paramagnetic in nature with the blocking temperature around 100K. The microwave-assisted and ultrasonic irradiation procedures influenced the size, shape and the size distribution of the magnetite ( $\text{Fe}_3\text{O}_4$ ) nanoparticles. Furthermore, self-assembled 'soccer ball-shaped' magnetite mesocrystals were formed with an evaporation-induced self-assembly process without using external magnetic field.



(a) TEM of silver nanoflower structure; (b) AFM height image of  $\text{TiO}_2$  mesocrystal; (c) SEM micrograph showing self-assembly of magnetite ( $\text{Fe}_3\text{O}_4$ ) nanoparticles; and (d) Micrographs showing highly ordered inverse opal photonic crystal hydrogel structure fabricated from polystyrene (PS) colloidal crystals.

### Responsive photonic crystal hydrogels based on polystyrene colloidal templates

Self-assembly of colloidal spheres to provide highly ordered crystal find applications in various fields such as preparation of ordered macro porous materials, photonic band gap materials, sensor, etc. Responsive photonic crystal hydrogels were fabricated using colloidal crystals as template. An evaporation induced assembly method was used for the preparation of highly ordered three dimensional polystyrene (PS) colloidal crystal templates. Optical properties of photonic crystal hydrogel were such that it Bragg diffracts visible light which generated structural color and photonic band gap. The analyte molecule was sensed by exploiting the change in photonic band gap brought about by volume responsive nature of hydrogel. This inverse opal hydrogel responded to alcohol and the extent of responds was equivalent to the concentration of the alcohol which in turn promises the fabrication of an optical sensor for alcohol. An optical sensor for the protein albumin was fabricated and studied their responses to different HSA (human serum albumin) concentrations. This is a label free method for using smart colloidal array for sensing analyte molecules (act as artificial antibody) and can be used as DNA sensors based on inverse opal structures.



## MAGNETIC MATERIALS

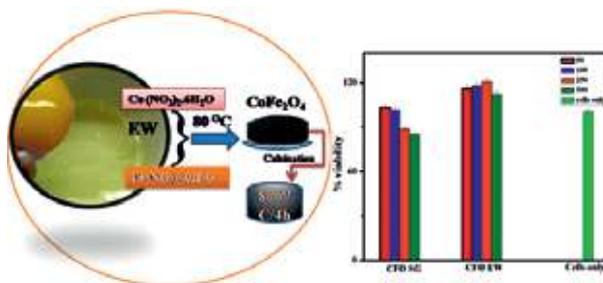
### 3-D magnetic vortices in iron nanospheres

Magnetic vortices are of great interest as they are potential candidates for improving the fundamental understanding on magnetism. Yet they also offer very promising applications in information and communication technology. So far, magnetic vortex states have been observed only in two dimensions; that is within a plane. In this work, silicon alkoxide sol-gel process was combined with hydrogen reduction for realizing 70 nm iron nanoparticles in a silica matrix. Magnetisation measurements along with micromagnetic simulations revealed that the ground state spin configuration in such soft magnetic nanoparticles adopt 3D vortex structure, in which the vortex core points along the applied magnetic field direction. A detailed micromagnetic simulations has been carried out to understand the magnetisation reversal process.

### Studies on double perovskites and Heusler alloys

Double perovskites showing complex magnetic properties are being investigated. One of the material studied is  $\text{La}_2\text{FeMnO}_6$ . Thermomagnetic analysis revealed the presence of Griffiths phase (GP). The M-T curves also showed two distinct transitions, one at a lower temperature, corresponds to the already reported glassy transition and the other one at 435 K, the ferromagnetic to paramagnetic phase transition. A coercivity of  $\sim 1140$  Oe and 35 Oe was observed at 2 K and room temperature respectively. Features attributed to GP were found in the material, possibly due to the presence of some ferromagnetic clusters in the paramagnetic region, owing to the intrinsic inhomogeneities associated with the mixed valent B site cations and B- site disorder. The Griffiths temperature was estimated to be 570 K.

### Magnetic nanoparticles for biomedical applications



Magnetic properties of  $\text{MFe}_2\text{O}_4$  (M = Mg, Mn, Fe, Co, Ni, Zn) spinel ferrite nanoparticles (NPs) were extensively studied using facile synthesis techniques. The  $\text{MFe}_2\text{O}_4$  NPs were synthesized using a cost-effective method, where egg-white was used as solvent. Conducted structural, magnetic and cytotoxicity studies on the  $\text{MFe}_2\text{O}_4$  NPs and found that the NPs using egg-white were superior to that of prepared *via* traditional synthesis techniques like sol-gel.

## MINERALS AND METALLIC MATERIALS

### Investigations on chemical beneficiation of low grade ilmenites

This study was aimed at upgrading the ilmenite with respect of  $\text{TiO}_2$  content in order to market the same for better value. The sponsor had supplied 2 grades of ilmenite namely, TIS and TVP grades containing 53.28 % and 44.36%  $\text{TiO}_2$  content respectively for further beneficiation in terms of  $\text{TiO}_2$  content. By resorting to metallization and aeration rusting, the  $\text{TiO}_2$  content of the above ilmenite samples were enhanced to 88.16% and 81.27% respectively for TIS grade and TVP grades. Satisfied with the laboratory results, scale up operation is under progress.

### Investigations on pressure leaching of beneficiated ilmenite produced from Orissa grade ilmenite

Investigations were carried out on metallization and aeration rusting of metalized product prepared



from Orissa grade ilmenite. The above investigations were aimed at finding alternate sources of ilmenite raw material for Chavara grade ilmenite required for the synthetic rutile production using the technology developed at the laboratory. Laboratory scale investigations revealed that the Orissa grade ilmenite behaved identical to Chavara grade ilmenite.

The beneficiated product generated after metallization and aeration rusting of Orissa Grade ilmenite was subjected to high pressure leaching with hydrochloric acid. Beneficiated product prepared by metallization and aeration rusting of Orissa grade ilmenite containing about 8.3% residual iron was subjected to high pressure acid leaching. The leaching experiments were carried out at CSIR-IMMT, Bhubaneswar in a high pressure leaching reactor lined with teflon at a batch size of 20gms. Initial set of experiments were carried out at 140°C using 30% HCl for 10 hours duration. The final product after the leaching showed 5.08%  $\text{Fe}_2\text{O}_3$  against the requirement 1.6-1.8%. As the results of the experiments were not satisfactory in terms of iron removal, the next set of experiments were planned for further optimization.

### **Utilisation of waste iron oxide from titanium mineral industries: Studies on de-acidification and de-chloridisation of waste iron oxide**

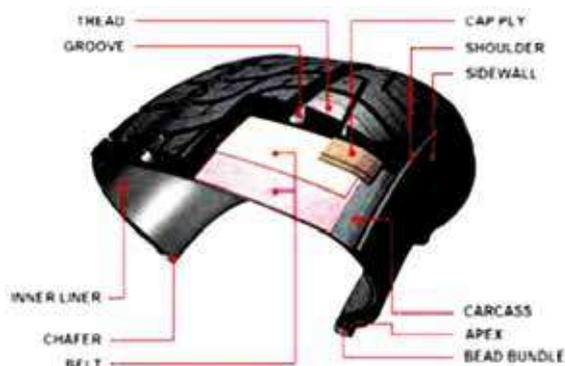
After a detailed characterization of waste iron oxide from KMML by XRD, particle size distribution analysis, TG-DTA and FTIR (AR-2013-14), it was revealed that the product is highly acidic and contain very high chloride content as a result of which the material is considered hazardous in terms of transport and usage. As a first step towards making the material acceptable for downstream processing, efforts were made to reduce the acidity and the chloride content of the waste iron oxide. In one of the method, multistage washings of waste iron oxide was resorted and the acidity of the filtrate was measured after the filtration. It was observed that the pH of the solid could be enhanced from 3.6 to 6.8 in four stages of washings. The chloride

content of the solid was also brought down from 1.896 to 0.071% during the process. Alternatively, efforts were also made to adopt pyro treatment of oxides to reduce its acidity and chloride content. Oxide samples heated at 550 ° C for 1 hour showed decrease of chloride content to 0.23% and the sample turning neutral pH. Investigations were also carried out at CLRI-Chennai on the pigment characterization and covering efficiency of pre treated oxide essentially to explore the possibility of using the above oxide as a low cost pigment for leather products. The covering power of the oxide samples were observed superior compared to commercial standards.

### **Specialty Materials Based on Engineered Clays**

Subsequent to initial mineralogical and geo chemical characterization and screening of a few clay samples, efforts were made to characterize these samples after hydrocycone and WHIMS separation treatments. Iron and titania impurities were analyzed at each stage of beneficiation treatments. Lead impurities in the clay sample being very critical for its application in pharmaceutical sector, analysis was carried out in selected samples as a function of particle size. The studies revealed that some of the clay samples from Orissa were very low in lead content and they could be the candidate clay samples for further beneficiation for pharmaceutical grade applications. SEM and EDAX analysis of such clay samples further revealed that the lead impurity originated not from lead containing mineral but probably in the form of soluble salts.

In the area of development of modified kaolin clay fillers as reinforcement into natural rubber for tire side wall applications, a 2D static failure prediction for critical stresses of an automobile tire side-wall made of natural rubber / rubber seed oil modified kaolin composites using MATLAB PDE Tool box was made. The prediction was found acceptable under static analysis with critical stress values of 5 – 25 MPa obtained around the tire side-wall which were higher than the applied maximum inflation.



Highly dispersed isotactic polypropylene (iPP) in surfactant free layered double hydroxide (LDH) nanocomposites were synthesized and the crystallization behaviour of iPP at varying LDH loading was studied. Crystallization half time of 1.9 minutes at 130° C was observed for iPP composite containing 2.5% LDH. High flame retardancy was achieved with iPP loaded with 6 wt% LDH containing Co, Zn and Al metals.

### Preparation of high purity neodymium metal

Investigations were carried out for the preparation of neodymium metal through calciothermic reduction of neodymium fluoride. Neodymium metal with 99% purity in terms of total REO was prepared with more than 99% yield. Tantalum crucibles were used for the reduction of neodymium fluoride with calcium metal. Reduction parameters were optimized for maximum metal yield. Efforts were also made for the preparation of Nd-Fe alloy powders by reduction diffusion process as the process is cheaper and involve very few intermediate steps compared to calciothermic reduction. Further the above process produced the alloy powders which can be directly used for magnetic alloy preparation. Expensive tantalum crucibles were replaced by alumina crucibles and the reduction experiments were carried out at lower temperatures compared to neodymium metal preparation by calciothermy. Optimization of reduction parameters, leaching conditions are in progress.

### Corrosion behavior of Mg-Gd-Zn alloys in aqueous NaCl solution

Rare earth (RE) containing Mg alloys exhibiting superior high temperature properties are considered as potential candidates for automobile applications. In the present investigation, the corrosion behavior of Mg-10Gd-xZn (x=2, 6 wt.%) alloys in 0.5 wt.% NaCl solution was studied. Microstructures of both the alloys consisted of  $(\text{Mg,Zn})_3\text{Gd}$  phase and lamellar long period stacking ordered (LPSO) phase. The morphology of the second phase at the grain boundary differed in both alloys. It was a continuous network structure in Mg-10Gd-6Zn, whereas it was relatively discrete in Mg-10Gd-2Zn. The dendrites were finer in size and highly branched in Mg-10Gd-6Zn. The corrosion results indicated that the increase in Zn content increased the corrosion rate in Mg-10Gd-xZn alloys. Micro-galvanic corrosion occurred near the grain boundary in both alloys initially as the grain boundary phase was stable and acted as a cathode, however, filiform corrosion dominated in the later stage, which was facilitated by the LPSO phase in the matrix. Severe micro-galvanic corrosion occurred in Mg-10Gd-6Zn due to the higher volume of second phase. The stability of the second phase at the grain boundary was altered, and it dissolved after the long immersion times. Probably the NaCl solution chemically reacted with the grain boundary phase and de-stabilized it during the long immersion times, and was removed by the chromic acid used for the corrosion product removal.



Typical filiform corrosion after 5 h of immersion (Mg-10Gd-2Zn alloy)



Typical corrosion morphology after 16 h of immersion (complete removal of GB phases; Mg-10Gd-6Zn alloy)

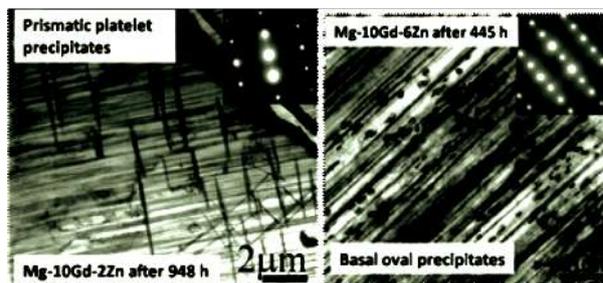


## Precipitate formation in Mg-Gd-Zn alloys during creep deformation

Mg-Gd-Zn alloys were developed as a new class of Mg based alloys that showed superior creep resistance compared with conventional WE43 alloys. To understand the creep behaviour of these alloys, a detailed microstructural investigation was carried out. Two alloys, Mg-10Gd-2Zn and Mg-10Gd-6Zn, were prepared in a resistance tilt furnace under a protective gas mixture of Ar +0.2%SF<sub>6</sub>. The creep tests were performed with ATS Lever Testing Systems at a range of constant temperatures of 250 and 300°C, and constant stress of 70, MPa. To decipher the contribution of creep stress from the elevated temperature exposure a separate sample was left at the same temperature as the creep test for the duration of the creep test. The microstructures of the as-cast, creep tested and the simulated creep tested samples were investigated with scanning electron microscopy (SEM) and transmission electron microscopy (TEM).

TEM investigation of Mg-10Gd-2Zn alloy crept at 250°C and 70MPa contained precipitates forming perpendicular to basal planes and provided resistance against creep deformation. These precipitates form due to the applied creep stress rather than precipitation of particles due to the high temperature. However, the increased creep deformation temperature to 300°C did not cause the formation of precipitates perpendicular to the basal planes and was expected to be due to a combination of lower super saturation of solute content and the shorter deformation time. Increase in the Zn content to 6 wt% in Mg-10Gd-xZn alloys resulted in changing the morphology of the precipitates that form during creep at 250°C to basal precipitates. These precipitates formed during heat treatment at 250°C as well as during creep deformation, thus the precipitate formation in this alloy had contributions from

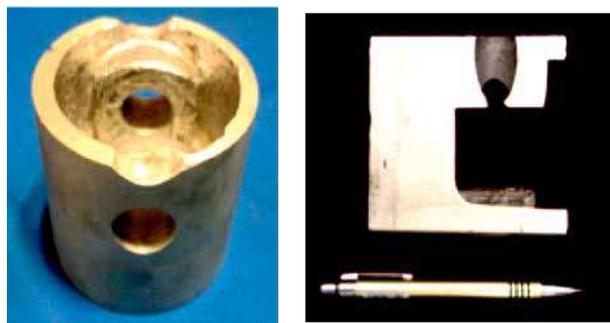
both the elevated temperature and creep stress unlike the case with the Mg-10Gd-2Zn alloy where no precipitates were observed in the heat treated samples.



Microstructures of alloys after creep at 250°C with 70 MPa

## Processing of functionally graded *in-situ* aluminium composites for automotive pistons

The present investigation aims at design, fabrication and evaluation of functionally graded automotive piston using *in-situ* primary silicon reinforced 390 aluminum composite by centrifugal casting technique with a view of obtaining improved thermo mechanical properties at specific locations. The centrifugal cast dies were designed and fabricated suitably to obtain the primary silicon rich region towards the head portion of the piston. Pistons with 390Al and 390Al-0.5% Mg functionally graded materials (FGM) were fabricated by centrifugal casting and compared the characteristics with gravity cast ones. Microstructure and chemical composition analysis of centrifugally cast FGM piston showed graded distribution of primary silicon particles towards the head portion of the piston, whereas the skirt region showed an eutectic composition providing higher hardness towards the head region. The wear testing revealed that the primary Si gradation provides remarkable enhancement in the wear properties of the piston head.



(a)

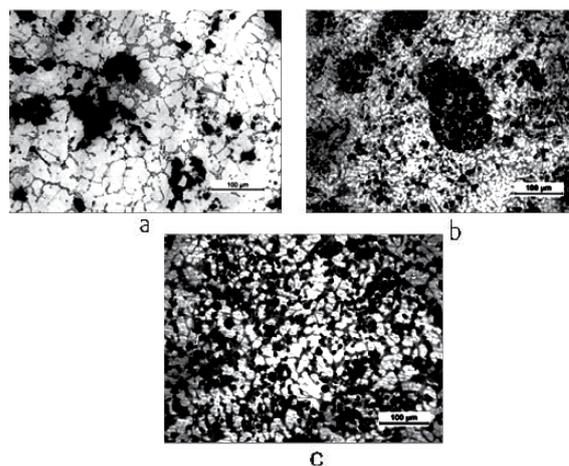
(b)

(a) Centrifugally cast A390 FGM piston

(b) Section of A390 FGM piston showing gradation of primary silicon at the head region

### Modified compocasting of microsilica reinforced aluminum matrix composite

A356 aluminium alloy reinforced with 7 % micro-silica composites were produced by the liquid metal stir casting and compocasting followed by squeeze casting route and their properties were examined. Microstructure of liquid metal stir cast Al MMC showed agglomeration of particles leading to the formation of high porosity level in the developed material. Adopting new route of compocasting cum squeeze casting process capitulate the agglomeration sites with uniform distribution and dispersion of the dispersoids in the matrix metal which enhanced the mechanical, tribological and corrosion properties of the composites. Superior wear-resistance properties were exhibited by the composite compared to alloy and abrasive type wear mechanism was observed in the case of composite. Increasing the sliding speed resulted in the quick evolution of tribolayer and the wear rate of composite got reduced. Presence of inter-metallic phases like  $MgAl_2O_4$ ,  $NaAlSi_3O_8$  and  $KAlSi_3O_8$  had a favorable effect on increased corrosion resistance of the composite. Microsilica particle significantly enhanced the compressive strength of composites compared to the alloy.



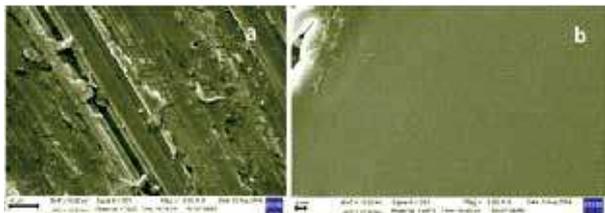
Microstructures of (a) surface treated A356-7% micro silica composite synthesized by liquid metal stir casting and gravity cast (b) A356-7% micro silica (treated) composite processed by compocasting followed by squeeze casting (c) Recasted final composite by remelting, stirring and squeeze casting.

### Adduct modified nano-clay dispersed polystyrene nanocomposites as advanced anti-corrosive coatings for aluminium alloys

A facile approach was developed to design and synthesize a series of polystyrene clay nanocomposite (PSC) coatings containing different adduct modified clay (AMC). These PSC materials were used as advanced anticorrosive coatings to protect aluminum 6061 alloy (Al alloy) against corrosion. Potentiodynamic and electrochemical impedance spectroscopy measurements in 3.5 wt % aqueous NaCl electrolyte indicated that the PSC coatings offered enhanced protection against corrosion than pristine polystyrene (PS) coating. The results showed that 10 wt % AMC loaded PSC coated Al alloy offered high protection because of high  $E_{corr}$  and impedance value. The significant increase in the properties such as corrosion protection, gas barrier, optical properties, thermal stability, and electrical conductivity was due to improved dispersion of AMC in polystyrene matrix. Effects of the material composition on the thermal stability, optical properties, electrical conductivity and surface



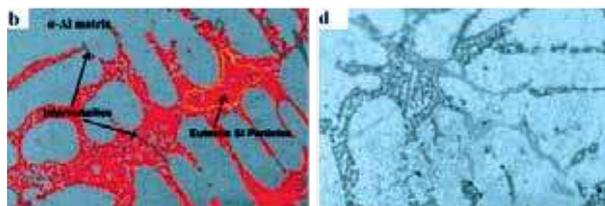
morphology of PS along with a series of PSC materials were characterized using thermogravimetric analysis (TGA), UV-visible absorption spectra, four-point probe technique and scanning electron microscopy (SEM), respectively.



SEM micrographs of (a) Polished Al alloy and (b) PSC-AC10 coated Al alloy.

### The effect of magnesium on the modifying efficiency of strontium in A356 alloy

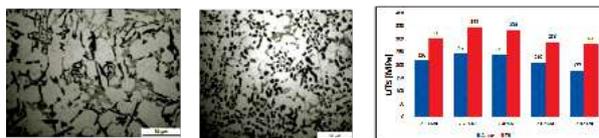
The objective of this study to investigate the effect of different concentrations of magnesium (0.2%, 0.3%, and 0.4%) on the modifying efficiency of Sr in A356 alloy. Both sand casting and gravity die castings were taken for the same composition. Modifying efficiency was studied quantitatively by measuring the size and shape of Si eutectic particles by using ImageJ image analyser and giving a modification rating (MR), developed by American Foundrymen's Society (AFS), for each microstructure ranging from 1 to 6, 1 being unmodified and 6 being completely modified very fine structures. The quantitative measurement of the Si particle characteristics such as average Si eutectic size and aspect ratio showed that in both sand casting and gravity die castings the addition of Mg resulted in an increase in average eutectic size with decrease in Si particle count which was a clear indication of deterioration of eutectic Si modification with increasing Mg. The reason for this may be due to the reaction between Mg and Sr to form complex intermetallic compounds like  $Mg_2SrSi_3Al_4$  as reported in literature.



Micrographs of sand cast specimens of (a) A356 (0.2%Mg)+0.04% Sr (b) A356 (0.4%Mg) + 0.04% Sr

### Role of nickel additions in aluminium-silicon piston alloy

In order to develop high strength Al piston alloy for elevated temperature applications of automotives, alloying elements such as Ni, Cu, Mg were added to Al-12Si alloy. The role of nickel content was varied from 2.1 to 2.8% in steps of about 0.2%. The influence of nickel on the microstructure and mechanical properties were studied using materials characterisation techniques. The as cast microstructure of Al-Si-Cu-Mg-Ni alloy consists of  $\alpha$ -aluminum dendritic halos with eutectic Si and complex intermetallic compounds (precipitates of  $Mg_2Si$  and  $Al_2Cu$  phase) in the inter-dendritic regions and primary Si. The features of the microstructure underwent changes upon heat treatment. Most of the intermetallic phases were partially dissolved and tend to spheroidize. The morphology change of the eutectic Si was obvious after heat treatment. An increased Ni content resulted in a clear reduction in the roundness ratio which was most pronounced at higher Ni containing alloys. The results reveal that the addition of 2.5% Ni could be an optimum level of addition required for enhancing the strength of the alloy.



As Cast T6 Condition

Optical micrographs of the permanent mould AlSiCuNiMg alloy in the as cast and T6 heat treated condition and Ultimate Tensile Strength values for different Ni containing Al-Si alloy (T6 heat treatment)



## PROCESS ENGINEERING AND ENVIRONMENTAL TECHNOLOGY DIVISION

The Process Engineering and Environmental Technology Division (PEET) develops processes and technologies for value addition to the region's resources and for the management of the region's environment. PEET innovations in pollution control and production have helped several industries to continue production. PEET environmental management services are used by industry and government for statutory environmental impact assessment studies and clearances of new projects in mining, infrastructure and process industry. PEET's computational modeling services provides computational tools and services for investigating natural phenomena and for designing engineering processes. PEET division of CSIR-NIIST is the only agency in Kerala to accord NABET / MOEF accreditation as an EIA consultant in category A projects. Among the issues addressed by the PEET's multi-disciplinary team are :

- Municipal and household waste treatment
- Industrial effluent treatment and odour control
- Dioxins and persistent organic pollutants in the environment
- Environmental impact analysis and water quality analysis
- Groundwater pollution from industrial waste disposal
- Anaerobic technology: retting for extraction of plant fibres and production of white pepper
- Beneficiation and value addition of clay minerals
- Improving profitability in small and medium scale foundries through affordable indigenous software
- Computational fluid dynamics applications in process industry
- Development of Agent Based Simulations for understanding behavior of biological systems

The activities of the Division are under four sections namely Chemical Process Engineering, Environmental Technology, Computational Modeling & Simulation and Dioxin Research. The main activities of these sections are reported below.

### Highlights

- Common Research and Technology Development Hub for Environmental Intervention in MSMEs to undertake R&D for problems of common interest to MSMEs.
- Full scale implementation of odour control system using gas biofilter at 500 tpd MSW processing plant for BBMP (Bengaluru city corporation).
- AutoCast XI commercial software upgrades
- Mapped groundwater contamination from perchlorate at Aluva
- Mapped spread of contaminants from industrial waste disposal ponds at KMML Chavara
- Demonstration plant commissioned for banana and pineapple fibre extraction
- Gas biofilter and effluent treatment plant commissioned for fish meal factory, Kakkadampoyil



## प्रक्रिया इंजीनियरिंग तथा पर्यावरण प्रौद्योगिकी प्रभाग

प्रक्रिया इंजीनियरिंग और पर्यावरण प्रौद्योगिकी प्रभाग (पीईईटी) इस क्षेत्र के संसाधनों के मूल्य वर्धन के लिए और इस क्षेत्र के पर्यावरण के प्रबंधन के लिए प्रक्रियाओं और प्रौद्योगिकियों का विकास करता है। प्रदूषण नियंत्रण और उत्पादन में पीईईटी के नवाचारों ने उत्पादन जारी रखने के लिए कई उद्योगों की मदद की है। उद्योग और सरकार द्वारा सांविधिक पर्यावरण प्रभाव आकलन अध्ययन के लिए और खनन, बुनियादी ढांचे और प्रक्रिया उद्योग में नई परियोजनाओं की मंजूरी के लिए पीईईटी की पर्यावरण प्रबंधन सेवाओं का इस्तेमाल किया जाता है। पीईईटी के कम्प्यूटेशनल मॉडलिंग सर्विज, प्राकृतिक घटना की जांच के लिए और इंजीनियरिंग प्रक्रियाओं का डिजाइन करने के लिए कम्प्यूटेशनल उपकरण और सेवाएं प्रदान करता है। सीएसआईआर-एनआईआईसीटी का पीईईटी प्रभाग, श्रेणी “क” की परियोजनाओं में, एक ईआईए सलाहकार के रूप में एनएबीटी/एमओईएफ मान्यता प्रदान करने में केरल की अकेली एजेंसी है। पीईईटी के बहुविषयी समूह द्वारा संबोधित कुछ मुद्दे ये हैं -

- नगरपालिका और घरेलू अपशिष्ट उपचार
- औद्योगिक बहिष्प्राव उपचार और गंध नियंत्रण
- पर्यावरण में डाईऑक्सीनों और सतत कार्बनिक प्रदूषकों
- पर्यावरण प्रभाव का विश्लेषण और पानी की गुणवत्ता का विश्लेषण
- औद्योगिक अपशिष्ट निपटान से भूजल प्रदूषण
- अवायवीय प्रौद्योगिकी: पादप फाइबर की निकासी और सफेद मिर्च के उत्पादन के लिए रेटिंग
- मिट्टी के खनिजों का इष्टतमीकरण और मूल्य वर्धन
- सस्ती स्वदेशी सॉफ्टवेयर के माध्यम से छोटे और मध्यम पैमाने की ढलाई में लाभप्रदता में सुधार
- प्रक्रिया उद्योग में कम्प्यूटेशनल तरल गतिकी अनुप्रयोग
- जैविक प्रणालियों के व्यवहार को समझने के लिए एजेंट आधारित सिमुलेशन का विकास

प्रभाग की गतिविधियाँ चार अनुभाग के अंतर्गत हो रही है, अर्थात् रासायनिक प्रक्रिया इंजीनियरिंग, पर्यावरण प्रौद्योगिकी, कम्प्यूटेशनल मॉडलिंग और सिमुलेशन और डाईऑक्सीन अनुसंधान। इन अनुभागों की मुख्य गतिविधियाँ, नीचे सूचित की जाती हैं।

### मुख्य विशेषताएं

- एमएसएमई के आम हित की समस्याओं पर कार्य करने के लिए एमएसएमई में पर्यावरण इंटरवेंशन के लिए आम अनुसंधान और प्रौद्योगिकी विकास हब
- बीबीएमपी (बेंगलुरु नगर निगम) के लिए 500 टीपीडी एमएसडब्ल्यू प्रसंस्करण संयंत्र में गैस जैव फिल्टर का उपयोग करके गंध नियंत्रण प्रणाली का, पूर्ण पैमाने पर कार्यान्वयन
- ऑटोकास्ट XI वाणिज्यिक सॉफ्टवेयर अपग्रेड
- अलुवा में पेरक्लोरेट भूजल संदूषण के लिए योजना बनायी गयी
- केएमएमएल, चवरा में औद्योगिक अपशिष्ट निपटान के तालाबों से संदूषकों के प्रसार के लिए योजना बनायी गयी
- केले और अनानास फाइबर की निकासी के लिए प्रदर्शन संयंत्र कमीशन किया
- मछली खाना कारखाना, कक्कडम्पोयिल के लिए गैस जैवफिल्टर और प्रवाह उपचार संयंत्र कमीशन किया



## ENVIRONMENTAL TECHNOLOGY

### Gas biofilter for fish meal factory

A gas biofilter 28 m x 12 m as per NIIST design installed and commissioned at a 100 tpd fish meal factory at Wayanad district in Kerala.



### Effluent treatment plant for fishmeal factory effluent

Fishmeal is produced from non-table variety fish. The process involves cooking, pressing, separation of oil for oily fishes, and drying of press cake and de-oiled press water. Effluent generated from fishmeal factory is characterized by medium strength COD and high N/C ratio. Effluent treatment is required to remove both COD and N.

While anaerobic treatment can effectively remove COD from fishmeal factory effluent, ammonia is not removed. In order to achieve high quality treatment, an effluent treatment plant with nitrification and de-nitrification was designed and installed at M/s. Collagen Marine Products Ltd. Kakkadampoyil. The design was carried out using the Activated Sludge Model No.1 for simulation of variable load conditions. The plant gave very good performance, so much so, that the factory is reusing the treated water during water shortage.



*Fishmeal ETP showing an anoxic tank and one of the activated sludge tanks with submerged fine bubble diffusers*

### Perchlorate (rocket fuel) contamination of ground water

Perchlorate (rocket fuel) is an emerging micropollutant in the environment, which is known to cause hypothyroidism in human. This oxyanion ( $\text{ClO}_4^-$ ) is the primary oxidizer of fuel in rockets, missiles and explosives. CSIR-NIIST has identified perchlorate contamination of ground water as a serious public health problem at few places in Kerala where perchlorate is handled in bulk.

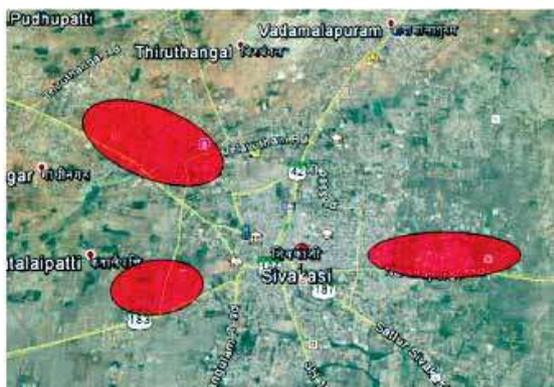
The institute has been monitoring the spatio-temporal distribution of perchlorate in the contaminated area around ISRO APEP plant in Keezhmad. It was found that even after one and a half year, the magnitude of contamination in the area is more or less the same, but variation in the conc. of perchlorate among the sampling wells was observed, probably due to the changes in hydrogeology in the area. There was a variation in the conc. of perchlorate in the lake water during the one year period. Maximum conc. was observed during March (7.7 to 19.5 ppm) and the lower values were observed during June (0.13 to 11.4 ppm). Recently the institute has also provided analytical support to the special committee constituted by the Ernakulam Dist. collector to study perchlorate contamination in Keezhmad area.



Positions of perchlorate contaminated community wells and pond in Keezhmad Panchayat.

## Perchlorate contamination of ground water in Sivakasi, Tamilnadu

Sivakasi is known for large number of fire-cracker manufacturing units. A preliminary assessment of perchlorate contamination in the area was undertaken during Jan 2015. Around 30 drinking water samples were collected from different points in Sivakasi and contaminations of both perchlorate and chlorate were found. The highest  $\text{ClO}_4^-$  conc. observed was 4500 ppb, and  $\text{ClO}_3^-$  was 1730 ppb. Places like Muthuramalingam nagar, Enjar, Vendiyaapuram, etc. were found severely contaminated. More detailed sample collection and analysis is required in that area and monitoring of thyroid functioning of people in the area also needs urgent attention. On public health point of view, this has been brought to the notice of local administration (Virudhunagar, TN).



Perchlorate contaminated places in Sivakasi area

## Bioremediation of perchlorate: Decontaminating perchlorate contaminated water in a prototype bioreactor

A microbial process for decontaminating perchlorate contaminated water was studied in a laboratory fixed-film type bioreactor. 5 ppm perchlorate water was continuously fed to the bioreactor. The microbial community that developed in the reactor under anoxic condition reduced perchlorate completely into non toxic chloride and oxygen. The reactor hydraulic retention time was ~3 hrs (51 L/day).

The redox potential of the reactor was maintained at -220 mV and pH around neutral range. Glucose was provided as substrate for supporting the microbial activity. The microbial community structure (Bacteria, Archaea and Protozoa) of the perchlorate reducing sludge was studied through molecular methods.



Perchlorate treating bioreactor

## Clean Technology for pulp processing

Natural fibres are available in plenty. Mechanical, chemical, chemi-mechanical processes are the major methods currently used in pulp and paper for the extraction of plant fibres and cellulose from plant biomass. It is observed that these methods have severe drawbacks such as fibre loss, fibre quality deterioration, environmental pollution, etc. Separation of these

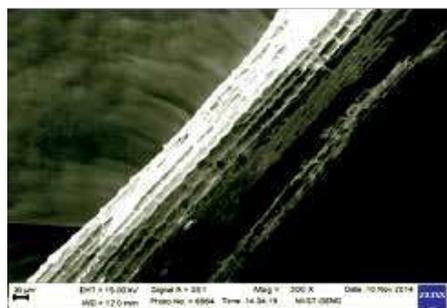
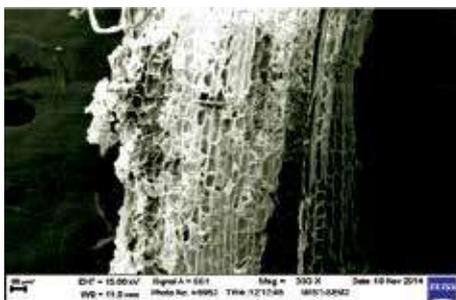


fibres without damage and pollution free are the requirement today for meeting our huge requirement in the paper & pulp industry.

In this work the non-woody fibre sources such as Zea maize, coconut plant frond bagasse were screened for pulp and paper using the anaerobic contact bed process (ACBP). The materials contain fibres, but could not be extracted effectively by the ACBP method. Alternatively a high solids anaerobic process was developed for the non-woody fibre extraction such as coconut leaf stalk.



*Clean fibres extracted by high solids anaerobic processing*



*Electron micrographs of coconut leafstalk fibre before and after anaerobic treatment*

## Commercialization of anaerobic digester cum biogas plant

An anaerobic treatment system cum biogas plant was developed and patented with a target to enable effective management of biomass wastes at household level. The major advantages of NIIST anaerobic digester include 1) an effective method to treat household biodegradable wastes at source, 2) compact and hygienic, 3) yields higher quantity of methane in the biogas, 4) composted wastes requires no further processing to use as organic fertiliser and 5) operation of the system requires no electricity. In the process of commercialisation technical support was provided to two licensees from Thane (W) and Ernakulam after obtaining the report from test marketing.



*Photograph of the commercial anaerobic treatment system cum biogas plant for household biomass wastes*

## Anaerobic treatment system for biomass wastes produced by commercial units

There are several operations such as hotels, canteens, hostels, apartment complexes, etc. in the country that produce biomass wastes (kitchen wastes) in the range of 50 -250 kg per day. On-site treatment of such wastes through anaerobic digestion enables wastes stabilization and production of biogas for fuel



application. In view of the above a high solids anaerobic digester was developed and operated in the institute with canteen wastes from April 2014. The installed experimental plant has the capacity to load more than 100kg/day.



*Photograph of the anaerobic digester for biomass wastes treatment at 100kg/day*

### **Demonstration plant for bioextraction of banana fibre**

Based on the anaerobic extraction method developed by the institute for plant fibres, a demonstration plant was installed for banana fibres with the financial support of DST, Govt. of India and self-help group, Kudumbashree at Kulathur, Thiruvananthapuram district, Kerala.



*Photograph of the demonstration plant set up for banana fibres at Kulathur, Thiruvananthapuram*

### **Development of coir fibre composite for acoustic applications**

The institute has been working in the area of coir fibres composites which could build up technological knowledge and expertise for developing materials to substitute wood in certain applications. Recognizing the competence in the area it was assigned the technical work for the development of coir fibre composite panel for acoustic applications by IIID-Kerala Chapter and National Coir Research and Management Institute, Govt. of Kerala. In this work a product was developed for acoustic application and tested the properties against the imported panels made up of glass and ceramic materials. Noise reduction coefficient (NRC) of the developed coir composite has similar values of the competing materials ranging from 0.50 to 0.6 for the ceilings.



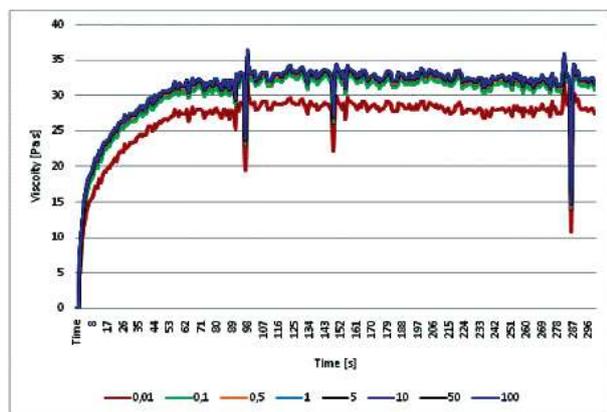
*Photograph of the coir composite panel developed for acoustic application*

### **Studies on settling and rheology of activated sludge**

Secondary treatment of activated sludge requires clarifiers occupying land areas as high as 1.5 hectares per influent flow rates of 1000 m<sup>3</sup>/day to achieve >90% settling efficiencies. The most effective way to reduce the settling area is by using stacks of tube/plate settlers. These settlers are used for various industrial sludges with the exception of activated sludge because of its non-Newtonian rheological behaviour. Rheological measurements were performed on

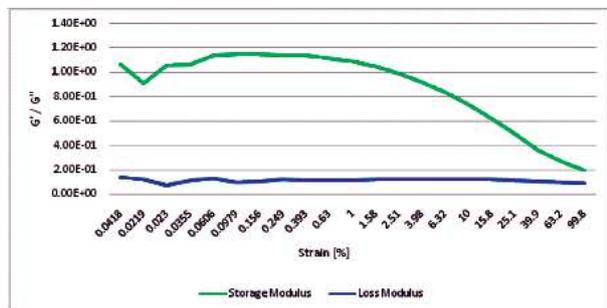


activated sludge collected from the Muttathara Sewage Treatment Plant (STP), Thiruvananthapuram. The viscosities as functions of time at shear rates ranged from 0.01 to 100  $s^{-1}$ . The viscosity flattened to a constant value after around 60 seconds. As the viscosity increased with increase in shear rate, the sludge shear was thickened. This means that the more the activated sludge is sheared the more is the resistance to flow. This may put a restriction on increasing the flow rate through settlers.



Viscosity of activated sludge as function of time at different shear rates.

The rheological measurements under oscillatory strain (strain sweep) were also performed. When the strain changed from 0.01% to 100%, the storage modulus  $G'$  and the loss modulus  $G''$  were fairly constant in the strain range from 0.1% to 1.0%, known as the Linear Visco Elastic (LVE) region. The determination of LVE region is important for performing frequency sweep measurements, which tells about the solid-like and liquid-like behaviour in activated sludge.



Storage and loss moduli of activated sludge as functions of strain.

With the measured rheological data, an innovative co-current tube settler was designed and fabricated out of poly carbonate sheets and tubes of square cross section. The tube settler after fabrication was subjected to hydraulic test to check for any leak before starting the experiments. Peristaltic pumps were connected to the inlet and underflow of the tube settler. Activated sludge was sent through the settler. The flow rates of inlet, underflow and overflow were measured by noting the volume of sludge collected in a particular time. The rotation speed of the peristaltic pump was adjusted to obtain the desired flow rates. The flow rate of the underflow was set as a percentage of the inlet flow rate (10%, 20%, 30% etc.). The total suspended solids (TSS) of the overflow was within the discharge standards, whereas that of the underflow was much higher than that of conventional clarifiers. This showed the efficiency of the tube settler fabricated in-house.



Photograph of the innovative co-current tube settler fabricated in-house at NIIST.

**Environmental impact assessment for renewal of mining lease and enhancement of mineral sand production from 2,50,000 tpa to 7,50,000 tpa in KMML Block-III along with mineral concentration and separation plant of KMML, Chavara, Kollam.**

The objective of the study is to identify the environmental impacts due to renewal of mining lease for



mining of beach sand minerals including mechanized dredge mining at KMML lease Block No: III covering an area of 88.119 hectares in Kollam district. The revised terms of reference has been accorded based on the presentation in mining appraisal committee at Ministry of Environment, Forest & climate Change. Coastal Zone Regulation (CRZ) clearance was obtained for all the four leases from the State Kerala Coastal Zone Management Authority (KCZMA). Hydrogeological survey, mapping of groundwater level, sampling of water and soil samples in the core and buffer zone of the study area were completed. Ambient air quality monitoring and social impact assessment study are in progress.

### **Environmental impact assessment (EIA) study for the old sludge ponds of Kerala Minerals & Metals Ltd (KMML), Chavara, Kollam**

The report of the study was submitted to KMML. Based on the measured reduced levels of 100 wells in the study area, it was ascertained that the flow of groundwater direction was predominantly towards Northwest, South west and to the west of the pond. Leachate from the iron oxide storage pond would influence the water quality of wells along the groundwater flow directions. The effect of seepage from storage pond was seen upto 1.2 km in the west and south west direction. The affected areas were in Ponmana, Mekkad and Chittoor of Panmana village of the Chavara Block Panchayat. Majority of the well water samples (61%) were acidic in character (pH values in the range 5-6.5). Iron content was higher than the permitted level (0.3mg/L) in 20 wells even after filtration. Aluminium was found to be present in significantly high levels (above 0.2 ppm) in 28 samples. Pollutant metals such as lead, cadmium, copper, silver and chromium were below the detection limits (< 1 ppb) in well water samples. The soil and sediment samples collected near wells showed high iron content, low pH, high TDS, and high chloride level. The pH, TDS, iron content, conductivity and chloride in these selected soil and well sediments showed pattern matching with groundwater water characteristics. The affected area was defined based on the following

criteria, pH < 6.5, filtered water iron > 1.0 mg/L, aluminium > 0.2 mg/L and manganese > 0.3mg/L. 74 hectares were identified as affected (using GIS). Mitigation measures were suggested as part of the report.

### **Specialty products based on engineered clays**

In the 12<sup>th</sup> Plan, NIIST is coordinating a network project involving 6 laboratories on the development of specialty products from engineered clays. The institute carried out analysis of clay deposits from various states the country to identify deposits that can be developed into cosmetic and pharmaceutical grade clay. The lead (Pb) content in many clay deposits was above the limits allowed in European and US pharmaceutical grade clays. The analysis has so far shown 3 deposits that can be used for preparation of export grade pharmaceutical clays.

### **COMPUTATIONAL MODELLING AND SIMULATION**

The Computational Modeling and Simulation Group make use of computational models for understanding and designing of processes like metal casting, mineral processing reactors and biological systems. This group is also involved in development of commercial technical software and providing computational support to other groups within the Institute. The focus this year has been on the development of additional modules of already commercialized **AutoCAST X1-FLOW+** software which is based on the **Virtual Casting Solver** technology and rendering technical support to 3D Foundry Tech Pvt. Ltd., Mumbai which is marketing and maintaining this product. In the area of biological modeling, an agent model has been developed to simulate the transmission of vector-borne disease (dengue) with emphasis on the mobility of humans in the spatial domain.

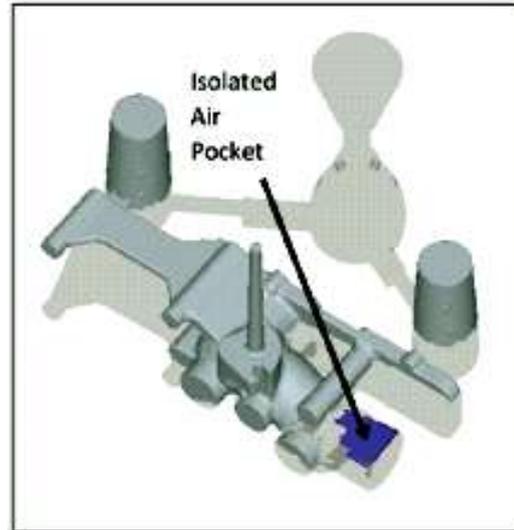
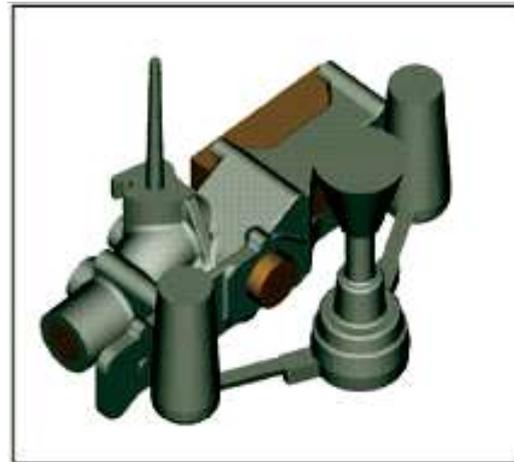
### **Development of new modules and rendering technical support for AutoCAST-X1-FLOW+ software**

Virtual Casting is a software package for the simulation of solidification process of industrial castings

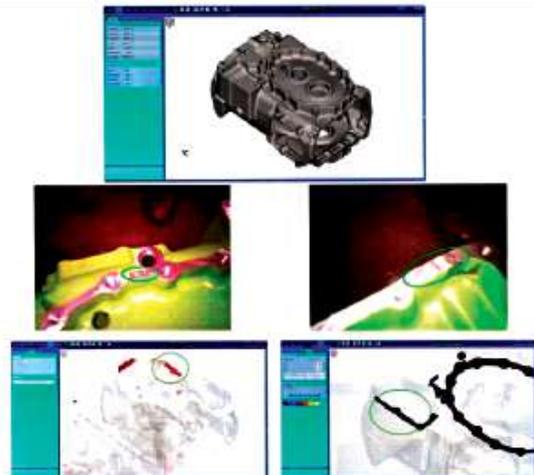


and was developed by CSIR-NIIST. In 2011, the Virtual Casting Solver technology was transferred to 3D Foundry Tech Pvt. Ltd., (3DFT). This company maintains and markets *AutoCAST* which uses an integrated easy to use environment for casting method design, solid modeling, and simulation. During 2012-13, Virtual Casting Solver was integrated with their casting design software *AutoCAST*, giving birth to *AutoCAST X1-FLOW+* software. During 2013-15, *AutoCAST X1-FLOW+* has been showcased at three Indian Foundry Exhibitions, and also being marketed in Far East (Taiwan, China and Japan). This led to 25 foundries and 7 educational institutes implementing the product (total 82 licenses). It has been used to train 1200 teachers from 200 colleges, by workshops conducted across the country.

The new module developed – ‘Gas and venting module’ is used to predict blowholes during filling for a given design. The module was exhibited at IFEX 2014. Currently the module is being benchmarked against industrial castings. The module was transferred to 3D Foundry Tech Pvt Ltd under a new license.



*Blow hole locations - experimental observations and predictions by **AutoCAST X1-FLOW+***

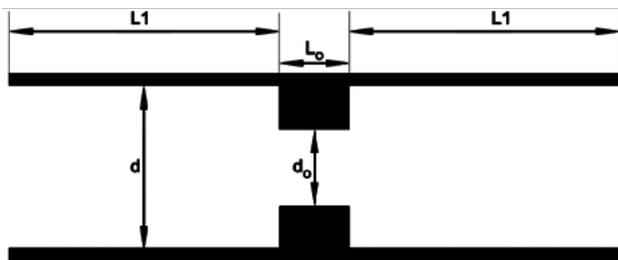


*Blow hole locations - experimental observation and prediction by **AutoCAST X1-FLOW+***



## CFD simulation of micro structured reactors (MSR's)

The institute is developing multi-scale models including reaction kinetics, heat and mass transfer for multi-phase micro-structured reactors (MSR's). CFD is used as an enabling technology for simulation of fluid dynamic parameters like pressure drop, mass transfer and heat transfer coefficient values for various combinations of micro channels. A correlation between the pressure drop across a circular orifice embedded within a micro-channel and the orifice Reynolds number has been developed based on CFD simulations.

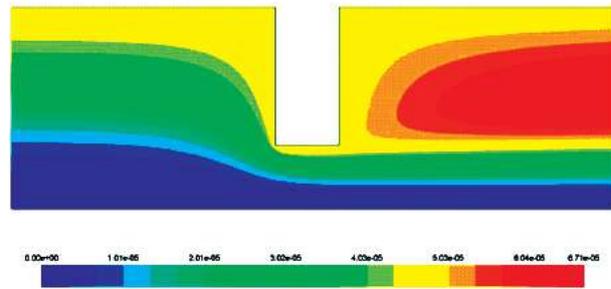


Schematic view of the circular micro channel with orifice in the centre

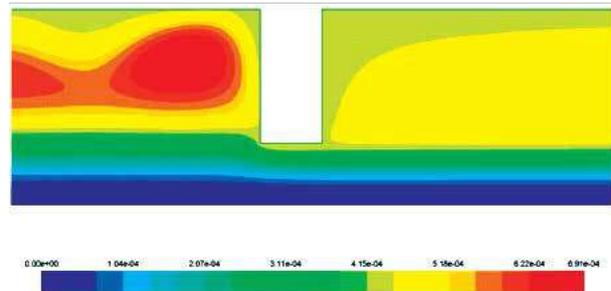
ANSYS-CFX was used to solve the Navier-Stokes equations for a steady state, incompressible Newtonian fluid flow through the system as appropriate for liquid flow in micro-channels larger than 0.1 mm. No-slip boundary conditions were applied at all solid surfaces as the impact of wall slip was expected to be negligible. A fully developed laminar flow profile with mean velocity,  $V$ , was imposed at the circular micro-channel inlet and the pressure at the micro-channel outlet was set to zero. The simulation was carried out for inlet velocity between 0.007 and 0.07 m/s, Reynolds number  $50 \leq Re \leq 500$ , fluid density  $1000 \text{ kg/m}^3$ , and fluid viscosity  $0.001 \text{ Pa}\cdot\text{s}$ . The computational geometry was discretized using tetrahedral elements inside the domain and prism elements at the wall. The channel geometry details are given in Table.

Table : Details of geometric parameters used for simulation

Geometry	Geometry Schematics	Number of Cells	Re	Open Area (%)	AS
G7-0.5		7	0.5	18	10
H7-1		7	1	18	10
G7-2		7	2	18	10
H7-0.5		7	0.5	28	10
H7-1		7	1	28	10
H7-2		7	2	28	10
H7-0.5		7	0.5	48	10
H7-1		7	1	48	10
H7-2		7	2	48	10



Contours of stream function (kg/s) for G7-0.5 for  $Re = 50$



Contours of stream function (kg/s) for G7-0.5 for  $Re = 500$

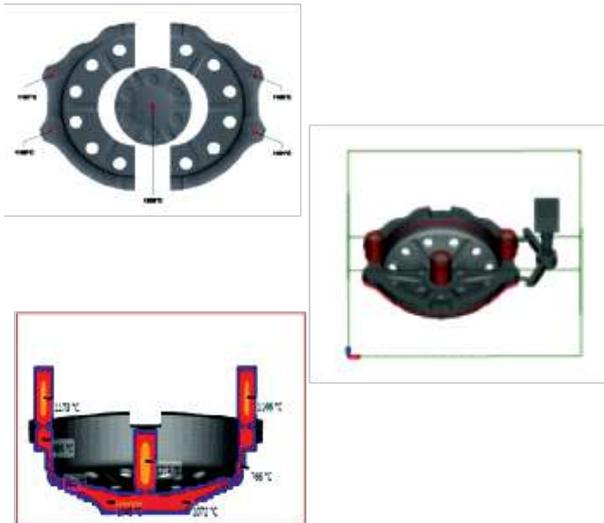
## Quantitative feeder design for metal castings

Casting simulation packages are used to check a design for its castability. A better starting design should need fewer simulation cycles to arrive at a defect-free component thus cutting computation and manpower costs. Virtual feed, a software for simulation-based quantitative feeder design, uses the solidification time/temperature data from the simulation to divide the casting into 3D feeding sections. The sections are created by following hotspots surrounded



by areas of decreasing solidification time. The algorithm becomes slow and hits the memory limit when the mesh elements exceed 15 million. In this new version, the neighbor finding algorithm which requires all the mesh elements to be present in memory, was replaced by a distance-based clustering scheme where the simulation data was divided into small chunks and loaded into memory sequentially. This has resulted in a faster algorithm with no memory limit, making it possible for complicated castings with large meshes to be processed in real time.

Feeders were built by the feeder design module of AutoCAST casting design software. The initial simulation and efficacy of the rigging was tested through Flow+ solidification module of AutoCAST. An industrial case study illustrated the software pipeline in a virtual foundry trial. The STL model of the bell housing steel component which weighs around 57 kg was imported. The material properties and process parameters were the input. The sand casting process has resin bonded sand as mold material. The pouring temperature was 1655°C. Five feeders having a total feeding weight of 7.86 kg were designed initially. Using Virtual Feed, the number of feeders was reduced to three with feeding weight of 4.34 kg and 92% yield. The feeders were created with the methoding module of AutoCAST.



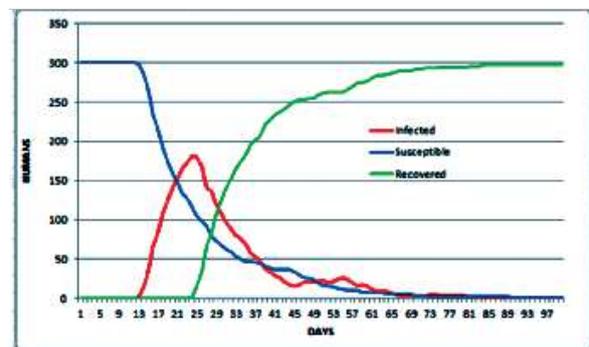
Feeding sections and feeders

Quantitative feeder design using a combination of software tools gave the number of feeders, where

to place them and the optimum size of feeders. Informed methoding can generate a design which will reduce the lead time and improve cast quality.

### Agent-based model for dengue transmission through a small population

A computational model was developed for simulating the transmission of dengue in a population under different mobility patterns of humans in a given area taking into account the geographical features of a region, as well as movement and behavior of mosquitoes. The short-term model aims to predict how one or more hotspots (with infected mosquitoes) spread through a region with humans moving in the space, resulting in an outbreak of dengue. The agents are mosquitoes, their eggs and human beings. The space in which the agents move is a grid which has landscape attributes (like vegetation, water body, etc.) and land use attributes (like canteen, offices, homes, shops etc.) assigned to the cells of the grid. Patches in the grid are the likely area for mosquitoes to breed and to lay eggs. The actions of agents (diffusion, sting, oviposition, movement, death) are triggered by the behaviour of other agents and the environment in which they move around. The epidemiological status of vector and host keep changing from susceptible to latent and infective. The rules for human and mosquito behavior with special reference to their mobility have been implemented. The mosquito's life cycle is considered from the egg hatching stage to death. Unnatural death of mosquitoes occurs if they are killed in a cleaning operation by humans. Assuming a daily pattern of human movement, the population graphs of humans with vector to human ratio equal to 2 is shown for a period of three months.



SIR graphs for human agents



# S & T SERVICE SECTIONS



## RESEARCH PLANNING AND BUSINESS DEVELOPMENT

### CONTRACT RESEARCH PROGRAMMES – 2014-15

SL NO	CLIENT	PROJECT TITLE	PROJECT LEADER
<b>AGROPROCESSING DIVISION</b>			
1	DST	A study on optimizing the material utilization in ayurvedic industry by replacing herbal roots by benign herbal parts and by developing new bio active application	Dr A Sundaresan
2	Dept of Agriculture, Govt of Kerala	Setting up of technology business incubation centre	Mr V V Venugopal
3	Dept of Agriculture, Govt of Kerala	Setting up a ginger processing plant at Wayanad	Mr V V Venugopal
4	DST	Study on the mechanism of anoikis in human mammary cancer cells, induced by a purified lectin from Morus alba L	Dr S Priya
5	HAFED, Haryana	Process development for blanching and drying of fresh turmeric	Mr V V Venugopal
6	DBT	Fluorescent probes for biosensing applications	Dr P Jayamoorthy
7	Spices Board, Cochin	Development of functional food products from spices and botanicals for better health management	Dr P Nisha
8	KSCSTE	Synthesis utility of dien aminodioate for synthesis of 1,2- dihydropyridines and its resulting derivatives for evaluational of their anti microbial, anti tuberculosis & anti malarial potential	Dr L Ravishankar
9	KSCSTE	Endophytic bacterial flora of the rice plants from the acidic soil of Kuttanad and their exploitation in improved paddy cultivation	Dr B S Dileepkumar
10	KSCSTE	Can enrichment of Palm Neera Syrup cause immunomodulation	Mrs M V Reshma
<b>BIOTECHNOLOGY DIVISION</b>			
11	DST	Glycerol based carbon acid catalyst for the production of ethanol and value added chemicals from biomass	Dr Ashok Pandey



12	MNRE	Sorghum stover based biorefinery for fuels and chemicals	Dr Ashok Pandey
13	DBT	Cloning and production of a genetically improved L asparaginase from <i>Escherichia coli</i>	Dr Ashok Pandey
14	Thermax Ltd	Bioprocess development for the production of L lactic acid, PGA and cellulose enzymes	Dr Ashok Pandey
15	DST	Biochemical and molecular investigation on stress mediated lipid accumulation and biomass productivity in microalgae	Dr Muthu Arumugham
16	DBT	Stereo selective synthesis of chiral alcohols of pharmaceutical importance via microbial oxido reductases: Process development and scale-up	Dr P Binod
17	DBT	Waste to wealth: Development of green process for the production of second generation biofuel from crop wastes	Dr R Sindhu
18	DST	Integrated technologies for economically sustainable bio- based energy	Dr Rajeev K Sukumaran
19	M/s DSM , India	Pretreatment of rice straw for bioenergy	Dr Ashok Pandey
20	DST	Improved cultivation, taxonomy and functional characterization of rare and novel rhizobacterial genomes of plants grown in abiotic stress soils	Dr N Ramesh Kumar
21	Ministry of Earth Sciences	Bioprospecting and taxonomic studies of marine micro organisms in search of novel anti-infectives	Dr N Ramesh Kumar
22	TIFAC	Centre for bio fuels Phase II	Dr Rajeev K Sukumaran
23	DST	Hydrotopic assisted pretreatment of ligno cellulosic biomass and adsorptive removal of fermentation inhibitors formed during pretreatment	Dr Leena Perumal Devendra
<b>CHEMICAL SCIENCES &amp; TECHNOLOGY DIVISION</b>			
24	IFCPAR	Development of fulvene based Zr (II) and Ti (II) chemistry: organometallics reactivity and applications in organic synthesis	Dr K V Radhakrishnan
25	DST	Organic and inorganic hybrid solar cells. Optimization of materials properties, Bulk Heterojunction morphology and device efficiencies( OISC/ Large Cells)	Dr K R Gopidas
26	DST	Investigation of conformational sub states and low frequency vibrational dynamics of native & non native Heme proteins	Dr Karunakaran Venugopal
27	DST	Green methods towards pharmaceutically impotent heterocycles & cyclo pentanoide	Dr K V Radhakrishnan



28	DST & SPAIN	Photodynamic therapy against the tumour vascular system	Dr Joshy Joseph
29	MNRE	Dye Sensitized Solar Cell (DSSC) quantum dot dye sensitized solar cell	Dr Joshy Joseph
30	ISRO	Development of bulk hetero junction solar cell based demo structure conducting polymer in organic hybrid composite for broad and solar spectrum	Dr J D Sudha
31	DST	Design and synthesis of multifunctional organic – DNA conjugates for biomolecular applications	Dr Joshy Joseph
32	KSCSTE	Development of biodegradable composites	Dr V S Prasad
33	DST	Cucurbit [n] uril homologues and their derivatives as receptors for a few ionic and neutral analytes	Dr Rakesh Mishra
34	DST	Design a smart drug delivery system using activatable cell penetrating peptides scaffold -based non- peptide carriers for targeting human cancer	Dr K K Maiti
35	DBT	Detection of zinc in epileptic condition using ratio metric probes	Dr Ajayaghosh
36	DST	Development of novel organic materials for photovoltaic applications	Dr C Vijayakumar
37	DST	Development of semi conducting pushpull polymers for photo voltaic applications	Dr B Bijitha
38	SERB	Utilization and activation of CO <sub>2</sub> via transition metal-mediated insertion reaction: A computational study	Dr V Prabha
39	KSCSTE	Silver starch hydrogel hybrid nano composite for anti microbial wound healing applications	Dr J D Sudha
40	SABIC, Saudi Arabia	Synthesis and development of photochromic dyes	Dr Mangalam S Nair
41	KSCSTE	Design, synthesis and structural properties of fluorescent protein chromophore based on organic materials. Metal organic framework membranes over porous substrate for Carbon Capture and Sequestration (CCS) applications	Dr Manoj
42	DST	J C Bose Fellowship- Design and synthesis of novel NIR absorbing squaraine dyes & star shaped donor accept molecular for optoelectric applications	Dr Suresh Das
43	DST	Solar Hydrogen: An alternative avenue	Dr Suraj Soman
44	DST	Application of linear scaling DFT methods on i) Electrochemical synthesis of graphene nanoribbon and ii) Diels aldur function alisation of graphenes	Dr Krishna Mohan
45	DST	Stimuli induced phase transition: A facile route to modulate optical properties in molecular crystals	Dr Sunil Vargheese



46	DST	Novel protocols for the construction of carbon-carbon and carbon- hetero atom bonds mediated by nucleophilic hetero cyclic carbenes and phosphines	Dr Vijay Nair
47	DST	Transition metal/ cyclic lewis acid mediated reactions of strained diazanorbornes and carbonyl compounds	Dr K V Radhakrishnan
48	DST	Sulfonimidamides: Its synthesis and applications in organic synthesis; Development of new methodologics for the synthesis of hetrocyclic systems	Dr Ganesh Chandra Nandi
<b>MATERIAL SCIENCE &amp; TECHNOLOGY DIVISION</b>			
49	DST	Supramolecular polyatomic nanomaterials with hierarchical morphologies	Dr Bhoje Gowd
50	ICDD	Generation and experimental powder diffraction data for new ceramic complex oxides	Dr P Prabhakar Rao
51	MHRD	Village community networks - technology development and pilot roll out plan for low cost opportunistic communication networks for rural areas of India	Dr M T Sebastain
52	DRDO	Design and development of environmentally friendly rare earth based NIR reflecting camouflage pigments for defence applications	Dr P Prabhakar Rao
53	M/s Schneider Electric DRC, France	Nano ceramic smart fillers for improving the thermal dissipation properly of epoxy polymer dielectrics	Dr S Ananthakumar
54	DST	Nano structured Ni based heusler alloys for magnetic refrigeration applications Part I Synthesis and physical characterization Part II Magnetic characterization	Dr Manoj Raama Varma
55	DST	Development of iron based superconductors	Dr U Syamaprasad
56	BRNS	Synthesis and spray granulation of lanthanum phosphate powders for thermal barrier coatings	Dr U S Hareesh
57	DST	Development of Mg Sb based alloy for high temperature applications	Dr U T S Pillai
58	KSCSTE	Development of rare earth based double peroskites $A_2\text{FeReO}_6$ (A= Sr, Ba, Ca, Ce, La, Nd)	Dr Manoj Raama Varma
59	Noritake Co Ltd, Japan	Adsorbants for gas and vapour molecules. Rational design of materials, porous nano structures and surface chemistry	Dr S Ananthakumar
60	BRNS	Development of photo catalytic reactor based on the wide spectrum nanotitania- organic hybrids for decomposition of dyes and recovery of precious additive / solvent on spent laser dye solution	Dr Saju Pillai
61	BRNS	Tailoring of magneto structural phase transitions near the room temperatures in inter metallic heusler alloys for the magnetic refrigeration applications	Dr Vasundhra



62	DST	Development and pilot scale production of microwave ceramic substrates and LTCC green tapes suitable for microwave circuits	Dr M T Sebastain
63	BRNS	Multicoloric effects in certain systems with magneto structural transisions	Dr Manoj Rama Varma
64	Binani Zinc Ltd	Development of high value ceramics and functional nanomaterials from Zn metal and zarosite resources produced by Binani Zinc Pvt Ltd	Dr S Ananthakumar
65	DST	Exchange biased magnetic heterostructures	Dr Senoy Thomas
66	DST	Dielectric inks for printed electronic: Materials to Devices	Dr K P Surendran
67	DST	Aluminium-Silicon piston alloy development by squeeze casting process for strategic application	Dr M Ravi
68	KSCSTE	Metal organic framework membranes over porous substrates for Carbon Capture and Sequestration (CCS) applications	Dr Seethalekshmy Sunil
69	DRDO	Development of aluminium piston by squeeze casting technology	Dr M Ravi
70	DST	Delaminated surfactant free layered double hydroxides as multifunctional fillers for semi crystalline polymers	Dr Bhoje Gowd
71	ICDD	Structural data of new ceramic complex oxides	Dr P Prabhkar Rao
<b>PROCESS ENGINEERING &amp; ENVIRONMENTAL TECHNOLOGY DIVISION</b>			
72	DST	Study of driven non equilibrium systems and biological processes	Dr Mamata Sahoo
73	KSCSTE	Development of modern and eco friendly beneficiation process and flow sheet for Kasargod & Kannur China clay	Dr P Raghavan
74	KSCSTE	Kinetics of respiratory enzymes involved in perchlorate reduction	Mrs Anupama
75	KSCSTE	Setting up of a demonstration plants for quality coir fibre production and bio energy recovery by closed retting	Dr V B Manilal
76	KSCSTE	Setting up of demonstration plants for pineapple leaf fibre and banana fibre using anaerobic extraction	Dr V B Manilal
77	DST	Novel hybrid nanostructured surface modified electrodes for sensors and biosensors	Dr Pratish
78	DSIR	Common research and technology development- Hub for environmental intervention in the MSME Sector	Dr Ajit Haridas

**CONSULTANCY PROGRAMMES**

Sl No	Client	Project Title	Project Leader
1	Dept of Agriculture, Govt of Kerala	Setting up of a ginger processing facility in Wayanad	Mr V V venugopal
2	Spices Board, Cochin	Technical evaluation of project proposals for technology upgradation process modification	Mr M M Sreekumar
3	M/s Parisons Food Private Ltd, Calicut	Development and standardization of Margarine formulation of Parisons Foods for application in the bakery products	Mrs M V Reshma
4	M/s Santhigram, Trivandrum	Perfection of ideas on molt type processing of quality jackfruit seeds into value added products & exploration of the feasibility of commercialization of the product	Dr P Nisha
5	M/s Vinvish Technologies Pvt Ltd, Trivandrum	Design and development of confocal microscope with super continuum white lazer source	Dr K Yoosaf
6	IRE	Mineralogical investigation of beach sediment sands by X-ray diffraction and optical microscopy	Mr H K Bhat
7	M/s V V Minerals	Scaled up studies metallization and rusting of low grade ilmenites and supply the products to V V Minerals	Mr H K Bhat
8	M/s HLL Life care Ltd, Trivandrum	Polymer nanocomposites	Dr Bhoje Gowd
9	M/s SRF Ltd	Microstructure analysis of Nylon-6 and polyster industrial yarns	Dr Bhoje Gowd
10	KMML	EIA for KMML project	Mr J Ansai
11	KMML	EIA study for KMML pond	Mr J Ansari
12	KSCSTE	Bioremediation of soil contaminated with perchlorate	Mr Prajesh
13	M/s 3D Foundary Tech Pvt Ltd, Mumbai	Additional module for flow for air blow hole identification during filling in casting	Dr S Savithri
14	WAPCOS	Marine study for 3 ports ( Bepore, Cochin Naval Base & Ratnagiri)	Mr J Ansari



15	Directorate General of Central Excise, Kochi	Evaluation of clays	Dr Ajit Haridas
16	Mr Cyriac Thomas	Coir composite horticulture box	Dr V B Manilal
17	Travancore Devaswam Board	Odour control of 5 MLD STP Sannidhanam	Dr Ajit Haridas
18	Institute of Indian Interior Designers	Development of coir fibre composite panel for acoustic applications	Dr V B Manilal
19	3D Foundary Tech Pvt Ltd	Additional module for Flow+ for prediction of fill related and solidification related defects in investment casting process	Dr S Savithri
20	Cochin University of Science & Technology	Screening of water samples for perchlorate contamination level	Dr B Krishankumar
21	PSV Seafood Thiruchendur	Fish meal factory odour control	Dr Ajit Haridas
22	IRE	EIA study for IRE block IV & IV EE, Kollam	Mr J Ansai
23	KUIDFC Ltd	Odour control for 500 TPD MSW composting at Kudlu and Lingadheernahalli	Dr Ajit Haridas



### List of MoU/Agreement

Sl No	Title	Date of signing	Nature of the MoU	Name of the firm/ firms with whom the MoU/ Agreement is entered into	Project leader
1	MoU for project titled Stereoselective synthesis of chiral alcohols of pharmaceutical importance via microbial oxidoreductases: Process development and scale up	12/04/2014	MoU	Department of Biotechnology	Dr Binod Parameswaran
2	MoU for obtaining funding from Ministry of New and Renewable Energy (MNRE) for a project titled "Sorghum stover based biorefinery for fuels and chemicals"	17/04/2014	MoU	CSIR-IICT, Tarnaka-Upal Road, Hyderabad 500 007, TERI Darbari Seth Block, IHC Complex, Lodhi Road, New Delhi - 110 003 & Motilal Nehru National Institute of Technology	Dr Ashok Pandey
3	Agreement for sponsored research for "Pre-treatment of rice straw for bio-energy"	21/04/2014	Agreement	DSM India Private Limited, # 401- 402, 4 <sup>th</sup> Floor NSG IT Park, Aundh Pune - 411 007 India	Dr Ashok Pandey
4	Agreement for release of PHASE II funding for Centre for Biofuels	21/04/2014	Agreement	Technology Information, Forecasting and Assessment Council (TIFAC), DST	Dr Ashok Pandey
5	MoU for project titled Waste to Wealth: Development of green process for the production of second generation biofuel from crop waste	21/04/2014	MoU	Department of Biotechnology	Dr Ashok Pandey/ Dr R Sindhu
6	MoU for revenue sharing in future on licensing of patents being filed.	05/05/2014	MoU	IISER, Computer Science Building, College of Engineering (Transit Campus), Thiruvananthapuram - 695 016	Business Development Division



7	NDA for assessing deconstruction technology to make cellulosic sugars and ethanol product from cellulosic sugars	07/05/2014	Agreement	Reliance Industries Ltd., Maker Chambers IV, 3 <sup>rd</sup> Floor, 222 Nariman Point, Mumbai- 400021	Dr Ashok Pandey
8	Agreement for transfer of microbial strain technology	22/05/2014	Technology Transfer	THERMAX Ltd., D-13, MIDC Industrial Area, RD Aga Road, Chinchwad, Pune - 411009	Dr Ashok Pandey
9	Material Transfer Agreement (MTA) and NDA for evaluating the suitability of pre-treated lingo-cellulosic biomass with NIIST enzymes to produce fermentable sugars	22/05/2014	Agreement	PRAJ Industries Ltd., 'Praj' Tower', 274 & 275/2, Bhumkar-Chowk-Hinjewadi Road, Hinjewadi, Pune - 411057	Dr Ashok Pandey
10	Mou for collaboration in areas of mutual interest	04/06/2014	MoU	HLL Life Care Ltd., HLL Bhavan, Poojappura, Thiruvananthapuram-695 012	Business Development Division
11	Mutual NDA for standardization of margarine formulations for application in bakery products	04/06/2014	Agreement	PARRISONS Foods Pvt. Ltd., 6/1183, Cherootty Road, Calicut - 673 032	Ms M V Reshma
12	MoU for research collaboration titled "Can enrichment of palm neera syrup cause immunomodulation"	27/06/2014	MoU	JNTBGRI, Palode, Thiruvananthapuram, Kerala-695 562	Dr B Dileep Kumar
13	MoU for detailed scientific analysis of different medicinal plants	08/07/2014	MoU	Swaminathan Foundation, Taramani, Chennai 600 113	Dr K V Radhakrishnan
14	Consultancy agreement for Acoustic panels with coir fibre	24/7/2014	Agreement	Institute of Indian Interior Designers (IIID), 2 <sup>nd</sup> Floor, Alpha Plaza Building, K P Vallon Road, Kadavanthra, Kochi-682020	Dr V B Manilal
15	Consultancy agreement for Coir composite boxes for horticulture applications	27/08/2014	Agreement	Mr Cyriac Thomas, 24/1 <sup>st</sup> Cross, New Mission Compound, Bangalore 560 027	Dr V B Manilal
16	MoU for collaborative work on natural product screening	01/09/2014	MoU	Regional Cancer Centre, Thiruvananthapuram	Dr K V Radhakrishnan



17	NDA for scale up of IR reflective rare earth blue pigment	10/9/2014	Agreement	M/s CeraDecor India Ltd, New Delhi	Dr S Ananthakumar
18	Agreement for technology transfer on white pepper	16/09/2014	Technology Transfer	Mr Niranjana, Coffee Planter, Sakleshpur-573134, Hassan District, Karnataka	Dr V B Manilal
19	NDA for scaled operations of metalization and aeration rusting of two grades of ilmenites	19/09/2014	Agreement	V V Mineral, Thirunelveli	Dr H K Bhat
20	Household waste to biogas generation technology	25/09/2014	Agreement	M/s Panch-Tatva Technologies & Services Thane	Dr V B Manilal
21	Polymer based nano composites	10/10/2014	Agreement	HLL Lifecare Ltd , Thiruvananthapuram	Dr E Bhoje Gowd
22	Additional module for FLOW+ for predicting defects during filling and solidification in investment casting process	15/10/2014	Agreement	3D Foundry Tech Pvt. Ltd, CM-05, SINE, CSRE, IIT-B, Powai, Mumbai 400 076	Dr S Savithri
23	MoU for research and development of nanocarrier based delivery system for targeted cancer drug delivery	16/10/2014	MoU	Regional Cancer Centre, Thiruvananthapuram	Dr K K Maiti
24	Structural data of new ceramic complex oxides	10/12/2014	Agreement	International Center for Diffraction Data 12, Campus, USA	Dr P Prabhakar Rao
25	Collaborative Research MoU on Non toxic IR reflecting blue pigments from rare earths having solar heat control property	11/12/2014	MoU	CeraDecor, Jasola, New Delhi	Dr P Prabhakar Rao
26	DSIR-BIRD-crf scheme: Partial financial support from DSIR-Government of India	15/12/2015	Agreement	DSIR, Govt of India	Dr Ajit Haridas
27	Technology transfer on nano-TiO <sub>2</sub>	19/02/2015	Technology Transfer	M/s Krishna Con Chem, Mumbai	Dr U S Hareesh



## PATENTS

### FILED IN INDIA

NF No	Title	Inventors	Filing Date	Application No
0112NF2014/IN	NEW INORGANIC BLUE PIGMENTS FROM COBALT DOPED MAGNESIUM HAVING TRANSITION ELEMENT OXIDES AND A PROCESS FOR THE PREPARING THE SAME	PADALA PRABHAKAR RAO, SARASWATHY DIVYA	22/SEP/2014	2706DEL2014
0163NF2014/IN	LANTHANUM PHOSPHATE BASED COATINGS AND MONOLITHS AS NON-REACTIVE SURFACES FOR MOLTEN METALS	SANKAR SASHIDHARAN, RAJESH KOMBAN, ABDUL AZEEZ PEER MOHAMED, SOLAIAPPAN ANATHAKUMAR, UNNIKRISHNAN NAIR SARASWATHY HAREESH, KRISHNA GOPAKUMAR WARRIER	24/SEP/2014	2737DEL2014

**FILED IN FOREIGN COUNTRIES**

NF No	Title	Inventors	Filing Date	Application No
0022NF2013/ WO	SEMICONDUCTOR OXIDE NANOTUBES-FLYASH AND SEMICONDUCTOR OXIDE NANOTUBES-METAL OXIDE COMPOSITE PARTICLES, THEIR PROCESSING VIA ION-EXCHANGE MECHANISM, AND METHODS FOR THEIR RECYCLING IN THE DYE-REMOVAL APPLICATION THEREOF	SHUKLA SATYAJIT VISHNU, PADINHATTAYIL HARREESH, NARAYANI HARSHA, JOSE MANU, KARUNKARAN REMYA	12/MAY/2014	PCT/ IN2014/000324
0022NF2013/ CN	SEMICONDUCTOR OXIDE NANOTUBES-FLYASH AND SEMICONDUCTOR OXIDE NANOTUBES-METAL OXIDE COMPOSITE PARTICLES, THEIR PROCESSING VIA ION-EXCHANGE MECHANISM, AND METHODS FOR THEIR RECYCLING IN THE DYE-REMOVAL APPLICATION THEREOF	SHUKLA SATYAJIT VISHNU, PADINHATTAYIL HARREESH, NARAYANI HARSHA, JOSE MANU, KARUNKARAN REMYA	2/MAY/2014	PCT/ IN2014/000324
0022NF2013/ TW	SEMICONDUCTOR OXIDE NANOTUBES-FLYASH AND SEMICONDUCTOR OXIDE NANOTUBES-METAL OXIDE COMPOSITE PARTICLES, THEIR PROCESSING VIA ION-EXCHANGE MECHANISM, AND METHODS FOR THEIR RECYCLING IN THE DYE-REMOVAL APPLICATION THEREOF	SHUKLA SATYAJIT VISHNU, PADINHATTAYIL HARREESH, NARAYANI HARSHA, JOSE MANU, KARUNKARAN REMYA	16/MAY/2014	103117292
0188NF2011/JP	A NOVEL METHOD OF DEVELOPING NANO-STRUCTURED SILVER OXIDE FILM BASED AQUEOUS VOLTAMMETRIC PESTICIDE SENSOR	PANAMPILLIL VIJAYAMMA SUBHA, VARGHESE SAUMYA, TALASILA PRASADA RAO	25/JUL/2014	Awaited



0188NF2011/ CN	A NOVEL METHOD OF DEVELOPING NANO-STRUCTURED SILVER OXIDE FILM BASED AQUEOUS VOLTAM-METRIC PESTICIDE SENSOR	PANAMPILLIL VIJAYAMMA SUBHA, VARGHESE SAUMYA, TALASILA PRASADA RAO	30/JUL/2014	201380007195.6
0014NF2012/EP	IMPROVED ANAEROBIC DIGESTER FOR HOUSEHOLD ORGANIC WASTES	VATTACKATT BALAKRISHNAN MANILAL	19/AUG/2014	13721120.7
0014NF2012/LK	IMPROVED ANAEROBIC DIGESTER FOR HOUSEHOLD ORGANIC WASTES	VATTACKATT BALAKRISHNAN MANILAL	17/SEP/2014	17909
0014NF2012/BR	IMPROVED ANAEROBIC DIGESTER FOR HOUSEHOLD ORGANIC WASTES	VATTACKATT BALAKRISHNAN MANILAL	18/SEP/2014	1120140231508
0014NF2012/ CN	IMPROVED ANAEROBIC DIGESTER FOR HOUSEHOLD ORGANIC WASTES	VATTACKATT BALAKRISHNAN MANILAL	18/SEP/2014	201380014935.9
0022NF2013/US	SEMICONDUCTOR OXIDE NANOTUBES-FLYASH AND SEMICONDUCTOR OXIDE NANOTUBES-METAL OXIDE COMPOSITE PARTICLES, THEIR PROCESSING VIA ION-EXCHANGE MECHANISM, AND METHODS FOR THEIR RECYCLING IN THE DYE-REMOVAL APPLICATION THEREOF	SHUKLA SATYAJIT VISHNU, PADINHATTAYIL HARREESH, NARAYANI HARSHA, JOSE MANU, KARUNAKARAN REMYA	13/ MAR/2015	14/428,131

## GRANTED IN INDIA

Title	Inventors	Grant Date	Patent No
PYRROLE END-CAPPED BIPYRIDINE ASSAY POWDER FOR SELECTIVE DETECTION OF ZINC IONS AND A PROCESS FOR THE PREPARATION THEREOF	AYYAPANPILLA AJAYAGHOSH, SIVARAMAPANICKER SREEJITH	06/FEB/2015	265110

**GRANTED IN FOREIGN COUNTRIES**

Title	Inventors	Grant Date	Patent No
A TRANSPARENT CHITAM GEL AND A PROCESS FOR THE PREPARATION THEREOF	THOLATH EMILIA ABRAHAM, CHANDROTH KALYAD SIMI	02/APR/2014	ZL200980149968.8
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 KARIUMPANOR JOHN, KUMARA PILLAI RAJENDRA PRASAD, SIVARAMAN SAVITHRI	10/APR/2014	10394356B4
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	23/APR/2014	1966326
PREPARATION OF GREEN COLORANT FROM MIXED RARE EARTH AND MOLYBDENUM COMPOUNDS AND PROCESS THEREOF AS SURFACE COATINGS	MUNDLAPUDI LAKSHMIPATHI REDDY	10/ MAY/2014	2515331
A TRANSPARENT CHITAM GEL AND A PROCESS FOR THE PREPARATION THEREOF	THOLATH EMILIA ABRAHAM, CHANDROTH KALYAD SIMI	11/JUL/2014	5575798
PREPARATION OF GREEN COLORANT FROM MIXED RARE EARTH AND MOLYBDENUM COMPOUNDS AND PROCESS THEREOF AS SURFACE COATINGS	MUNDLAPUDI LAKSHMIPATHI REDDY	30/JUL/2014	ZL201080017745.9



A PROCESS FOR THE PREPARATION OF NOVEL NON-TOXIC YELLOW INORGANIC COLORANT/PIGMENT FROM SAMARIUM AND MOLYBDENUM COMPOUNDS	MUNDLAPUDI LAKSHMIPATHI REDDY	31/JUL/2014	2009343120
A PROCESS FOR THE PREPARATION OF NOVEL NON-TOXIC YELLOW INORGANIC COLORANT/PIGMENT FROM SAMARIUM AND MOLYBDENUM COMPOUNDS	MUNDLAPUDI LAKSHMIPATHI REDDY	20/SEP/2014	2528668
PROCESS FOR THE PRODUCTION OF VIOLACEIN AND ITS DERIVATIVE DEOXYVIOLACEIN CONTAINING BIOACTIVE PIGMENT FROM CHROMOBACTERIUM SP. (MTCC5522)	KRISHNAKUMAR BHASKARAN	11/ NOV/2014	8883461
PROCESS FOR THE PRODUCTION OF VIOLACEIN AND ITS DERIVATIVES CONTAINING BIOACTIVE PIGMENT FROM CHROMOBACTERIUM SP. NIIST-CKK-01	KRISHNAKUMAR BHASKARAN	12/ NOV/2014	2545181



## KNOWLEDGE RESOURCE CENTRE

The Knowledge Resource Centre fosters the research and development activities of NIIST through its wide-ranging services such as specialized collection of documents; facilitating access to the electronic journals and databases of major publishers; offering value added information services; IT backup support to the scientific fraternity. KRC also offers the essential IT services to the institute that involve planning, installation, operation, enhancement and maintenance of IT infrastructure of the laboratory. With its highly sophisticated technology backup, quality services, technical expertise, well-positioned staff and dissemination of information, KRC could retain its status as one of the most essential supporting sections of the institute during 2014-15 also.

During the period 2014-15, KRC took measures to enhance the existing collection of documents and information resources including Books, Periodicals, CD-ROM databases, PhD Thesis and, to continue with and provide access to additional knowledge-based electronic resources for the benefit of the user community. The existing internet bandwidth was enhanced from 14 Mbps to 16 Mbps dedicated leased line in addition to the 100Mbps leased line from National Knowledge Network to fulfill all the Internet requirements of the lab during the reporting year. Both the links are being regularly monitored using web based tool that enables to gain a real-time, end-to-end view with respect to system and network performance.

National Knowledge Network Bandwidth (NKN BW) used to enable WAN-based research collaboration across all the research institutes interconnected over (NKN BW).

The software package currently used for in-house library operations is Libsuite, the integrated information management system for library automation. A notable achievement of the period was the introduction of KOHA, the open source software for library activities in addition to the existing Libsuite. All the modules and data from Libsuite could be migrated to KOHA which facilitates database management, issue and return of documents, and access to Online Public Access Catalogue (OPAC).

### RESOURCES:

**Print collection:** The total print collection has crossed 45500 documents which includes 13,239 Books, 10947 Standards and 11387 Bound Volumes of Periodicals. During 2014-15, 100 books were added to the collection and 67 foreign and 81 Indian periodicals were subscribed including 50 titles in online version. 9 periodicals and 13 books were received gratis.

**e-Resources:** KRC could provide effective online access to more than 4000 leading journals of major publishers and 5 prominent Science & Technology bibliographic and full text databases under the National Knowledge Resource Consortia of CSIR and DST Labs. The usage of these resources was overwhelming. To



promote awareness of library services and resources and to enhance the level of usage of the embedded wealth of knowledge, promotional programmes were carried out at frequent intervals. This included regular announcements and broadcasting of messages of new facilities/ services initiated and hosting in the intranet with search links to each item. Trial access to various e-resources was also enabled for researchers.

During the period, researchers could access full text journal databases of major publishers such as American Chemical Society, Elsevier, Institute of Electrical and Electronics Engineers, Nature Publishing Group, Royal Society of Chemistry, Science Magazine, Springer, Taylor & Francis and Wiley – Blackwell. Access was also activated to SCI-Finder, a research discovery application that provides unlimited access to the world's most comprehensive and authoritative information in chemistry and related sciences. Web of Science- Science Citation Index expanded assisted the scientists and students in their literature search and in the analysis of their publications.

Patent databases Derwent Innovations Index and Qpat fully supported the patent information requirements of the institute. The ASTM Standards for a wide range of materials, products, systems and services were subscribed to improve product quality and enhance safety. These were referred profusely by the scientific fraternity. Subscription to Grammarly, writing support tool and plagiarism prevention tool was an added boon to the staff as a whole.

**Information Technology Infrastructure :** A state-of-the-art data center maintains high end servers, storage devices, UTM devices and core switches which provides high speed network through dedicated leased lines on OFC link with Ethernet and wireless connectivity to all researchers. These 24X7 services with 100% throughput and >99% network uptime cater to the bandwidth of critical applications and in-

ternet browsing, data upload/download, emails, video conferencing etc.

All the buildings in the campus are interconnected through gigabit fiber optic backbone. Separate VLANs have been created to connect a large no of High end personal computers to the campus network. Wi-Fi facilities are implemented covering all areas of NIIST with a secured wireless network. 250 new wired connections had been given to the state-of-art Silver Jubilee and 85 wired connections to the Biotechnology buildings apart from maintaining existing around 800+ internet connections through wired and wireless network. Division also provides secured VPN connectivity to allow scientists to connect to their NIIST office computers from home.

KRC had deployed a security UTM device for secured data access routing, load balancing, fail-over and also maintains an IP based surveillance system and maintains state-of-the-art server/storage hardware consisting of latest technology to manage the network and application resources

## SERVICES

**Library services:** All the in-house databases of books, periodicals, Ph.D. theses, publications of NIIST scientists, etc were updated regularly and made available through NIIST website as well as through Intranet. KRC continued to extend the resource facilities and services to external users especially to those from Industrial, R & D and Academic sectors. NIIST KRC was visited and used by nearly 500 persons from institutes and universities in and around Kerala. Database searches were carried out by KRC staff based on specific requests from scientists and students and this included searches on citation database, and databases of Standards and Patents. The NIIST Institutional Repository was updated and consists of 1238 journal articles, 224 PhD Theses and 114 News items. Reprographic and Photographic services were rendered as a



general Laboratory facility. KRC maintained excellent rapport with nearby institutes, all CSIR and DST labs and other R & D institutes which facilitated resource sharing and interlibrary loan activities.

**Scientometric service:** Continued the Bibliometric/Scientometric/Impact Factor Analysis of NIIST Publications using Journal Citation Report and Web of Science - Science Citation Index Expanded. Necessary assistance was offered for publishing in journals with high Impact Factor.

**Information Technology services:** All scientist, staff and research students are provided with institutional e-mail id through open source Zimbra E-mailing system for powerful and speedy means of communication. The mail server is well equipped with adequate anti-virus, anti-spam and intrusion prevention systems. The institutional websites are being developed, hosted, maintained and updated regularly in bilingual format as a part of Official language implementation. All the internal information, guidelines and announcements are hosted regularly on intranet website. Conference sites were developed specially for International Conference on Advanced Functional Materials (ICAFM-2014) and TFOC 2014, a conference on Transcending Frontiers in Organic Chemistry. The sites are maintained by regular updating of the contents.

The smooth functioning of all desktops, laptops and other computer peripherals is being ensured through an annual maintenance contract with a local agency. A help desk is maintained to help users in solving issues related to software installations, re-installations, repairs, software updates, network and IT related issues. The lab also manages various applications like Stores and Purchase Software, D-Space for Institutional Repository, Libsuite, Chemdraw, Sigma-plot and Origin. A backup solution was also installed for generating periodic backup of the applications and also backup for mails and website contents. KRC

procured licenses for deploying server grade antivirus software which provides virus-free network environment at NIIST. KRC implemented online recruitment processing system for the selection of Assistants and Stenographers. The unit provides printing and scanning facility through a wide variety of printers such as Heavy Duty Color Multi-Function Laser Printers and A3/A4 Scanners to all researchers.

The division designed and issued Institutional ID cards to all the staff, research scholars, project students and pensioners. KRC has taken extensive initiatives in implementing the CSIR-ERP system.

### Trainings organized by KRC

1. Demonstration-cum-training programme on '**Grammarly**', Writing Support Tool and Plagiarism checker, **25<sup>th</sup> of Sep 2014**. Resource person Mr. Suresh Narayanan, Director – Learning Solutions, Technology Division, Bridge People Consultancy Services, Bangalore.
2. Training session on **Web of Science**, **19<sup>th</sup> November 2014**. Resource person Basha Kodidela, Manager, Customer Relationship Management with Thomson Reuters for IP & Science Division
3. Training session on **Questel's Orbit Patent Database**, **17 Dec 2014**. Resource person Ms Nurjahan M, IPR Product Expert



## LIST OF PUBLICATIONS: 2014

1. RENJITH (S), PRASADA RAO (T) and SUDHA (J D)  
Bio-based ionic liquid crystalline quaternary ammonium salts: Properties and applications  
***ACS Applied Materials and Interfaces* 6 (6):4126-4133;26 Mar 2014**
2. LINSHA (V), TALASILA (S), PEER MOHAMED (A A) AND ANANTHAKUMAR (S)  
Mesochanneled hierarchically porous Aluminosiloxane Aerogel Microspheres as a stable support for pH-responsive controlled drug release  
***ACS Applied Materials and Interfaces* 6(17):15564-15574;10 Sep 2014**
3. AJITH KUMAR (K K), ABHILASH (V), RAJAN (T P D), PILLAI (U T S) AND PAI (B C)  
Physical, mechanical, and tribological attributes of stir-cast AZ91/SiCp composite  
***Acta Metallurgica Sinica (English Letters)* 27(2):295-305;Apr 2014**
4. RAJAN (T P D) AND PAI (B C)  
Developments in processing of functionally gradient metals and metal-ceramic composites: A review  
***Acta Metallurgica Sinica (English Letters)* 27(5):825-838;Oct 2014**
5. BABITHA (K B), WARRIER (K G K) AND SHUKLA (S)  
Decolorization of aqueous solution containing Organic Synthetic-Dye via Dark-Catalysis process using hydrothermally synthesized semiconductor-oxides nanotubes  
***Advanced Science, Engineering and Medicine* 6(2):173-183;Feb 2014**
6. SAMANTA (A), DAS (R K), PARK (S J), MAITI (K K) AND CHANG (Y T)  
Multiplexing SERS nanotags for the imaging of differentiated mouse embryonic stem cells (mESC) and detection of teratoma in vivo  
***American Journal of Nuclear Medicine and Molecular Imaging* 4(2):114-124;2014**
7. ADARSH (N), MEGHA (S K) AND RAMAIAH (D)  
Sensitive naked eye detection of Hydrogen Sulfide and Nitric Oxide by Aza-BODIPY dyes in aqueous medium  
***Analytical Chemistry* 86(18):9335-9342;16 Sep 2014**



8. ANEESH (P K), SINDHU (R N), PRASADA RAO (T) AND AJAYAGHOSH (A)  
Electrochemically synthesized partially reduced graphene oxide modified glassy carbon electrode for individual and simultaneous voltammetric determination of ascorbic acid, dopamine and uric acid  
***Analytical Methods 6(14):5322-5330;21 Jul 2014***
9. MANU KRISHNAN, SEEMA (S), VINOD KUMAR (A), VARTHINI (N P), SUKUMARAN (K), PAWAR (V R) AND ARORA (V)  
Corrosion resistance of surface modified nickel titanium archwires  
***Angle Orthodontist 84 (2):358-367;2014***
10. SALINI (C P), NISHY (P), VISHNUMAYA (R S) AND MINI (S)  
A bibliometric evaluation of organic chemistry research in India  
***Annals of Library & Information Studies 61(4): 332-342; Dec 2014***
11. KUMAR (S N), BALA NAMBISAN, SUNDARESAN (A), MOHANDAS (C) AND ANTO (R J)  
Isolation and identification of antimicrobial secondary metabolites from *Bacillus cereus* associated with a rhabditid entomopathogenic nematode  
***Annals of Microbiology 64(1):209-218;Mar 2014***
12. VARSHA (K K), PRIYA (S), DEVENDRA (L) AND NAMPOOTHIRI (K M)  
Control of spoilage fungi by protective lactic acid bacteria displaying probiotic properties  
***Applied Biochemistry and Biotechnology 172(7):3402-3413;Apr 2014***
13. NISHANTH KUMAR (S), RAVI S LANKALAPALLI AND DILEEP KUMAR (B S)  
In vitro antibacterial screening of six proline-based cyclic dipeptides in combination with beta-lactam antibiotics against medically important bacteria  
***Applied Biochemistry and Biotechnology 173(1):116-128;May 2014***
14. PRIYA RANI (M), RAGHU (K G), MANGALAM S NAIR AND PADMAKUMARI (K P)  
Isolation and Identification of alpha-Glucosidase and Protein Glycation Inhibitors from *Stereospermum colais*  
***Applied Biochemistry and Biotechnology 173(4):946-956;June 2014***
15. MISHRA (A K), MORANG (P), DEKA (M), NISHANTH KUMAR (S) AND DILEEP KUMAR (B S)  
Plant growth-promoting Rhizobacterial Strain-Mediated induced systemic resistance in Tea (*Camellia sinensis* (L.) O. Kuntze) through Defense-Related Enzymes against Brown Root Rot and Charcoal Stump Rot  
***Applied Biochemistry and Biotechnology 174(2):506-521;Sep 2014***
16. NISHA (V M), ANUSREE (S S), PRIYANKA (A) AND RAGHU (K G)  
Apigenin and Quercetin Ameliorate Mitochondrial alterations by Tunicamycin-Induced ER stress in 3T3-L1 Adipocytes  
***Applied Biochemistry and Biotechnology 174(4):1365-1375;Oct 2014***



17. **DHANYA (M) and NAMPOOTHIRI (K M)**  
Synthesis, colloidal properties and cytotoxicity of Biopolymer nanoparticles  
***Applied Biochemistry and Biotechnology 174 (6):2181-2194;Nov 2014***
  
18. **ROHINI (K N), SUDHA (J D) AND PRASADA RAO (T)**  
Robust fibrillar nanocatalysts based on silver nanoparticle-entrapped polymeric hydrogels  
***Applied Catalysis A: General 483:31-40;05 Aug 2014***
  
19. **KRISHNAPRASAD (P S), MOHANAN (P), SUBODH (G), SEBASTIAN (M T) AND JAYARAJ (M K)**  
A novel Sr<sub>3</sub> Pb<sub>6</sub> Ce<sub>2</sub> Ti<sub>12</sub> O<sub>36</sub> ferroelectric thin film grown by pulsed laser ablation  
***Applied Physics A: Materials Science and Processing 116(1):199-206;Jul 2014***
  
20. **SENOY THOMAS, NISSEN (D) AND ALBRECHT (M)**  
Temperature dependent magnetization reversal of exchange biased magnetic vortices in IrMn/Fe micro-caps  
***Applied Physics Letters 105(2):Art No. 022405;14 Jul 2014***
  
21. **KRISHNAKUMAR (P), LAKSHUMANAN (C), JONATHAN (M P), SUNDARARAJAN (M) AND NAVARRE-TE-LOPEZ (M)**  
Trace metal in beach sediments of Velanganni Coast, South India: Application of autoclave leach method  
***Arabian Journal of Geosciences 7(7):2655-2665;Jul 2014***
  
22. **THIVYA (C), CHIDAMBARAM (S), THILAGAVATHI (R), PRASANNA (M V), SINGARAJA (C), NEPOLIAN (M) AND SUNDARARAJAN (M)**  
Identification of the geochemical processes in groundwater by factor analysis in hard rock aquifers of Madurai District, South India  
***Arabian Journal of Geosciences 7(9):3767-3777;Sep 2014***
  
23. **PRIYANKA (A), ANUSREE (S S), NISHA (V M) AND RAGHU (K G)**  
Curcumin improves hypoxia induced dysfunctions in 3T3-L1 adipocytes by protecting mitochondria and down regulating inflammation  
***BioFactors 40(5):513-523;Sep/Oct 2014***
  
24. **SHYNI (G L), KAVITHA (S), INDU (S), ARYA (A D), ANUSREE (S S), VINEETHA (V P), VANDANA SANKAR, SUNDARESAN (A) AND RAGHU (K G)**  
Chebulagic acid from Terminalia chebula enhances insulin mediated glucose uptake in 3T3-L1 adipocytes via PPAR gamma signaling pathway  
***Biofactors 40(6):646-657; Nov-Dec 2014***



25. **LALITHA DEVI (G), BINOD (P), SAJNA (K V), PANDEY (A) AND RAJEEV K SUKUMARAN**  
Growth and butanol production by *Clostridium sporogenes* BE01 in rice straw hydrolysate: Kinetics of inhibition by organic acids and the strategies for their removal  
***Biomass Conversion and Biorefinery 4(3):277-283;September 2014***
26. **LEYA THOMAS, ABHILASH JOSEPH AND LALITA DEVI (G)**  
Xylanase and cellulase systems of *Clostridium* sp.: An insight on molecular approaches for strain improvement  
***Bioresource Technology 158:343-350;Apr 2014***
27. **NAWANI (N), BINOD (P), KOUTINAS (A A) AND KHAN (F)**  
Special issue on International Conference on Advances in Biotechnology and Bioinformatics 2013 - Preface  
***Bioresource Technology 165(Sp Iss SI):199-200;Aug 2014***
28. **UMMALYMA (S B) AND RAJEEV K SUKUMARAN**  
Cultivation of microalgae in dairy effluent for oil production and removal of organic pollution load  
***Bioresource Technology 165:295-301;Aug 2014***
29. **ARAVIND MADHAVAN AND RAJEEV K SUKUMARAN**  
Promoter and signal sequence from filamentous fungus can drive recombinant protein production in the yeast *Kluyveromyces lactis*  
***Bioresource Technology 165:302-308;Aug 2014***
30. **LEYA THOMAS, USHASREE (M V) AND PANDEY (A)**  
An alkali-thermostable xylanase from *Bacillus pumilus* functionally expressed in *Kluyveromyces lactis* and evaluation of its deinking efficiency  
***Bioresource Technology 165:309-313;Aug 2014***
31. **DEEPTHY (A), ABRAHAM (M) AND RAJEEV K SUKUMARAN**  
Esterases immobilized on aminosilane modified magnetic nanoparticles as a catalyst for biotransformation reactions  
***Bioresource Technology 167:547-550;Sep 2014***
32. **USHASREE (M V), VIDYA (J) AND PANDEY (A)**  
Gene cloning and soluble expression of *Aspergillus niger* phytase in *E-coli* cytosol via chaperone co-expression  
***Biotechnology Letters 36(1):85-91;Jan 2014***
33. **RAJI (R), MANJUNATH (G), NAMPOOTHIRI (K M) AND PANDEY (A)**  
Extracellular methionine Amino peptidase (MAP) production by *Streptomyces gedanensis* in solid-state fermentation  
***Brazilian Archives of Biology and Technology 57(2):187-193;Mar-Apr 2014***



34. SHALIN (T), SINDHU (R), BINOD (P), SOCCOL (C R) AND PANDEY (A)  
Mixed cultures fermentation for the production of Poly- beta-Hydroxybutyrate  
***Brazilian Archives of Biology and Technology 57(5):644-652;Sep-Oct 2014***
35. FARHA (A K), DHANYA (S R), MANGALAM S NAIR, GEETHA (B S), LATHA (P G), REMANI (P)  
Deoxyelephantopin impairs growth of cervical carcinoma SiHa cells and induces apoptosis by targeting multiple molecular signaling pathways  
***Cell Biology and Toxicology 30(6):331-343; 2014***
36. VINEETHA JAMES, PRABHAKAR RAO (P), SAMEERA (S) AND DIVYA (S)  
Multiferroic based reddish brown pigments: Bi<sub>1-x</sub>MxFeO<sub>3</sub> (M=Y and La) for coloring applications  
***Ceramics International 40(1 Part B):2229-2235;Jan 2014***
37. ANNROSE SUNNY, VARSHA VISWANATH, SURENDRAN (K P) AND SEBASTIAN (M T)  
The effect of Ga<sup>3+</sup> addition on the sinterability and microwave dielectric properties of RE<sub>3</sub>Al<sub>5</sub>O<sub>12</sub> (Tb<sup>3+</sup>, Y<sup>3+</sup>, Er<sup>3+</sup> and Yb<sup>3+</sup>) garnet ceramics  
***Ceramics International 40(3):4311-4317;Apr 2014***
38. CHAMESWARY (J) AND SEBASTIAN (M T)  
Development of butyl rubber-rutile composites for flexible microwave substrate applications  
***Ceramics International 40(5):7439-7448;Jun 2014***
39. BAHULEYAN (A), JOBIN VARGHESE, SURENDRAN (K P) AND SEBASTIAN (M T)  
Microwave dielectric and thermal properties of mixed rare earth ortho phosphate [RE<sub>mix</sub>PO<sub>4</sub>]  
***Ceramics International 40(8 Part B):13075-13081;Sep 2014***
40. SUJITH (S S), ARUN KUMAR (S L), MANGALARAJA (R V), PEER MOHAMED (A) AND ANANTHAKUMAR (S)  
Porous to dense LaPO<sub>4</sub> sintered ceramics for advanced refractories  
***Ceramics International 40(9 Part B):15121-15129;Nov 2014***
41. PRAKASH (S P) AND GOPIDAS (K R)  
Palladium-nanoparticle-linked organic frameworks: Heterogeneous recyclable catalysts in aqueous medium  
***ChemCatChem 6 (6):1641-1651;Jun 2014***
42. ANU JOSE, JAYAKRISHNAN (A J), BALARAMAN (V), RAJEEV S MENON, SUNIL VARUGHESE, SURESH (E) AND VIJAY NAIR (G)  
A phosphine-mediated reaction of cyclic 1,2-diones and 3-alkyl allenates: An efficient protocol for benzannulation applicable to the synthesis of polycyclic aromatic hydrocarbons  
***Chemical Communications 50(35):4616-4619;2014***



43. **DIVYA (K P), SAVITHRI (S) AND AJAYAGHOSH (A)**  
A fluorescent molecular probe for the identification of zinc and cadmium salts by excited state charge transfer modulation  
***Chemical Communications* 50(45):6020-6022;2014**
44. **RATHEESH (K V), MESKERS (S C J), ABDUL RAHIM (M) AND SURESH DAS**  
Bulk photovoltaic effect in an organic polar crystal  
***Chemical Communications* 50(49):6530-6533;2014**
45. **SREEDEVI (K C G), AJESH P THOMAS, APARNA (K H), RENUKA (P), REDDY (M L P), LOURDERAJ (U) AND SRINIVASAN (A)**  
Photoenolization via excited state double proton transfer induces "turn on" fluorescence in diformyl diaryl dipyrromethane  
***Chemical Communications* 50(63):8667-8669;14 Aug 2014**
46. **HOLADAY (M G D), TARAFDAR (G), ADINARAYANA (B), REDDY (M L P) AND SRINIVASAN (A)**  
Chemodosimetric cyanide sensing in a 5,15-porphodimethene Pd(II) complex  
***Chemical Communications* 50(74):10834-10836;25 Sep 2014**
47. **KARTHIK (G), SRINIVASAN (A), SURESH (C H) AND CHANDRASHEKAR (T K)**  
Fused core-modified planar antiaromatic  $32\pi$  heptaphyrins: Unusual synthesis and structural diversity  
***Chemical Communications* 50 (81):12127 -12130;18 Oct 2014**
48. **DAYANANDA (D), SARVA (V R), PRASAD (V S), ARUNACHALAM (J) AND GHOSH (N N)**  
Preparation of CaO loaded mesoporous Al<sub>2</sub>O<sub>3</sub>: Efficient adsorbent for fluoride removal from water  
***Chemical Engineering Journal* 248:430-439;15 Jul 2014**
49. **SREEREMYA (T S), ASHA KRISHNAN, PEER MOHAMED (A), HAREESH (U S) AND GHOSH (S K)**  
Synthesis and characterization of cerium oxide based nanofluids: An efficient coolant in heat transport applications  
***Chemical Engineering Journal* 255:282-289;01 Nov 2014**
50. **BIRADAR (J S), RAJESAB (P) AND SASIDHAR (B S)**  
Design and synthesis of novel thiopheno-4-thiazolidinylindoles as potent antioxidant and antimicrobial agents  
***Chemical Papers* 68(3):392-400;Mar 2014**
51. **SANTHOSH BABU (S), PRAVEEN (V K) AND AJAYAGHOSH (A)**  
Functional  $\pi$ -Gelators and their applications  
***Chemical Reviews* 114(4):1973-2129;26 Feb 2014**



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A ratiometric fluorescent molecular probe with enhanced two-photon response upon Zn<sup>2+</sup> binding for in vitro and in vivo bioimaging  
***Chemical Science* 5(9):3469-3474;Sep 2014**
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Oligo(phenylenevinylene) hybrids and self-assemblies: Versatile materials for excitation energy transfer  
***Chemical Society Reviews* 43(12):4222-4242;27 May 2014**
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Symmetrical diiodinated squaraine as an efficient photosensitizer for PDT applications: Evidence from photodynamic and toxicological aspects  
***Chemico-Biological Interactions* 222:44-49;05 Oct 2014**
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Titanium-catalyzed hydroalumination of conjugated dienes: Access to fulvene-derived allylaluminium reagents and their diastereoselective reactions with carbonyl compounds  
***Chemistry - A European Journal* 20(18):5433- 5438;25 Apr 2014**
56. SANKARALINGAM (M), BALAMURUGAN (M), PALANIANDAVAR (M), VADIVELU (P) AND SURESH (CH)  
Nickel(II) complexes of Pentadentate N5 Ligands as catalysts for Alkane Hydroxylation by using m-CPBA as oxidant: A combined experimental and computational study  
***Chemistry - A European Journal* 20(36):11346-11361;01 Sep 2014**
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A reversible dual mode chemodosimeter for the detection of cyanide ions in natural sources  
***Chemistry - An Asian Journal* 9(6):1636-1642;Jun 2014**
58. SANTHOSH BABU (S), PRAVEEN (V K), KARTHA (K K), MAHESH (S) AND AJAYAGHOSH (A)  
Effect of the bulkiness of the End Functional Amide Groups on the optical, gelation, and morphological properties of Oligo(p-phenylenevinylene) pi-Gelators  
***Chemistry - An Asian journal* 9(7):1830-1840;Jul 2014**
59. ATHIRA RAJ (K V), PRABHAKAR RAO (P), SAMEERA (S), VINEETHA JAMES AND DIVYA (S)  
Synthesis of novel nontoxic yellow pigments: Sr<sub>2</sub>Ce<sub>1-x</sub>TbxO<sub>4</sub>  
***Chemistry Letters* 43(7):985-987;05 Jul 2014**
60. KABEER (F A), SREEDEVI (G B), MANGALAM S NAIR, RAJALEKSHMI (D S), GOPALAKRISHNAN (L P) AND REMANI PRATHAPAN  
Isodeoxyelephantopin from *Elephantopus scaber* (Didancao) induces cell cycle arrest and caspase-3-mediated apoptosis in breast carcinoma T47D cells and lung carcinoma A549 cells  
***Chinese Medicine (United Kingdom)* 9(1):Art. No. 14;2014**



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Electromagnetic interference shielding properties of butyl rubber-single walled carbon nanotube composites  
***Composites Science and Technology 101:139-144;12 Sep 2014***
62. **SEETHALEKSHMI (S), SUNIL VARUGHESE, GIRI (L) and PEDIREDDI (V R)**  
Molecular complexes of 4-halophenylboronic acids: A systematic exploration of isostructurality and structural landscape  
***Crystal Growth and Design 14(8):4143-4154;06 Aug 2014***
63. **GANGAN PRATHAP**  
The myth of frugal innovation in India  
***Current Science 106(3):374-377; 10 Feb 2014***
64. **GANGAN PRATHAP**  
The world of research according to Science and Engineering Indicators 2014  
***Current Science 106 (5):649-650;10 Mar 2014***
65. **GANGAN PRATHAP**  
Rationalization of the S.S. Bhatnagar prizes scheme (Correspondence)  
***Current Science 106 (6):790-792;25 Mar 2014***
66. **GANGAN PRATHAP**  
A bibliometric profile of current science  
***Current Science 106(7):958-963;10 Apr 2014***
67. **GANGAN PRATHAP**  
India's declining share in computational mechanics research  
***Current Science 106(8):1110-1113;25 Apr 2014***
68. **GANGAN PRATHAP**  
Leading Indian higher education institutions and the Leiden 2014 and SIR 2013 rankings  
***Current Science 106(11):1467-1468;10 Jun 2014***
69. **GANGAN PRATHAP**  
Field-normalized bibliometric evaluation of leading research institutions in chemistry in China and India  
***Current Science 107(2):269-272;25 Jul 2014***
70. **GANGAN PRATHAP**  
The performance of research-intensive higher educational institutions in India  
***Current Science 107(3):389-396;10 Aug 2014***
71. **GANGAN PRATHAP**  
Open access and impact factors revisited  
***Current Science 107(5):733;10 Sep 2014***



72. **GANGAN PRATHAP**  
End-to-end performance analysis of CSIR in SIR 2014  
***Current Science* 107(8):1221-1222;25 Oct 2014**
73. **HOLADAY (M G D), TARAFDAR (G), ARUN KUMAR, REDDY (M L P) and SRINIVASAN (A)**  
Exploring anagostic interactions in 5,15-porphodimethene metal complexes  
***Dalton Transactions* 43(21):7699-7703;2014**
74. **RAMYA (A R), SUNIL VARUGHESE and REDDY (M L P)**  
Tunable white-light emission from mixed lanthanide (Eu<sup>3+</sup>, Gd<sup>3+</sup>, Tb<sup>3+</sup>) coordination polymers derived from 4-(dipyridin-2-yl)-aminobenzoate  
***Dalton Transactions* 43(28):10940-10946;2014**
75. **SANDHYA (K S) and SURESH (C H)**  
Designing metal hydride complexes for water splitting reactions: A molecular electrostatic potential approach  
***Dalton Transactions* 43(32):12279-12287;22 Jul 2014**
76. **BALAMURUGAN (M), PRABHA VADIVELU and PALANIANDAVAR (M)**  
Iron(III) complexes of tripodal tetradentate 4N ligands as functional models for catechol dioxygenases: The electronic vs. Steric effect on extradiol cleavage  
***Dalton Transactions* 43 (39):14653-14668;21 Oct 2014**
77. **SAMEERA (S), PRABHAKAR RAO (P), VINEETHA JAMES, ATHIRA RAJ (K V), CHITRADEVI (G R) and LEELA SANDHYAKUMARI**  
Probing structural variation and multifunctionality in niobium doped bismuth vanadate materials  
***Dalton Transactions* 43(42):15851-15860;14 Nov 2014**
78. **GANGAN PRATHAP**  
A Bibliometric evaluation of Research on the Monsoon  
***DESIDOC Journal of Library & Information Technology* 34(3):191-196;May 2014**
79. **SAMEERA (S), PRABHAKAR RAO (P), VINEETHA JAMES, DIVYA (S) and ATHIRA RAJ (K V)**  
Influence of (LiLa) 1/2MoO<sub>4</sub> substitution on the pigmentary properties of BiVO<sub>4</sub>  
***Dyes and Pigments* 104:41-47;May 2014**
80. **SHEETHU JOSE, AISWARIA PRAKASH, LAHA (S), NATARAJAN (S) and REDDY (M L P)**  
Green colored nano-pigments derived from Y<sub>2</sub>BaCuO<sub>5</sub>: NIR reflective coatings  
***Dyes and Pigments* 107:118-126;Aug 2014**
81. **KRISHNAKUMAR (P), LAKSHUMANAN (C), KISHORE (V P), SUNDARARAJAN (M), SANTHIYA (G) and CHIDAMBARAM (S)**  
Assessment of groundwater quality in and around Vedaraniyam, South India  
***Environmental Earth Sciences* 71(5):2211-2225;Mar 2014**



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Unveiling aminopeptidase P from *Streptomyces lavendulae*: Molecular cloning, expression and biochemical characterization  
***Enzyme and Microbial Technology* 55:7-13;05 Feb 2014**
83. **VIDYA (J), USHASREE (M V) and PANDEY (A)**  
Effect of surface charge alteration on stability of L- asparaginase II from *Escherichia* sp  
***Enzyme and Microbial Technology* 56:15-19;05 Mar 2014**
84. **DEEPTHY (A), ANJU (S), PANDEY (A) and RAJEEV K SUKUMARAN**  
Esterase active in polar organic solvents from the yeast *pseudozyma* sp. NII 08165  
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85. **SUBODH (G), TASSEL (C), HAYASHI (N), GOTO (Y), BOUILLY (G), YAJIMA (T), KOBAYASHI (Y) and KAGEYAMA (H)**  
Charge disproportionation and magnetoresistivity in a double perovskite with alternate Fe<sup>4+</sup>(d<sup>4</sup>) and Mn<sup>4+</sup>(d<sup>3</sup>) layers  
***European Journal of Inorganic Chemistry* (15):2576-2581;May 2014**
86. **ANTU (K A), RIYA (M P), MISHRA (A), SHARMA (S), SRIVASTAVA (A K) and RAGHU (K G)**  
*Symplocos cochinchinensis* attenuates streptozotocin-diabetes induced pathophysiological alterations of liver, kidney, pancreas and eye lens in rats  
***Experimental and Toxicologic Pathology* 66(7):281-291;Sep 2014**
87. **SUDHA (J D), SIVAKALA (S), CHANDRAKANTH (C K), NEETHU (K S), ROHINI, (K N) and RAMAKRISHNAN (R)**  
Percolated conductive polyaniline-clay nanocomposite in polyvinyl chloride through the combined approach porous template and self-assembly  
***eXPRESS Polymer Letters* 8(2):107-115;Feb 2014**
88. **VINEETHA (V P), GIRIJA (S), SOUMYA (R S) and RAGHU (K G)**  
Polyphenol-rich apple (*Malus domestica* L.) peel extract attenuates arsenic trioxide induced cardiotoxicity in H9c2 cells via its antioxidant activity  
***Food & Function* 5(3):502-511;26 Feb 2014**
89. **SOUMYA (R S), RESHMI (R), JOMON (S), ANTU (K A), RIYA (M P) and RAGHU (K G)**  
Synthesis, characterization and evaluation of the antioxidant potential of vanadium encapsulated guar gum nanoparticles  
***Food & Function* 5(3):535-544;26 Feb 2014**
90. **RIYA (M P), ANTU (K A), PAL (S), SRIVASTAVA (A K), SHARMA (S) and RAGHU (K G)**  
Nutraceutical potential of *Aerva lanata* (L.) Juss. Ex Schult ameliorates secondary complications in streptozotocin-induced diabetic rats  
***Food & Function* 5(9):2086-2095;20 Aug 2014**



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An in vitro study reveals the nutraceutical potential of puniic acid relevant to diabetes via enhanced GLUT4 expression and adiponectin secretion  
***Food & Function 5(10):2590-2601;01 Oct 2014***
92. SHAMLA (L) and NISHA (P)  
Acrylamide in deep-fried snacks of India  
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93. AGGELOPOULOS (T), KATSIERIS (K), BEKATORO (A), PANDEY (A), BANAT (I M) and KOUTINAS (A A)  
Solid state fermentation of food waste mixtures for single cell protein, aroma volatiles and fat production  
***Food Chemistry 145:710-716;15 Feb 2014***
94. DHANYA (R), ARUN (K B), SYAMA (H P), NISHA (P), SUNDARESAN (A), SANTHOSH KUMAR (T R) and JAYAMURTHY (P)  
Rutin and quercetin enhance glucose uptake in L6 myotubes under oxidative stress induced by tertiary butyl hydrogen peroxide  
***Food Chemistry 158:546-554;01 Sep 2014***
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- 187 SALIN RAJ (P), PRATHAPAN (A), JOMON (S), ANTU (K A), RIYA (M P), PREETHA RANI (M R), BIJU (H), PRIYA (S) and RAGHU (K G)  
*Parmotrema tinctorum* exhibits antioxidant, antiglycation and inhibitory activities against aldose reductase and carbohydrate digestive enzymes: An in vitro study  
**Natural Product Research 28(18):1480-1484;Sep 2014**
- 188 GORANTLA (J N), JAMSHEENA (V), LEKSHMI (R N), ANTO (R J) and RAVI S LANKALAPALLI  
Cytotoxicity studies of semi-synthetic derivatives of thebeside derived from the aqueous extract of leaves of suicide tree *Cerbera odollam*  
**Natural Product Research 28(18):1507-1512;2014**



- 189 SAJIN FRANCIS (K), SURESH (E) and MANGALAM S NAIR  
Chemical constituents from *Myristica fragrans* fruit  
***Natural Product Research* 28(20):1664-1668;2014**
- 190 SARATH CHAND (S), SARANYA (S), PREETHANUJ (P), DHANYA (B P), JIJY (E), PRAKASH (P), SASIDHAR (B S), SZYMONIAK (J), SANTHINI (P V) and RADHAKRISHNAN (K V)  
Trapping the Lewis acid generated transient species from pentafulvene derived diazanorbornenes with ortho-functionalized aryl iodides and aliphatic alcohols  
***Organic and Biomolecular Chemistry* 12(19):3045-3061;21 May 2014**
- 191 SANTHI (M), VANDANA (S), JYOTHI (B N), RAGHU (K G) and MAITI (K K)  
A lysosome-targeted drug delivery system based on sorbitol backbone towards efficient cancer therapy  
***Organic and Biomolecular Chemistry* 12(34):6564-6569;06 Aug 2014**
- 192 CHALLA (C), JAMSHEENA (V), RAVINDRAN (J) and RAVI S LANKALAPALLI  
A metal-free one-pot cascade synthesis of highly functionalized biaryl-2-carbaldehydes  
***Organic and Biomolecular Chemistry* 12(43):8588-8592;21 Nov 2014**
- 193 SEETHA LAKSHMI (K C), SINU (C R), PADMAJA (D V M), GOPINATHAN (A), SURESH(E) and VIJAY NAIR (G)  
A novel intramolecular homoenolate annulation leading to the formation of cyclopentene-fused macrocycles  
***Organic Letters* 16(21):5532-5535;07 Nov 2014**
- 194 SEETHA LAKSHMI (K C), KRISHNAN (J), SINU (C R), SUNIL VARUGHESE and VIJAY NAIR (G)  
N-Heterocyclic carbene catalyzed annulation of enals to aurone analogs: Synthesis of cyclopentene-fused spirobenzofuran-3-ones  
***Organic Letters* 16(24):6374-6377;19 Dec 2014**
- 195 SHAFEEKH (K M), SOUMYA (M S), RAHIM (M A), ANNIE ABRAHAM and SURESH DAS  
Synthesis and characterization of near-infrared absorbing water soluble squaraines and study of their photodynamic effects in DLA live cells  
***Photochemistry and Photobiology* 90(3):585-595;May-Jun 2014**
- 196 PRASANTH (C S), SUNEESH (C K), ALBISH (K P), KUSSOVSKI (V), MANTAREVA (V), RAMAIAH (D), SELVARAJ (L), ANGELOV (I), AVRAMOV (L), NANDAKUMAR (K) and SUBHASH (N)  
Antimicrobial photodynamic efficiency of novel cationic porphyrins towards periodontal gram-positive and gram-negative pathogenic bacteria  
***Photochemistry and Photobiology* 90(3):628-640;May-Jun 2014**
- 197 NEENU LEKSHMI (P), VASUNDHARA (M), MANOJ RAAMA VARMA, SURESH (K G) and VALANT (M)  
Structural, magnetic and dielectric properties of rare earth based double perovskites RE<sub>2</sub>NiMnO<sub>6</sub> (RE=La, pr, Sm, Tb)  
***Physica B:Condensed Matter* 448:285-289;01 Sep 2014**



- 198 ANEESH (P K), SINDHU (R N), PRASADA RAO (T) and AJAYAGHOSH (A)  
Electrochemical synthesis of a gold atomic cluster-chitosan nanocomposite film modified gold electrode for ultra-trace determination of mercury  
***Physical Chemistry Chemical Physics 16(18):8529-8535;14 May 2014***
- 199 VISHNU (S N), PAREEK (Y), VENUGOPAL (K), RAVIKANTH (M) and AJAYAGHOSH (A)  
Cyclotriphosphazene appended porphyrins and fulleropyrrolidine complexes as supramolecular multiple photosynthetic reaction centers: Steady and excited states photophysical investigation  
***Physical Chemistry Chemical Physics 16(21):10149-10156;2014***
- 200 DEEPA (K S), SHAIJU (P), SEBASTIAN (M T), BHOJE GOWD (E) and JOSE JAMES  
Poly(vinylidene fluoride)-La<sub>0.5</sub>Sr<sub>0.5</sub>CoO<sub>3</sub>Δ composites: The influence of LSCO particle size on the structure and dielectric properties  
***Physical Chemistry Chemical Physics 16(32):17008-17017;28 Aug 2014***
- 201 LINDA FRANCIS (T), PRABHAKAR RAO (P), MARIYAM THOMAS, MAHESH (S K), RESHMI (V R) and SREENA (T S)  
Structural influence on the photoluminescence properties of Eu<sup>3+</sup> doped Gd<sub>3</sub>MO<sub>7</sub> (M = Nb, Sb, and Ta) red phosphors  
***Physical Chemistry Chemical Physics 16(32):17108-17115;28 Aug 2014***
- 202 KARTHA (K K), SANDEEP (A), NAIR (V C), TAKEUCHI (M) and AJAYAGHOSH (A)  
A carbazole-fluorene molecular hybrid for quantitative detection of TNT using a combined fluorescence and quartz crystal microbalance method  
***Physical Chemistry Chemical Physics 16(35):18896-18901;13 Aug 2014***
- 203 ATHIRA RAJ (K V), PRABHAKAR RAO (P), SREENA (T S), SAMEERA (S), VINEETHA JAMES and RENJU (U A)  
Remarkable changes in the photoluminescent properties of Y<sub>2</sub>Ce<sub>2</sub>O<sub>7</sub>:Eu<sup>3+</sup> red phosphors through modification of the cerium oxidation states and oxygen vacancy ordering  
***Physical Chemistry Chemical Physics 16(43):23699-23710;21 Nov 2014***
- 204 BEENA JOY, NISHANTH KUMAR (S), SOUMYA (M S), RADHIKA (A R), VIBIN (M) and ANNIE ABRAHAM  
Embelin (2,5-dihydroxy-3-undecyl-p-benzoquinone): A bioactive molecule isolated from *Embelia ribes* as an effective photodynamic therapeutic candidate against tumor in vivo.  
***Phytomedicine : International Journal of Phytotherapy and Phytopharmacology 21(11):1292-1297;25 Sep 2014***
- 205 PRATHAPAN (A), VINEETHA (V P) and RAGHU (K G)  
Protective effect of *Boerhaavia diffusa* L. against mitochondrial dysfunction in angiotensin II induced hypertrophy in H9c2 cardiomyoblast cells  
***PLOS ONE 9(4):13 p. e96220;2014***



- 206 ANTU (K A), RIYA (M P), MISHRA (A), ANILKUMAR (K S), CHANDRAKANTH (C K), TAMRAKAR (A K), SRIVASTAVA (A K) and RAGHU (K G)  
Antidiabetic property of *Symplocos cochinchinensis* is mediated by inhibition of alpha glucosidase and enhanced insulin sensitivity  
***PLOS ONE* 9(9):13p. e105829;Sep 2014**
- 207 VAISAKH (S S), HASSANZADEH (M), METZ (R), RAMAKRISHNAN (S), CHAPPELLE (D), SUDHA (J D) and ANANTHAKUMAR (S)  
Effect of nano/micro-mixed ceramic fillers on the dielectric and thermal properties of epoxy polymer composites  
***Polymers for Advanced Technologies* 25(2):240-248;Feb 2014**
- 208 JAMSHIDIJAM (M), MANGALARAJA (R V), AKBARI-FAKHRABADI (A), ANANTHAKUMAR (S) and CHAN (S H)  
Effect of rare earth dopants on structural characteristics of nanocerium synthesized by combustion method  
***Powder Technology* 253:304-310;Feb 2014**
- 209 USHASREE (M V), VIDYA (J) and PANDEY (A)  
Extracellular expression of a thermostable phytase (phyA) in *Kluyveromyces lactis*  
***Process Biochemistry* 49(9):1440-1447;Sep 2014**
- 210 SINDHU (R), KUTTIRAJA (M), BINOD (P), RAJEEV K SUKUMARAN and PANDEY (A)  
Physicochemical characterization of alkali pretreated sugarcane tops and optimization of enzymatic saccharification using response surface methodology  
***Renewable Energy* 62:362-368;Feb 2014**
- 211 SUYANA (P), KUMAR (S N), KUMAR (B S D), NAIR (B N), PILLAI (S C), PEER MOHAMED (A), WARRIER (K G K) and HAREESH (U S)  
Antifungal properties of nanosized ZnS particles synthesised by sonochemical precipitation  
***RSC Advances* 4(17):8439-8445;2014**
- 212 VAISAKHAN THAMPI (D S), PRABHAKAR RAO (P) and RADHAKRISHNAN (A N)  
Influence of Ce substitution on the order-to-disorder structural transition, thermal expansion and electrical properties in  $\text{Sm}_2\text{Zr}_{2-x}\text{Ce}_x\text{O}_7$  system  
***RSC Advances* 4(24):12321-12329;2014**
- 213 VIDYA (K), SMITHA (V S), PEER MOHAMED (A), HAREESH (U S) and WARRIER (K G K)  
Temperature assisted acid catalyzed peptization of  $\text{TiO}_2$ ; Facile sol-gel approach for thermally stable anatase phase  
***RSC Advances* 4(41):21664-21671;2014**



- 214 **SUCHITHRA (M), SHANMUGAM (P) and LUXMI VARMA (R)**  
Synthesis of novel ferrocenyl N/O-heterocycles, chiral P,N-ligand and  $\alpha$ -dehydro- $\beta$ -amino acid derived short peptides from Morita-Baylis-Hillman adducts of ferrocenealdehyde  
***RSC Advances* 4(50):26211-26214;2014**
- 215 **SREEREMYA (T S), ASHA KRISHNAN, SATAPATHY (L N) and GHOSH (S K)**  
Facile synthetic strategy of oleophilic zirconia nanoparticles allows preparation of highly stable thermo-conductive coolant  
***RSC Advances* 4(53):28020-28028;2014**
- 216 **SUNEESH (C K), ALBISH (K P) and RAMAIAH (D)**  
Effective discrimination of GTP from ATP by a cationic tentacle porphyrin through “turn-on” fluorescence intensity  
***RSC Advances* 4(58):30644-30647;2014**
- 217 **MILJA (T E), KRUPA (V S) and PRASADA RAO (T)**  
Synthesis, characterization and application of uranyl ion imprinted polymers of aniline and 8-hydroxy quinoline functionalized aniline  
***RSC Advances* 4(58):30718-30724;2014**
- 218 **ARAVIND (S R), SREELEKHA (T T), DILEEP KUMAR (B S), NISHANT KUMAR (S) and MOHANDAS (C)**  
Characterization of three depside compounds from a Western Ghat lichen *Parmelia erumpens* Kurok with special reference to antimicrobial and anticancer activity  
***RSC Advances* 4(65):34632-34643;2014**
- 219 **SELVAKUMAR (K), LINGAM (K A P) and LUXMI VARMA (R)**  
Development of a mild and efficient protocol for the protection and O-alkylation of allyl alcohols  
***RSC Advances* 4(69):36538-36543;2014**
- 220 **JOBIN VARGHESE, SURENDRAN (K P) and SEBASTIAN (M T)**  
Room temperature curable silica ink  
***RSC Advances* 4(88):47701-47707;2014**
- 221 **HARIDAS (V), PRAVEEN KUMAR (P P) and SURESH (C H)**  
Cysteine-based fluorescence “turn-on” sensors for Cu<sup>2+</sup> and Ag<sup>+</sup>  
***RSC Advances* 4(99):56539-56542;2014**
- 222 **VIJI (M), AKHIL (K N), NANDAJAN (P C) and RAMAIAH (D)**  
Fluorescent chemodosimeter based on NHC complex for selective recognition of cyanide ions in aqueous medium  
***RSC Advances* 4(89):47982-47986;2014**



- 223 MUTHU (C), NAGAMMA (S R) and NAIR (V C)  
Luminescent hybrid perovskite nanoparticles as a new platform for selective detection of 2,4,6-trinitrophenol  
**RSC Advances 4(99):55908-55911;2014**
- 224 SMITHA (V S), SAJU PILLAI, HAREESH (U S), BALAGOPAL NAIR and WARRIER (K G K)  
Photoluminescent, self-cleaning titanium oxide nanocomposites with multifunctional properties  
**RSC Advances 4 (106):61727-61735**
- 225 BHEEMESWAR (D)  
Management by objectives (MBO): A strategic tool for R & D organizations  
**Science India :42-46;Jan 2014**
- 226 BIRADAR (J S), RAJESAB (P), BIRADAR (N J) and SASIDHAR (B S)  
A mini library of novel Triazolothiadiazepinyndole analogues: Synthesis, antioxidant and antimicrobial evaluations  
**Scientific World Journal. Article Number:581737;2014**
- 227 GANGAN PRATHAP  
Big data and false discovery: Analyses of bibliometric indicators from large data sets  
**Scientometrics 98(2):1421-1422;Feb 2014**
- 228 GANGAN PRATHAP  
A three-dimensional bibliometric evaluation of research in polymer solar cells  
**Scientometrics 101(1):889-898;Oct 2014**
- 229 GANGAN PRATHAP  
Single parameter indices and bibliometric outliers  
**Scientometrics 101(3):1781-1787;Dec 2014**
- 230 LAVANYA DEVI (C), SHAMEEL (T), HARI SHANKAR (B) and RAMAIAH (D)  
Selective and dual naked eye detection of Cu<sup>2+</sup> and Hg<sup>2+</sup> ions using a simple quinoline-carbaldehyde chemosensor  
**Sensors and Actuators B:Chemical 204:480-488;Dec 2014**
- 231 BHOJE GOWD (E), KOGA (T), ENDOH (M K), KUMAR (K) and STAMM (M)  
Pathways of cylindrical orientations in PS-b-P4VP diblock copolymer thin films upon solvent vapor annealing  
**Soft Matter 10(39):7753-7761;21 Oct 2014**
- 232 SOUMYA (S), PEER MOHAMED (A), LUCY PAUL, KIRAN MOHAN and ANANTHAKUMAR (S)  
Near IR reflectance characteristics of PMMA/ZnO nanocomposites for solar thermal control interface films  
**Solar Energy Materials and Solar Cells 125(6):102-112 ;Jun 2014**



- 233 DEEPA (J P), RAJAN (T P D), PAVITHRAN (C) and PAI (B C)  
Studies on electroless nickel boride coating on boron carbide particles  
**Surface Engineering 30(10):702-708;Oct 2014**
- 234 PRAVEEN (P), APARNA (P S), JIJY (E), SANTHINI (P V), VARUGHESE (S) and RADHAKRISHNAN (K V)  
Rhodium(III)-catalyzed C-H activation of phenylazoles toward C-N bond cleavage of diazabicyclic olefins: A facile access to mono- and biscyclo-pentenyl-functionalized aza-heteroaromatics  
**Synlett 25(2):275-279;23 Jan 2014**
- 235 BAIJU (T V), AJESH (V), NAYANA JOSEPH, PREETHANUJ (P), RADHAKRISHNAN (K V), SURESH (E) and YAMAMOTO (Y)  
Bis-functionalization of 1,3-dienes through 1,4-conjugate addition of amphiphilic bis- $\pi$ -allyl and related palladium intermediates  
**Synlett 25(3):359-364;13 Feb 2014**
- 236 SEETHA LAKSHMI (K C), PAUL (R R), SURESH (E) and VIJAY NAIR (G)  
N-heterocyclic carbene mediated homoenate annulation of benzofuran-2,3-diones: Stereoselective synthesis of bis-spirofuranones  
**Synlett 25(6)Art. no.5634:853-857;Apr 2014**
- 237 BAIJU (T V), NAYANA JOSEPH, JAINU AJIT, PRAVEEN PRAKASH, RADHAKRISHNAN (K V), SUNIL VARUGHESE and YAMAMOTO (Y)  
Palladium-catalyzed interceptive decarboxylative addition of allyl carbonates with carbonyl group  
**Synlett 25(9):1246-1252;Jun 2014**
- 238 JIJY (E), PRAVEEN PRAKASH, BAIJU (T V), SHIMI (M), YAMAMOTO (Y), SURESH (E) and RADHAKRISHNAN (K V)  
Palladium catalyzed ring opening of cyclopropane appended spirotricyclic olefins with soft nucleophiles and organoboronic acids: Facile synthesis of functionalized spiro[2.4]heptanes  
**Synthesis 46(19):2629-2643;Oct 2014**
- 239 VIJAY NAIR (G), ANI DEEPTHI, DEVIPRIYA (A), ANABHA (E R) and PAUL (R R)  
1,4-Dipolar cycloadditions and related reactions  
**Tetrahedron 70(19):3085-3105;13 May 2014**



- 240 AJISH (K R), DHANYA (B P), NAYANA JOSEPH, PRIYA RANI (M), RAGHU (K G), VINEETHA (V P) and RADHAKRISHNAN (K V)  
Synthesis of novel zerumbone derivatives via regioselective palladium catalyzed decarboxylative coupling reaction: a new class of  $\alpha$ -glucosidase inhibitors  
***Tetrahedron Letters* 55(3):665-670;15 Jan 2014**
- 241 APARNA (P S), PRABHA (B), PRAKASH (P), JIJY (E), LUXMI VARMA (R) and RADHAKRISHNAN (K V)  
Ruthenium catalyzed desymmetrization of diazabicyclic olefins to access heteroaryl substituted cyclopentenes through C-H activation of phenylazoles  
***Tetrahedron Letters* 55(4):865-868;22 Jan 2014**
- 242 PRAVEEN (P), JIJY (E), APARNA (P S), VIJI (S) and RADHAKRISHNAN (K V)  
Rhodium(III) catalyzed synthesis of isoquinolone fused azabicycles through C-H activation of N-pivaloyloxy benzamides  
***Tetrahedron Letters* 55(4):916-920;22 Jan 2014**
- 243 SUJITH (S S), ARUN KUMAR (S L), MAHESH (K V), PEER MOHAMED (A) and ANANTHAKUMAR (S)  
Sintering and thermal shock resistance properties of LaPO<sub>4</sub> based composite refractories  
***Transactions of the Indian Ceramic Society* 73(2):161-164;Apr-Jun 2014**
- 244 DUTTA (S), MORANG (P), NISHANT KUMAR (S) and DILEEP KUMAR (B S)  
Fusarial wilt control and growth promotion of pigeon pea through bioactive metabolites produced by two plant growth promoting rhizobacteria  
***World Journal of Microbiology & Biotechnology* 30(3):1111-1121;Mar 2014**



## GENERAL INFORMATION

### VISITS ABROAD

NAME OF THE SCIENTIST	COUNTRY VISITED	DURATION	PURPOSE OF VISIT
Dr A Ajayaghosh	France	19.05.14 - 23.05.14	53 <sup>rd</sup> Scientific Council and 24 <sup>th</sup> Industrial Research Committee meetings and the Vision Group meeting of CEFIPRA.
	France	13.07.14 - 16.07.14	Invited lecture at XXV <sup>th</sup> IUPAC Symposium on Photochemistry, supported by Royal Society of Chemistry
	Singapore	21.09.14 - 23.09.14	Invited lecture at the Humboldt Kolleg symposium on Environment and Health in 21 <sup>st</sup> Century.
	Muscat	25.10.14 - 29.10.14	To receive TWAS 2013 Prize in Chemistry
	Japan	28.11.14 - 06.12.14	Indo-Japan joint project (DST-JSPS) at Osaka University
	Japan	11.12.14 - 17.12.14	Invited Talk at the 2014 International Symposium on Supramolecular Chemistry & Functional Materials organized by CEMS, RIKEN Tokyo, Japan.
Mr J Ansari	Germany	30.04.14 - 30.06.14	Leibniz Univesrity, Hannover, Germany
Dr Ashok Pandey	France	02.05.14 - 27.06.14	University of Blaise-Pascal, France
	Sweden	20.08.14 - 21.08.14	Indo Sweden workshop on bio-economy development
	France	07.09.14 - 10.09.14	10 <sup>th</sup> European Conference of Biochemical Engineering Sciences
Dr P Binod	Switzerland	01.09.14 - 31.10.14	Swiss Federal Institute of Technology
Dr E Bhoje Gowd	US	01.03.14 - 31.05.14	Stony Brook University, US
	Italy	22.09.14 - 25.09.14	10 <sup>th</sup> International IUPAC Conference
	Germany	26.09.14 - 30.09.14	Talk at Leibniz of Polymer Research



Dr K R Gopidas	Belgium	23.06.14 - 25.06.14	Brussels, Belgium
	Germany	26.06.14 - 28.06.14	Bayreuth, Germany
Dr U S Hareesh	Japan	04.11.14 - 08.11.14	Invited for talk on Photoactive Surfaces: Newer materials and better efficiencies
Dr K MadhavanNam-poothiri	Germany	15.10.14 - 26.10.14	Indo-German Collaborative Program with DST and DDAD-Germany University of Bielefeld
Dr P Nisha	Germany	18.05.14 - 24.05.14	Max Rubner Institute, Keil, Germany
Dr Rajeev K Sukumaran	Sweden	20.08.14 - 21.08.14	Indo Swedish workshop on Bio-Based Economy
Dr K P Surendran	Portugal	08.09.14 - 13.09.14	University of Aveiro
Dr C H Suresh	Japan	17.03.14 - 01.04.14	Nagoya University, Japan



## HONOURS & AWARDS

Dr A Ajayaghosh	ISAS National Award for Excellence in Science and Technology 2014, Indian Society of Analytical Scientists
	CHEMTECH CEW Award 2015 for Leadership and Excellence in Research and Development
	J. C. Bose National Fellowship 2015, DST
Dr K V Radhakrishnan	League of Extra Ordinary Chemists, TCI-India-League of Extraordinary Chemists, Tokyo Chemical Industries(India) Pvt Ltd.
Dr T P D Rajan	Chandran Menon Memorial Award for Applied Research and Innovative Technology 2015, The Institute of Indian Foundrymen (IIF), Kolkata
Dr M L P Reddy	Selected as Fellow of Andhra Pradesh Academy of Sciences, 2014
Dr P Binod	Kerala State Young Scientist Award 2014
Dr R Sindhu	Reviewer Award 2014, Industrial Crops and Products (Elsevier)
Dr Vandana Sankar	Young Scientist award 2014, KSCSTE
Ms Vini C Sekhar	Best paper award, Microbial degradation of electronic waste plastics, International conference on Emerging trends in Biotechnology (ICETB 2014), XI convention of the Biotech Research Society of India & Indo-Italian Workshop on Industrial Pharmaceutical Biotechnology, Jawaharlal Nehru University, New Delhi, Nov 6-9, 2014
Ms Syed Sajitha	Best paper award, Cloning and production of genetically improved L-Asparaginase from E. coli. International conference on Emerging trends in Biotechnology (ICETB 2014), XI convention of the Biotech Research Society of India & Indo-Italian Workshop on Industrial Pharmaceutical Biotechnology, Jawaharlal Nehru University, New Delhi, Nov 6-9, 2014
Ms Sankar Vani	Best paper award, An artificial neural network model for predicting the effect of substrate loading and particle size on sugar yield during enzyme biomass hydrolysis, International conference on Emerging trends in Biotechnology (ICETB 2014), XI convention of the Biotech Research Society of India & Indo-Italian Workshop on Industrial Pharmaceutical Biotechnology, Jawaharlal Nehru University, New Delhi, Nov 6-9, 2014
Ms Sabeel Beevi	Best paper award, Evaluation of fresh water micro-algal isolates for growth and lipid production in sea water medium, International conference on Emerging trends in Biotechnology (ICETB 2014), XI convention of the Biotech Research Society of India & Indo-Italian Workshop on Industrial Pharmaceutical Biotechnology, Jawaharlal Nehru University, New Delhi, Nov 6-9, 2014



Ms J B Divya	Best paper award, Folate fortification by probiotic <i>Lactococcus lactis</i> , 2 <sup>nd</sup> Annual conference of Probiotic Association of India (PAI) and International symposium on Probiotics and Microbiome: Gut and Beyond, Nov 3-4, 2014
Ms R K Annu Raju	Best Research Paper Award, Effective enhancement of anticorrosive properties of polystyrene on aluminum alloys by polystyrene-clay nanocomposite coatings, Seventeenth National Congress on Corrosion Control, CECRI, Karaikudi, Aug 21-23, 2014
Dr M Ravi	Best paper award, Influence of alloying elements and casting process on the mechanical properties of Al-Si piston alloy, National Conference on Advances in Materials and Advances in Bioprocess Engineering, Mohandas College of Engineering, Trivandrum, Dec 10-12, 2014
Mr K V Mahesh	Best oral presentation award, Ultra thin MAXene nanostructures for multifunctional applications, National Seminar on Advances in Materials Chemistry AMAC-I, UGC sponsored National Seminar, Department of Chemistry, Christian College, Chengannur 15-17 October, 2014
Ms S Sameera	Best poster award, Ecological IR reflecting pigments $\text{In}(\text{BiV})_x(\text{CaMo})_{1-x}\text{O}_4$ for Cool roof applications, National Conference on Advanced Technologies for Materials Processing and Diagnostics, (ISAS 2014)
Ms P Suyana	Best poster award, Enhanced photocatalytic hydrogen evolution in ZnO-C3N4 semiconductor heterostructures, International Conference on Alumina and other Functional Ceramics, AOFC 2015, CSIR- CGCRI, Kolkata, Mar 11-13, 2015
Mr S Sankar	Best poster award, LaPO <sub>4</sub> - ZrO <sub>2</sub> nanocomposites - A new class of ceramics with possible high temperature applications, International Conference on Alumina and other Functional Ceramics, AOFC 2015, CSIR- CGCRI, Kolkata, Mar 11- 13, 2015
Ms Linsha Vazhayil	Best poster award, Supramolecular association of 2D alumino-siloxane nanotapes to tridimensional hydrogel for injectable and topical delivery of fluconazole antifungal drug, NANO INDIA-2015, SASTRA University, Tamil Nadu, India, Jan 29-30, 2015.
Mr B Nagendra and Dr E Bhoje Gowd	Best Poster Award, Highly dispersed layered double hydroxides/polymer nanocomposite in National Seminar on Frontiers of Polymers and Advanced Materials (FPAM-2014), Department of Chemistry, University of Kerala, Thiruvananthapuram, India, November 05-07, 2014
Ms Kavitha Sasidharan	Naranjan S Dhalla Award for best poster presentation, Indo Canadian Symposium on Heart Failure: Progress & Prospects, RGCB, Trivandrum, Mar 12-14, 2015
Ms Reshma P L	First prize in poster presentation, International Academy of Cardiovascular Sciences (IACS) during 7th International conference on Recent Advances in Cardiovascular Sciences, Amity University, Noida, Mar 10-11, 2015



## LIST OF PH.D. AWARDEES

(April 2014-March 2015)

Sl No.	Name	Title of Ph.D. thesis	Name of Guide	University
1	Krishna Kartha K	Exploring oligo (p-phenylenevinylene) gelators as sensors and stimuli responsive materials	Dr A Ajayaghosh	CUSAT
2	Manu K M	Investigation on low loss silicate based ceramics and their composites for electronic applications	Dr S Ananthakumar/ Dr M T Sebastian	Kerala
3	Chameswari J	Butyl rubber-ceramic composites for flexible electronic applications	Dr S Ananthakumar/ Dr M T Sebastian	CUSAT
4	Ushasree M V	Development of microbial phytase with improved characteristics for industrial application using site-directed mutagenesis	Dr Ashok Pandey	Kerala
5	Vidya J	Recombinant expression of L-asparaginase II from <i>Escherichia</i> sp. and property improvements through amino acid substitutions	Dr Ashok Pandey	Kerala
6	Jisha Babu	Gold nanoparticle-quinaldine hybrid systems: Synthesis, properties and application towards sensing of metal cations	Dr R Luxmi Varma	Kerala
7	Arya Nandan	Proline specific aminopeptidase from <i>Streptomyces lavendulae</i>	Dr K Madhavan Nampoothiri	Kerala
8	Priya Rani M	Investigation on phytochemical constituents & biological potential of some traditional medicinal plants	Dr K P Padmakumari/ Dr K G Raghu	CUSAT



9	Ajith Kumar K K	Processing properties & modification of magnesium-silicon alloy	Dr U T S Pillai	IIT Bhubaneswar
10	Dhanya S	Optical and electrochemical sensors for detection and quantification of selected inorganic anions in aqueous media	Dr T Prasada Rao	Kerala
11	Sindhu R Nambiar	Hybrid gold atomic cluster nanocomposites for electrochemical sensing and phase formation studies	Dr T Prasada Rao	Kerala
12	Praveen Prakash	Transition metal mediated construction of carbocycles and heterocycles <i>via</i> a strain release of diazanorbornenes	Dr K V Radhakrishnan	Kerala
13	Jijy E	Carbon-carbon and carbon-heteroatom bond formation <i>via</i> transition metal catalyzed desymmetrization of strained diazanorbornenes.	Dr K V Radhakrishnan	Kerala
14	Ajish K R	Synthetic Transformations of phytochemicals from <i>Zingiber zerumbet</i> (L) Smith and synthesis of carbohydrate appended allylidine cyclopentenes as bioactive analogues	Dr K V Radhakrishnan	Kerala
15	Jinesh M Kuthanampallil	Palladium and organocatalyzed transformations of isatylidenes and 8, 8-dicyanoheptafulvene	Dr K V Radhakrishnan	Kerala
16	Nayana Joseph	Transition metal catalyzed synthetic transformations of azabicyclic olefins: Facile synthesis of indanones, indanols and cyclopentenes	Dr K V Radhakrishnan	Kerala
17	Sholly Claire George	Palladium and organocatalyzed transformations of isatylidenes and 8, 8-dicyanoheptafulvene	Dr K V Radhakrishnan	Kerala
18	Rajasree K P	Glucosidases from <i>Aspergillusunguis</i> NII 08123: Molecular characterization, properties and applications	Dr Rajeev K Sukumaran	CUSAT
19	Akhil K Nair	Design of metal architectures: Synthesis and study of their photophysical and biomolecular recognition properties	Dr D Ramaiah	CUSAT



20	Betsy M	Design of functionalized porphyrins for photodynamic therapy and study of their photophysical photobiological and self-assembly aspects	Dr D Ramaiah	Kerala
21	Ramya A R	Design and development of efficient photosensitizers for Ln <sup>3+</sup> ions based on aromatic carboxylates	Dr M L P Reddy	Kerala
22	Sarika Sivakumar	Design and development of efficient light conversion molecular devices based on lanthanide carboxylates"	Dr M L P Reddy	Kerala
23	Shafeek K M	Synthesis of some novel squaraine dyes and exploration of their application as sensors and sensitizers	Dr Suresh Das	Kerala
24	Abdul Rahim	Design, synthesis and study of some novel squaraine dyes for applications in solar cells	Dr Suresh Das	Kerala
25	Deepak D Prabhu	Design, synthesis and study of photophysical and self assembling properties of some novel C <sub>3</sub> -symmetric donor-acceptor molecules	Dr Suresh Das	Kerala
26	Sandhya K S	Design and study of homogeneous Ru(II) pincer hydride and octahedral metal hydride complexes for hydrogen production from water and alcohol	Dr C H Suresh	Kerala
27	Neetha Mohan	Molecular electrostatics for probing hydrogen bonds, halogen bonds and lone pair pi-interactions and design of receptors for lone pair bearing molecules	Dr C H Suresh	CUSAT
28	Jaimy K B	Nanocrystalline visible light active sol gel titanium dioxide catalysts and coatings for functional applications	Dr K G K Warriar/ Dr S K Ghosh	Kerala
29	Smitha V S	Sol gel photocatalytic titanium oxide multifunctional nanocomposites and coatings	Dr K G K Warriar/ Dr S K Ghosh	CUSAT



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Department of Materials Engineering  
Indian Institute of Science  
Bengaluru-560 012

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Distinguished Professor  
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Matunga, Mumbai- 400019

**Prof M K Mathew**

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Tata Institute of Fundamental Research  
GKVK, Bellary Road, Bengaluru-560 065

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**Prof Gunasekaran**

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Serkkadu, Vellore- 632115

**Dr P G Rao**

Technical Consultant and Former Director,  
CSIR- NEIST, Jorhat- 785006

**Shri A C Shroff**

Chairman & MD  
Excel Industries Limited  
184-87, S V Road,  
Jogeshwari (West), Mumbai- 400102

**Dr K S Dasgupta**

Director  
Indian Institute of Space Science  
& Technology  
Valiamala P O  
Thiruvananthapuram- 695547

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**Dr R Brakaspathy**

Scientist G  
Science and Engineering Research Board,  
5 & 5A, Lower Ground Floor,  
Vasant Square Mall, Sector- B,  
Pocket-5, Vasant Kunj, New Delhi- 110 070

### DG NOMINEE

**Dr Vivek V Ranade**

Head, Catalysis, Reactors & Separators Unit  
CSIR- National Chemical Laboratory  
Pune- 411008

### SISTER LABORATORY

**Dr Vijayamohanan K Pillai**

Director  
Central Electrochemical Research Institute  
Karaikudi-630 006, Tamil Nadu

### CLUSTER DIRECTOR

**Dr M O GARG**

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Indian Institute of Petroleum (IIP)  
P O IIP, Mohkampur, Dehradun-248 005

### DIRECTOR

**Dr Suresh Das**

Director  
National Institute for Interdisciplinary  
Science & Technology  
Thiruvananthapuram-695 019

### PERMANENT INVITEE

Head or His Nominee  
Planning & Performance Division (PPD)  
Council of Scientific & Industrial Research  
Anusandhan Bhawan, 2, Rafi Marg,  
New Delhi-110 001

### SECRETARY

**Dr A Sundaresan**

Chief Scientist  
National Institute for Interdisciplinary  
Science & Technology  
Thiruvananthapuram-695 019



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Director, IIIST

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Dr Gangan Prathap, Scientist, IIIST (Special Invitee)

Dr C Chandrasekhara Bhat, Scientist, IIIST

Dr M Vasundhara , Scientist, IIIST

Dr E Bhoje Gowd, Scientist, IIIST

Dr K Madhavan Nampoothiri, Scientist, IIIST

Sri M Brahmakumar, Principal Technical Officer, IIIST

Sri M M Sreekumar, Head, RPBD, IIIST

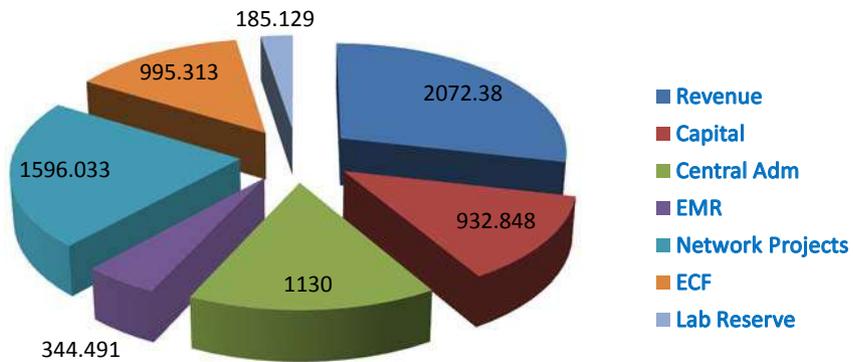
Sri T V Sankaran, CoFA, IIIST

### MEMBER SECRETARY

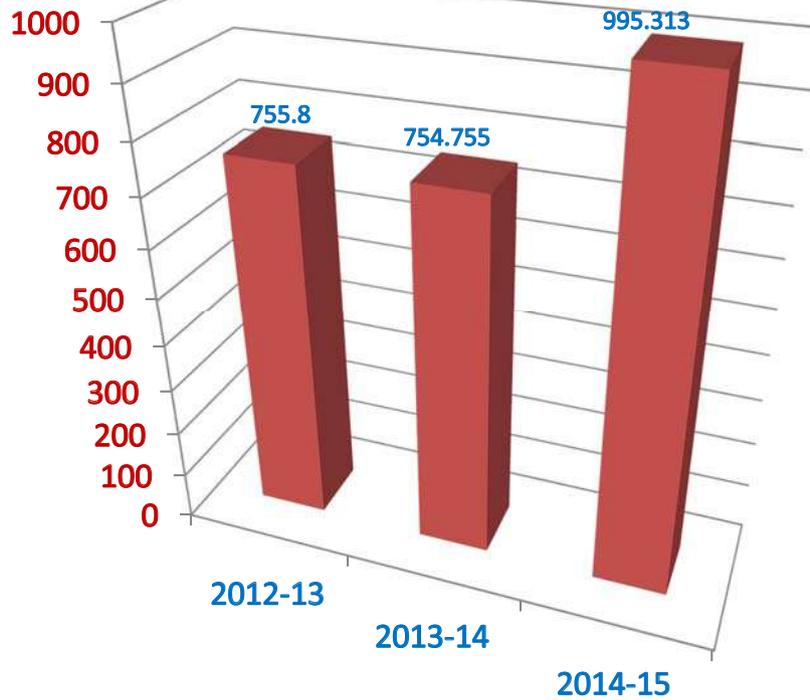
AO, IIIST



## BUDGET 2014 - 2015 (Rs. Lakh)



## ECF (Rs. Lakh)





## STAFF LIST AS ON 31/03/2015

<b>DIRECTOR'S OFFICE</b>	
DR GANGAN PRATHAP	ACTING DIRECTOR
DR SURESH DAS	DIRECTOR (Retired on 28/2/2015)
MR S SURESHKUMAR	CHIEF SCIENTIST (Retired on 31/5/2014)
MR T S SASI KUMAR	PRIVATE SECRETARY (Retired on 30/11/2014)
MRS SREELETHA NAIR	PRIVATE SECRETARY
MRS ELIZABETH THOMAS	SR STENO (MACP)
MR A KRISHNANKUTTY	LAB ASSISTANT (Retired on 30/11/2014)
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MRS M V RESHMA	SR SCIENTIST
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DR P JAYAMURTHY	SCIENTIST
DR (MRS) S PRIYA	SCIENTIST
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MR D R SOBAN KUMAR	SR TECH OFFICER
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DR RAJEEVKUMAR SUKUMARAN	SR SCIENTIST
DR P BINOD	SCIENTIST
DR N RAMESH KUMAR	SCIENTIST



DR MUTHU ARUMUGAM	SCIENTIST
MR M KIRAN KUMAR	SCIENTIST
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DR T PRASADA RAO	CHIEF SCIENTIST
DR (MRS) MANGALAM S NAIR	CHIEF SCIENTIST
DR (MRS) A JAYALAKSHMI	CHIEF SCIENTIST (Retired on 31/5/2014)
DR (MRS) R LUXMI VARMA	SR PRINCIPAL SCIENTIST
DR K V RADHAKRISHNAN	PRINCIPAL SCIENTIST
DR C H SURESH	PRINCIPAL SCIENTIST
DR K N NARAYANAN UNNI	PRINCIPAL SCIENTIST
DR KAUSTABH KUMAR MAITI	SR SCIENTIST
DR BISWAPRIYA DEB	SR SCIENTIST
DR KARUNAKARAN VENUGOPAL	SR SCIENTIST
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DR L RAVI SHANKAR	SCIENTIST
DR JOSHY JOSEPH	SCIENTIST
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MR ROBERT PHILLIP	SR TECH OFFICER
MRS S VIJI	TECH OFFICER
MR KIRAN MOHAN	TECH OFFICER
MR J S KIRAN	TECH ASSISTANT
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DR M T SEBASTIAN	CHIEF SCIENTIST (Retired on 31/5/2014)
DR P PRABHAKAR RAO	CHIEF SCIENTIST
DR JOSE JAMES	CHIEF SCIENTIST
MR K HARIKRISHNA BHAT	CHIEF SCIENTIST
MR M C SHAJI	SR PRINCIPAL SCIENTIST



DR U T S PILLAI	SR PRINCIPAL SCIENTIST & HEAD, ESD
DR A R R MENON	SR PRINCIPAL SCIENTIST
DR MANOJ RAAMA VARMA	SR PRINCIPAL SCIENTIST
DR M RAVI	SR PRINCIPAL SCIENTIST
DR S ANANTHAKUMAR	PRINCIPAL SCIENTIST
DR T P D RAJAN	SR SCIENTIST
DR S V SHUKLA	SR SCIENTIST
DR U S HAREESH	SR SCIENTIST
DR E BHOJE GOWD	SR SCIENTIST
DR A SRINIVASAN	SCIENTIST
DR M SUNDARARAJAN	SCIENTIST
DR K P SURENDRAN	SCIENTIST
DR SAJU PILLAI	SCIENTIST
DR (MS) M VASUNDHARA	SCIENTIST
DR K G NISHANTH	SCIENTIST
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DR V S PRASAD	PRINCIPAL TECH OFFICER
MR M BRAHMA KUMAR	PRINCIPAL TECH OFFICER
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MR P PERUMAL	PRINCIPAL TECH OFFICER
MRS LUCY PAUL	SR TECH OFFICER (Retired on 31/5/2014)
MR M R CHANDRAN	SR TECH OFFICER 2
MR A PEER MOHAMED	SR TECH OFFICER
MR S SASIBHUSHANAN	SR TECHNICIAN 2
MR T SOMAN	SR TECHNICIAN 2
MR V ANTONY	SR TECHNICIAN 2
MR V SREEKANTAN	LAB ASSISTANT (Retired on 30/11/2014)
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DR (MRS) S SAVITHRI	SR PRINCIPAL SCIENTIST
DR V B MANILAL	SR PRINCIPAL SCIENTIST
MR J ANSARI	SR PRINCIPAL SCIENTIST
DR (MRS) RUGMINI SUKUMAR	PRINCIPAL SCIENTIST (Retired on 31/12/2014)
DR M ANBU	PRINCIPAL SCIENTIST
DR B KRISHNAKUMAR	SR SCIENTIST



MR B ABDUL HALEEM	SCIENTIST
MR K RISHI ARVIND	SCIENTIST (Resigned on 10/6/2014)
DR K P PRATHISH	SCIENTIST
MRS VIJAYA PRASAD	SR TECH OFFICER 3
MR V K SHAJIKUMAR	SR TECH OFFICER
DR S RAMASWAMY	SR TECH OFFICER
MRS P M SAHARUBA	TECH OFFICER
MR T P PAULOSE	SR TECHNICIAN 3
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<b>ENGINEERING &amp; SERVICES DIVISION</b>	
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MR G CHANDRA BABU	EXEC ENGINEER
MR K PRASAD	EXEC ENGINEER (Retired on 30/11/2014)
MR B KARTHIK	ASST ENGINEER (CIVIL)
MR P ARUMUGAM	ASST ENGINEER (CIVIL)
MR N SUDHILAL	SR TECHNICIAN 3
MR P V THAMPY	SR TECHNICIAN 2 (Retired on 31/1/2015)
MR M JAYADEEP	SR TECHNICIAN 2
MR K S PRAMOD	TECHNICIAN 2
MR K SURESH KANNAN	TECHNICIAN 2
MR U DHARANIPATHY	TECHNICIAN 2
MR R SUKUMARAN	LAB ASSISTANT (Retired on 30/11/2014)
MR C P NARAYANAN	LAB ASSISTANT
MR P SOMAN	LAB ASSISTANT
MR T V SATHEESH	GR C NON-TECH (MACP)
<b>KNOWLEDGE RESOURCE CENTRE</b>	
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MR V MONI	SCIENTIST
MR S B RIBIN JONES	SCIENTIST
DR (MRS) S MINI	PRINCIPAL TECH OFFICER



MR M RAMASAMY PILLAI	PRINCIPAL TECH OFFICER
MR S PUSHKIN	TECH OFFICER
MR P N SIVANKUTTY NAIR	SR TECHNICIAN 2
MR G NAGASRINIVASU	SR TECHNICIAN 2
MR PUSHPAKUMAR K R NAIR	GR C NON-TECH (MACP)
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DR V G MOHANAN NAIR	CHIEF SCIENTIST
DR C CHANDRASEKARA BHAT	SR PRINCIPAL SCIENTIST
MR D BHEEMESWAR	PRINCIPAL SCIENTIST
MR C K CHANDRAKANTH	SR SCIENTIST
MR R S PRAVEEN RAJ	SR SCIENTIST
DR M SANKARANARAYANAN	PRINCIPAL TECH OFFICER
MRS V J SAROJAKUMARI	SR STENO(ACP) (Retired on 30/9/2014)
MR K C CHACKO	GR C NON-TECH (MACP)
<b>ADMINISTRATION</b>	
MR K MURALEEDHARAN	COA
MR N S RAJU	AO (Transfer on 23/9/2014 ) [NIO, GOA]
MRS S SOBHANA	AO
MR K F JOSEPH	SO (G)
MR M K SIVADASAN	SO (G)
DR R VIJAYNATH	MEDICAL OFFICER
MR T J BABU	SR SECURITY OFFICER
MRS K S LATHIDEVI	HINDI OFFICER
MR K P KRISHNAN	ASST (G) GR I
MR V MOHANAN NAIR	ASST(G) GR I
MRS PARVATHI RAJEEVAN	ASST(G) GR I
MRS JYOTHI R THAMPI	ASST (G) GR II (Retired on 28/2/2015)
MRS MERCY JOSEPH	ASST(G) GR II
MR R K RAMESH KUMAR	ASST(G) GR II
MRS T S LATHA	ASST(G)GR II (MACP)
MRS P S PADMINI	SR STENO (MACP)
MR T H BASHEER	SR TECHNICIAN 2
MR B VENUGOPAL	SR TECHNICIAN 2
MR S HARIDASAN PILLAI	SR TECHNICIAN 2



MR PRAVEEN KANNAL	TECHNICIAN 2
MR B RADHAKRISHNAN	TECHNICIAN 1
MRS SHANA S NAIR	STAFF NURSE
MR M P VARKEY	LAB ASSISTANT
MRS M GEETHA	LAB ASSISTANT
MR K UNNIKRISHNAN	GR C NON-TECH
MR SASIDHARAN	BEARER (MACP)
MR K MADHU	DRIVER
MR A SREEKUMARAN	WASHBOY (MACP)
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MR T V SANKARAN	COFA
MRS P V VIJI	SO(F&A)
MR M KRISHNA KUMAR	SO(F&A)
MRS REMANI DEVARAJ	SO(F&A)
MR K G PILLAI	ASST(F&A)GR I (MACP)
MRS G GEETHA	ASST(F&A)GR I
MR SANJEEV SADANANDAN	ASST(G)GR I
MRS KOMALA SOMAN	ASST(F&A)GR II
MR S RAJU	SR STENO (MACP)
MR P PARAMESWARAN PILLAI	GR C NON-TECH (MACP) (Expired on 12/08/2014)
MRS R REMADEVI	RECORD KEEPER (Retired on 30/11/2014)
<b>STORES &amp; PURCHASE</b>	
MR M R DEVASIS	SPO
MR SANJAY SUMAN	SO (Transferred on 19/9/2014)
MR C M KRISHNADAS	ASST(S&P)GR I
MR M ANILKUMAR	ASST(S&P)GR I
MRS L LATHA	SR TECHNICIAN 2
MR B AJAYAKUMAR	SR TECHNICIAN 2
MR T R SURESH KUMAR	SR TECHNICIAN 2
MR T K GHOSH	GR C NON-TECH (MACP)
MR T K GOPI	GR C NON-TECH (Retired on 30/6/2014)
MR G BHAKTHAVALSALAM	GR C NON-TECH
MR B SATHEESH KUMAR	GR C NON-TECH



## OTHER ACTIVITIES AND CELEBRATIONS

### National Technology Day Celebration

The National Technology day was celebrated on May 12, 2014 at the Institute. Shri S Somanath, Project Director, GSLV MkIII, VSSC Trivandrum was the Chief Guest and delivered the National Technology



*National Technology Day Celebrations- Director Dr. Suresh Das delivering the presidential address. On the stage Dr. Manoj Raama Verma and Chief Guest Shri S Somanath*

Day Lecture entitled “Challenges faced in the development of cryogenic technology: GSLV and GSLV MkIII experience”. The Chief Guest in his address, carried the audience to the enchanting world of space research in India. The Institute Director while welcoming the guest and the gathering highlighted the significance of the National Technology Day and the leaps made by our country.

### Transcending Frontiers in Organic Chemistry (TFOC-2014)

CSIR- NIIST jointly in collaboration with Kerala State Council for Science Technology and Environ-

ment (KSCSTE) and under the co-sponsorship of Srinivasa Ramanujan Institute for Basic Sciences (SRIBS), Kottayam conducted a three-day National Symposium on organic Chemistry entitled “Transcending Frontiers in Organic Chemistry (TFOC-2014)” during October 09 - 11, 2014 at CSIR- NIIST, Trivandrum. The programme commenced with the lighting of the lamp by the dignitaries Dr Tushar Kanti Chakraborty (IISc Bangalore), Dr Suresh Das, Director, CSIR-NIIST, Prof V N Rajasekharan Pillai (Executive Vice President, KSCSTE), Dr K V Radhakrishnan (Convener) and Dr R Luxmi Varma (Co-Convener). The keynote address was given by Prof V N Rajasekharan Pillai followed

by the release of Souvenir. There were 30 invited lectures, 10 oral presentations and 134 numbers of posters from the researchers in organic chemistry along with an Academic-Industrial interactive session and a brief cultural programme. The symposium highlighted the recent developments in Organic Chemistry and attracted industrial participation. The Academic-Industrial interactive session (bridging the gap) was dedicated for discussion on the topics related to identifying the gaps, which limit interaction between scientists in academia and industry. This helped to formulate guidelines for promoting or bridging the gap between academy and industry for improving societal benefits through research and development efforts.



### Various scenes of Inaugural session



### Polymer Conference for Young Researchers, (PCYR-14)

The Thiruvananthapuram Chapter of SPSI organized a one-day conference on “Polymer science and Technology” at NIIST exclusively for the young researchers on Oct 18, 2014. The event was sponsored by Kerala State Council for Science, Technology and Environment (KSCSTE). The conference focused on research topics and major advances that are taking place in various polymer science laboratories across India. The Seminar was inaugurated by Dr Suresh Das, CSIR- NIIST, Thiruvananthapuram and was presided over by Dr A Ajayaghosh (CSIR-NIIST), Dr C P Regunadhan Nair (VSSC, Trivandrum), Prof T S Anirudhan

(University of Kerala) and Dr J D Sudha (CSIR-NIIST). The conference was an excellent platform for the student community to discuss and exchange their findings and to expand the scope of their research work.



Release of Souvenir



## 8<sup>th</sup> Asian Photochemistry Conference



The 8<sup>th</sup> Asian Photochemistry was jointly organized by CSIR-NIIST and IISER, Trivandrum during November 10-13, 2014 at Kovalam. The Conference (APC-2014) showcased the recent developments in photochemistry and related areas across the globe. Scientific sessions of APC-2014 also focused on photochemistry related research that spans from physics, material science, engineering, technology, medicine to biology. Major aim of this international gathering was to facilitate scientific discussions among the participants and look for solutions to global issues pertinent to this area of research. APC-2014 provided a platform for the young researchers to interact with the pioneers in photochemistry.

### Professor G N Ramachandran Memorial Lecture

The year 2014 was declared the International Year of Crystallography (IYCr2014) by the United Nations in concurrence with International Union of Crystallography (IUCr) in order to raise awareness in the world at large about the importance of crystallography in the modern world. As a part of the IYCr2014 celebration, Royal Society of Chemistry (RSC), Kerala State Council for Science and Technology and Environment (KSCSTE) together with CSIR-National Institute of Interdisciplinary Science and Technology (CSIR-NIIST) facilitated a memorial lecture on 29 September 2014 to pay respect to the celebrated crystallographer,

Professor G N Ramachandran. Prof Ramachandran, a physicist by training, developed the Ramachandran plot for understanding peptide structure and was the first to propose a triple-helical model for the structure of collagen using X-ray diffraction. The renowned structural chemist and immediate Past President of IUCr, Professor Gautam R Desiraju, Indian Institute of Science (IISc) Bangalore delivered the memorial lecture on "Crystallography Across the Sciences". The lecture was attended by students and faculties from the host Institute as well as various neighbouring academic and research institutions.



*Professor Gautam R Desiraju, Indian Institute of Science (IISc) Bangalore delivering the lecture*

### Vigilance Awareness Week

Vigilance Awareness week was celebrated in the Institute on 27 October to 1 November 2014. Various competitions on Elocution, Essay writing and Debate were conducted for staff members and students during 28<sup>th</sup> October to 1<sup>st</sup> November 2014. Shri Rishiraj Singh, IPS, Chief Vigilance Officer, KSEB delivered the Vigilance Day Lecture. The valedictory function and prize distribution were held on 1<sup>st</sup> November 2014. Dr Ajayaghosh, Director-In-Charge presided over the function and he gave away prizes to the winners of various competitions.



Shri Rishi Raj Singh, IPS, Chief Vigilance Officer, KSEB delivering Vigilance Day lecture

Valedictory function / Prize distribution function- various scenes



### CSIR Foundation Day Celebration

CSIR-NIIST celebrated the CSIR Foundation Day on 24<sup>th</sup> September 2014 at the NIIST auditorium. Dr K M Chandrashekar, Vice-Chairman, Kerala State Planning Board was the Chief Guest. The laboratory observed open day. The highlight of the day was

the CSIR Foundation Day lecture by the renowned chief guest. The chief guest also gave away mementos and Samman Patra to the retirees and studentships to outstanding students.



Dr K M Chandrashekar, Vice-Chairman, Kerala State Planning Board speaking on the occasion

### NIIST Foundation Day Celebration

NIIST Foundation Day was celebrated on 15<sup>th</sup> October 2014. Dr Anil Bharadwaj, Director, Space Physics Laboratory, VSSC, Thiruvananthapuram was the chief guest. Dr Suresh das, Director, NIIST welcomed the chief guest and introduced to the audience. The laboratory observed open day. The lab showcased its R & D achievements and instrumentation capabilities to the visitors who came in large numbers. The highlight of the day was the CSIR Foundation Day lecture by the chief guest on "Success story of PSLV and GSLV".



Dr Anil Bharadwaj, Director, Space Physics Laboratory, VSSC, Thiruvananthapuram delivering Foundation Day lecture



## National Science Day Celebration

National Science Day was celebrated in CSIR NIIST on 26<sup>th</sup> February 2015. Institute observed open day for the function and as many as 400 students visited the Institute to get the live wire feel of applied and basic research of interdisciplinary nature. On the occasion Prof. KL Sebastian, FNA, IISc, Bangalore, delivered the National Science Day Lecture on Nano Devices. In the lecture he carried the audience down the memory lane to the early stages of his work involving the fascinating world of DNA mapping. Prof Sebastian also gave a short pep talk on why to choose research as a career for the young aspirants present among the audience.



*Prof. KL Sebastian, FNA, IISc, Bangalore with Director NIIST and Dr Luxmi Verma*

## Official Language Implementation Activities

### Demonstration Programme On 3-D Photography

On the occasion of the World Photography Day, i.e. On 19<sup>th</sup> August 2014, a demonstration Programme on 3-D Photography in Hindi was organised in the Institute. The programme was conducted by Dr V G M Nair, Chief Scientist, NIIST and member of Photographic Society of America. In his speech he illustrated the method of taking the traditional pictures as well as 3D pictures using normal camera. He also demonstrated different methods of taking 3-D photography i.e., the "Cha Cha" method, details of the slide bar, etc. and participants were also taken on practical ex-

ercises. Participants were also given information on different types of 3D Cameras available in the market like Twined camera, digital stereo camera etc



## Hindi Day/ Hindi Week Celebration

Institute observed 11 September, 2014 as the Hindi day and the week succeeding as Hindi Week with great zeal and enthusiasm. Director Dr Suresh Das presided over the function and he formally inaugurated the ceremony by lighting the lamp and later on delivered the inaugural address. The Hindi Officer of the Institute read out Home Minister Shri Rajnath Singh's Hindi Day message to the participants. Mr Sanjay Suman, Section Officer (stores and purchase) and Member, Organizing Committee, gave a very informative lecture on "Purchase Procedure of CSIR" in Hindi.



*Formal inauguration of the Hindi Day by Director Dr Suresh Das*



During the entire week, a series of competitions were organized for the staff members of the Institute including research students, project staff and their school children. Valedictory function and prize distribution was held on 17.9.2014 at 4.30 PM. Dr. (Mrs.) Thankmony Amma, Executive Council Member, Mahatma Gandhi International Hindi University, Wardha, was the chief guest. In her concluding remarks, she justified making Hindi as the National and Official language.



*Dr (Mrs) Thankmony Amma, Executive Council Member, Mahatma Gandhi International Hindi University, Wardha, delivering the lecture*

### SSBM Tournament

#### The 46<sup>th</sup> Santhi Swarup Bhatnagar Memorial Tournament (Indoor Zonals )

CSIR-NIIST, Trivandrum organized Shanti Swarup Bhatnagar Memorial Tournament (SSBMT), Indoors-Zonal during 19-21 September 2014. The eleven CSIR Laboratories/Offices participated in the Indoor Zonal Tournament. About 180 participants competed against each other in games such as, Bridge, Carroms, Chess, Table tennis and Badminton. The tournament was inaugurated by Mr Jacob Punnoose, IPS (Retd., Former DGP, Kerala) on 19<sup>th</sup> September 2014. All the games were organized under the supervision of the CSIR-Sports Promotion Board members, Mr Ranjit Singh Solanki and Mr B N Singh. From each game,

two finalists (individual/team) were selected for the finals to be organized by CSIR-NCL, Pune during 26-28 February 2015.



*Chief Guest of the function Dr Jacob Punnoose, IPS and Director, NIIST receiving the guard-of-Honour.*

### Swachh Bharat Mission Activities

Institute carried out intensive cleanliness campaign on 2<sup>nd</sup> October 2014 as part of the Swachh Bharat Initiative of Prime Minister. Staff members carried out cleaning activities inside the laboratory and at the premises of the Institute. Oath taking ceremony and cleanliness campaign were organised in the Institute.





## ONAM Celebrations

On September 03, 2014, under the auspices of the Institute's Staff Recreation Club, Onam festival was celebrated with various entertainment programs like Athappookkalam competition, Onappattu competition, Thiruvathira Kali, songs by NIIST family members

and their children, skit, sundarikku pottukuthal, Kalamudakkal etc. on that day. Ms Nandhini, play back singer was the chief guest during the occasion. A very delicious and delectable Onasadya was another attraction of the day. The events were very enjoyable and it marked the unity of NIIST family.



*Some of the highlights of the ceremony*



# हिंदी रूपांतर सामान्य सूचनाएं



## विदेश में दौरा

वैज्ञानिक का नाम	दौरा किया देश	अवधि	यात्रा का उद्देश्य
डॉ ए अजयघोष	फ्रांस	19.05.14 - 23.05.14	53 वीं वैज्ञानिक परिषद् और 24वीं औद्योगिक अनुसंधान समिति की बैठकों और सीईएफआईपीआरए के विजन ग्रुप की बैठक।
	फ्रांस	13.07.14 - 16.07.14	रसायन विज्ञान की रॉयल सोसायटी द्वारा समर्थित फोटो रसायनविज्ञान पर XXVI वें आईयूपीएसी सम्मेलन में आमंत्रित व्याख्यान
	सिंगापुर	21.09.14 - 23.09.14	21 वीं सदी में पर्यावरण और स्वास्थ्य पर हम्बोल्ड्ट कोल्लेग संगोष्ठी में आमंत्रित व्याख्यान
	मस्कट	25.10.14 - 29.10.14	रसायन विज्ञान में टीडब्ल्यूएस 2013 पुरस्कार प्राप्त करने के लिए
	जापान	28.11.14 - 06.12.14	ओसाका विश्वविद्यालय में भारत-जापान संयुक्त परियोजना (डीएसटी-जेएसपीएस)
	जापान	11.12.14 - 17.12.14W	सीईएमएस, आरआईकेईएन टोक्यो, जापान द्वारा अतिआण्विक रसायन शास्त्र और कार्यात्मक सामग्री पर आयोजित अंतर्राष्ट्रीय संगोष्ठी-2014 में आमंत्रित व्याख्यान
श्री जे अंसारी	जर्मनी	30.04.14 - 30.06.14	लाइबनिट्स विश्वविद्यालय, हनोवर, जर्मनी
डॉ अशोक पाण्डेय	फ्रांस	02.05.14 - 27.06.14	ब्लेज पास्कल विश्वविद्यालय, फ्रांस
	स्वीडन	20.08.14 - 21.08.14	जैव-अर्थव्यवस्था के विकास पर इंडो स्वीडन कार्यशाला
	फ्रांस	07.09.14 - 10.09.14	बायोकेमिकल इंजीनियरिंग विज्ञान के 10 वें यूरोपीय सम्मेलन
डॉ पी बिनोद	स्विट्जरलैंड	01.09.14 - 31.10.14	स्विस फेडरल प्रौद्योगिकी संस्थान



डॉ ई भोजे गौड	अमेरिका	01.03.14 - 31.05.14	स्टोनी ब्रुक विश्वविद्यालय, अमेरिका
	इटली	22.09.14 - 25.09.14	10 वां अंतर्राष्ट्रीय आईयूपीएसी सम्मेलन
	जर्मनी	26.09.14 - 30.09.14	लाइबनिट्स विश्वविद्यालय में पॉलिमर अनुसंधान पर व्याख्यान
डॉ के आर गोपिदास	बेल्जियम	23.06.14 - 25.06.14	ब्रुसेल्स, बेल्जियम
	जर्मनी	26.06.14 - 28.06.14	बेरुत, जर्मनी
डॉ यू एस हरीश	जापान	04.11.14 - 08.11.14	फोटो सक्रिय सतहों: नई सामग्रियों और बेहतर क्षमता पर आमंत्रित व्याख्यान
डॉ के माधवन नंपूतिरि	जर्मनी	15.10.14 - 26.10.14	डीएसटी और डीएएडी -जर्मनी के साथ इंडो-जर्मन सहयोगी कार्यक्रम बिलेफेल्ड विश्वविद्यालय
डॉ पी निशा	जर्मनी	18.05.14 - 24.05.14	मैक्स रुबेनर संस्थान, किल, जर्मनी
डॉ राजीव के सुकुमारन	स्वीडन	20.08.14 - 21.08.14	जैव आधारित अर्थव्यवस्था पर इंडो स्वीडन कार्यशाला
डॉ के पी सुरेन्द्रन	पुर्तगाल	08.09.14 - 13.09.14	अविरो विश्वविद्यालय
डॉ सी एच सुरेश	जापान	17.03.14 - 01.04.14	नागोया विश्वविद्यालय, जापान



## सम्मान और पुरस्कार

डॉ ए अजयघोष	विज्ञान तथा प्रौद्योगिकी में उत्कृष्टता के लिए आईएसएस राष्ट्रीय पुरस्कार-2014, भारतीय विश्लेषणात्मक वैज्ञानिक सोसायटी
	अनुसंधान और विकास के क्षेत्र में नेतृत्व और उत्कृष्टता के लिए केमटेक सीईडब्ल्यू अवार्ड 2015
	जे सी बोस नेशनल फेलोशिप 2015, डीएसटी
डॉ केवी राधाकृष्णन	असाधारण कैमिस्ट के संघ- टीसीआई-भारत -असाधारण कैमिस्ट के संघ टोक्यो केमिकल इंडस्ट्रीज (इंडिया) प्राइवेट लिमिटेड
डॉ टीपीडी राजन	एप्लाइड रिसर्च और अभिनव प्रौद्योगिकी के लिए चंद्रन मेनन मेमोरियल पुरस्कार-2015 भारतीय संधानीकर्म संस्थान (आईआईएफ), कोलकाता
डॉ एमएलपी रेड्डी	आंध्र प्रदेश विज्ञान अकादमी के फेलो-2014 के रूप में चयनित
डॉ पी बिनोद	केरल राज्य युवा वैज्ञानिक पुरस्कार 2014
डॉ आर सिंधु	समीक्षक पुरस्कार 2014, औद्योगिक फसलों और उत्पादों (एल्सेविअर)
डॉ वंदना शंकर	युवा वैज्ञानिक पुरस्कार 2014, केएससीएसटीई
सुश्री विनी सी शेखर	सर्वोत्तम शोधपत्र पुरस्कार, “इलेक्ट्रॉनिक कचरे प्लास्टिक की माइक्रोबियल गिरावट”, जैव प्रौद्योगिकी में उभरती प्रवृत्तियों पर अंतर्राष्ट्रीय सम्मेलन (आईसीईटीबी-2014), भारत की बायोटेक रिसर्च सोसायटी का 11वीं सम्मेलन, औद्योगिक फार्मास्युटिकल जैव प्रौद्योगिकी पर भारत-इतालवी कार्यशाला, जवाहर लाल नेहरू विश्वविद्यालय, नई दिल्ली 6-9, नवंबर 2014
सुश्री सैयद सजिता	सर्वोत्तम शोधपत्र पुरस्कार, “ई कोलाई से क्लोनिंग और आनुवंशिक सुधार से एल ऐस्पैरजाइनेस का उत्पादन”, जैव प्रौद्योगिकी में उभरती प्रवृत्तियों पर अंतर्राष्ट्रीय सम्मेलन (आईसीईटीबी-2014), भारत की बायोटेक रिसर्च सोसायटी का 11वीं सम्मेलन, औद्योगिक फार्मास्युटिकल जैव प्रौद्योगिकी पर भारत-इतालवी कार्यशाला, जवाहर लाल नेहरू विश्वविद्यालय, नई दिल्ली 6-9, नवंबर 2014
सुश्री शंकर वाणी	सर्वोत्तम शोधपत्र पुरस्कार, “एंजाइम बायोमास हाइड्रोलिसिस के दौरान चीनी उपज पर सबस्ट्रेट लदान और कण आकार के प्रभाव की भविष्यवाणी के लिए एक कृत्रिम तंत्रिका नेटवर्क मॉडल”, जैव प्रौद्योगिकी में उभरती प्रवृत्तियों पर अंतर्राष्ट्रीय सम्मेलन (आईसीईटीबी-2014), भारत की बायोटेक रिसर्च सोसायटी का 11वीं सम्मेलन, औद्योगिक फार्मास्युटिकल जैव प्रौद्योगिकी पर भारत-इतालवी कार्यशाला, जवाहर लाल नेहरू विश्वविद्यालय, नई दिल्ली 6-9, नवंबर 2014
सुश्री सबीला बीवी	सर्वोत्तम शोधपत्र पुरस्कार, “इवैल्यूएशन ऑफ़ फ्रेश वाटर माइक्रो-ऐलगल ऐसोलेट्स फॉर ग्रोथ एंड लिपिड प्रोडक्शन इन सी वाटर मीडियम”, जैव प्रौद्योगिकी में उभरती प्रवृत्तियों पर अंतर्राष्ट्रीय सम्मेलन (आईसीईटीबी-2014), भारत की बायोटेक रिसर्च सोसायटी का 11वीं सम्मेलन, औद्योगिक फार्मास्युटिकल जैव प्रौद्योगिकी पर भारत-इतालवी कार्यशाला, जवाहर लाल नेहरू विश्वविद्यालय, नई दिल्ली 6-9, नवंबर 2014



सुश्री जे बी दिव्या	सर्वोत्तम शोधपत्र पुरस्कार, “फोलेट फोर्टीफिकेशन बाय प्रोबायोटिक लैक्टोकॉक्स लैटिस”, भारतीय प्रोबायोटिक एसोसिएशन (पीएआई) की द्वितीय वार्षिक सम्मेलन और “प्रोबायोटिक्स और माइक्रोबयोम: पेट और परे” अंतर्राष्ट्रीय संगोष्ठी -नवंबर 3-4, 2014
सुश्री आर के अन्नू राजू	सर्वोत्तम शोधपत्र पुरस्कार, “इफेक्टिव एनहांसमेंट ऑफ़ एंटी करोसिव प्रॉपर्टीज ऑफ़ पॉलीस्टीरीन ओन एलुमिनियम अलॉयज बाय पॉलीस्टीरीन -क्ले नैनोकम्पोजिट कोटिंग्स”, करेशन नियंत्रण पर 17वाँ राष्ट्रीय कांग्रेस, सीईसीआरआई, कारैकुडी 21-23 अगस्त, 2014
डॉ एम रवि	सर्वोत्तम शोधपत्र पुरस्कार, “Al-Si पिस्टन मिश्र धातु के यांत्रिक गुणों पर मिश्रण घटक और कार्स्टिंग प्रक्रिया का प्रभाव”, सामग्रियों और बायोप्रोसेस इंजीनियरिंग में उन्नति, राष्ट्रीय संगोष्ठी, मोहनदास कॉलेज ऑफ़ इंजीनियरिंग, तिरुवनंतपुरम, 10-12 दिसम्बर, 2014
श्री के वी महेश	सर्वोत्तम मौखिक प्रस्तुति पुरस्कार, “अल्ट्रा थिन मक्सेन नैनोस्ट्रक्चर्स फॉर मल्टीफंक्शनल अप्लिकेशन्स” “सामग्री रसायन विज्ञान के क्षेत्र में उन्नतियाँ एएमएसी-1, रसायन विज्ञान विभाग, क्रिस्टियन कॉलेज, चेंगन्नूर में यूजीसी द्वारा प्रायोजित राष्ट्रीय संगोष्ठी 15-17, अक्टूबर 2014
सुश्री एस समीरा	सर्वोत्तम पोस्टर पुरस्कार, “(BiV)x(CaMo)1-xO4 में शांत छत अनुप्रयोगों के लिए पारिस्थितिक आईआर परिलक्षित पिगमेंट ” सामग्री प्रसंस्करण और निदान, (आईएसएस-2014) के लिए उन्नत प्रौद्योगिकियों पर आयोजित राष्ट्रीय सम्मेलन
सुश्री पी सुयना	सर्वोत्तम पोस्टर पुरस्कार, “एनहांस्ड फोटो कैटेलिटिक हाइड्रोजन ईवोल्यूशन इन ZnO-C3N4 सेमीकंडक्टर हेटेरो स्ट्रक्चर्स”, अंतर्राष्ट्रीय सम्मेलन-सीएसआईआर-सीजीसीआरआई, कोलकाता, मार्च 11- 13, 2015
श्री एस शंकर	सर्वोत्तम पोस्टर पुरस्कार, “LaPO4- ZrO2 नैनो कंपोजिट - संभव उच्च तापमान अनुप्रयोगों के साथ सिरेमिक्स का एक नया वर्ग” अंतर्राष्ट्रीय सम्मेलन-सीएसआईआर सीजीसीआरआई, कोलकाता मार्च 11- 13, 2015
सुश्री लिनशा वषयिल	सर्वोत्तम पोस्टर पुरस्कार, “सुप्रामोलेक्युलर एसोसिएशन ऑफ़ 2डी अलुमिनो -सिलोक्सेन नैनोटेपेस टु ट्राइ डायमेशनल हाइड्रोजेल फॉर इंजेक्टेबल एंड टोपिकल डिलीवरी ऑफ़ फ्लूकोनाज़ोल एंटीफंगल ड्रग” भारत-2015, शास्त्र विश्वविद्यालय, तमिलनाडु, भारत 29-30 जनवरी, 2015
श्री बी नागेंद्र और डॉ ई भोजे गौड	सर्वोत्तम पोस्टर पुरस्कार, “ अत्यधिक छित्री स्तरित डबल हाइड्रॉक्साइड / बहुलक नैनो कम्पोजिट” रसायन विज्ञान विभाग, केरल विश्वविद्यालय, तिरुवनंतपुरम, भारत में पॉलिमर और उन्नत सामग्री (एफपीएएम-2014) की सीमाओं पर आयोजित राष्ट्रीय संगोष्ठी 05-07 नवम्बर, 2014
सुश्री कविता शशिधरन	सर्वोत्तम पोस्टर प्रस्तुति के लिए नरंजन एस ढल्ला अवार्ड, “दिल की विफलता: प्रगति एवं संभावनाएं” इंडो कैनेडियन संगोष्ठी आरजीसीबी, तिरुवनंतपुरम 12-14 मार्च, 2015
सुश्री रेश्मा पी एल	पोस्टर प्रस्तुति के लिए प्रथम पुरस्कार, इंटरनेशनल अकादमी ऑफ़ कार्डियोवैस्कुलर साइंसेज (आईएसीएस) द्वारा मार्च 10-11, 2015 के दौरान एमिटी विश्वविद्यालय, नोएडा में हृदय विज्ञान में हाल के अग्रिमों पर आयोजित 7वाँ अंतर्राष्ट्रीय सम्मेलन



## पीएच डी सम्मानित

क्रम सं	नाम	पीएचडी थीसिस का शीर्षक	गाइड	
1	कृष्णन कर्ता के	एक्सप्लोरिंग ओलिगो (पी - फेन्येनविनयलेन) जलेटर्स आस सेंसर्स एंड स्टिमुली रेस्पॉसिव मैटेरियल्स	डॉ ए अजयघोष	कुसट
2	मनू के एम	इन्वेस्टीगेशन ओन लो लोस्स सिलिकेट बेस्ड सिरैमिक्स एंड देयर कंपोजिट्स फॉर इलेक्ट्रॉनिक अप्लिकेशन्स	डॉ एस अनंतकुमार/	केरल
3	चामेश्वरी जे	ब्यूटाइल रबर -सिरैमिक कंपोजिट्स फॉर फ्लेक्सिबल इलेक्ट्रॉनिक अप्लिकेशन्स	डॉ एस अनंतकुमार/ डॉ एम टी सेबास्टियन	कुसट
4	उषश्री एम वी	डेवलपमेंट ऑफ़ माइक्रोबियल फाइटेस विथ इम्प्रोव्ड कैरक्टेरिस्टिक्स फॉर इंडस्ट्रियल अप्लिकेशन यूसिंग साइट -डिरेक्टेड म्यूटाजेनेसिस	डॉ अशोक पाण्डेय	केरल
5	विद्या जे	रिकम्बीनैट एक्सप्रेसन ऑफ़ एल - एस्पेरजिनेस II फ्रम एशरिकिआ स्पीशीज एंड प्रॉपर्टी इम्प्रोवमेंट्स थ्रू एमिनो एसिड सब्स्ट्रूशन्स	डॉ अशोक पाण्डेय	केरल
6	जिशा बाबू	गोल्ड नैनोपार्टिकल -क्विनालिडिन हाइब्रिड सिस्टम्स: सिंथेसिस, प्रॉपर्टीज एंड अप्लिकेशन टुवर्ड्स सेंसिंग ऑफ़ मेटल कैटयन्स	डॉ आर लक्ष्मी वर्मा	केरल
7	आर्यानंदन	प्रोलीन स्पेसिफिक एमिनोपेप्टिडेस फ्रम स्ट्रेप्टोमाइसीज लावेंडुले	डॉ के माधवन नंबूतिरि	केरल
8	प्रिया रानी एम	इन्वेस्टीगेशन ओन फाइटोकेमिकल कॉस्टीटूवेन्ट्स एंड बायोलॉजिकल पोटेण्शियल ऑफ़ सम ट्रेडिशनल मेडिसिनल प्लांट्स	डॉ के पी पद्मकुमारी/ डॉ के जी रघु	कुसट
9	अजित कुमार के के	प्रोसेसिंग प्रॉपर्टीज एंड मॉडिफिकेशन ऑफ़ मैग्नीशियम-सिलिकॉन अलॉय	डॉ यूटीएस पिल्लै	आईआईटी भुवनेश्वर



10	धन्या एस	ऑप्टिकल एंड इलेक्ट्रोकेमिकल सेंसर्स फॉर डिटेक्शन एंड क्वांटिफिकेशन ऑफ़ सिलेक्टेड इनऑर्गेनिक ऑनयन्स इन एक्वस मीडिया	डॉ टी प्रसादा राव	केरल
11	सिंधु आर नंब्यार	हाइब्रिड गोल्ड एटॉमिक क्लस्टर नैनोकंपोजिट्स फॉर इलेक्ट्रोकेमिकल सेंसिंग एंड फेज फार्मेशन स्टडीज	डॉ टी प्रसादा राव	केरल
12	प्रवीण प्रकाश	ट्रांजीशन मेटल मीडिएटेड कंस्ट्रक्शन ऑफ़ कार्बो- साइकल्स एंड हेटेरोसाइकल्स वया ए स्ट्रेन रिलीज़ ऑफ़ डायज़ानोरबोर्नेन्स	डॉ के वी राधाकृष्णन	केरल
13	जीजी ई	कार्बन -कार्बन एंड कार्बन -हेटेरोएटम बांड फार्मेशन वाया ट्रांजीशन मेटल कैटलाइज़ेड डिसिमेट्रिजाइसेशन ऑफ़ स्ट्रैनेड डायज़ानोरबोर्नेन्स	डॉ के वी राधाकृष्णन	केरल
14	अजीश के आर	सिंथेटिक ट्रांस फोर्मेशन्स ऑफ़ फाइटोकेमिकल्स फ्रम जिंजिबर जेरुम्बत्त (एल) रिमथ एंड सिंथेसिस ऑफ़ कार्बोहायड्रेट अप्पेंडेड अलिथिलडिन साइक्लोपेन्टेन्स आस बायोएक्टिव अनलोगस	डॉ के वी राधाकृष्णन	केरल
15	जिनेश एम कुत्तनामपल्लील	पैलेडियम एंड ओर्गानो कैटलाइज़ेड ट्रांसफोर्मेशन्स ऑफ़ इसतयलिडेन्स एंड 8, 8-डाइसयानोहेप्टाफुल्वेन	डॉ के वी राधाकृष्णन	केरल
16	नयना जोसफ	ट्रांजीशन मेटल कैटलाइज़ेड सिंथेटिक ट्रांसफोर्मेशन्स ऑफ़ अज़ाबाइसाइक्लिक ओलेफिंस: फाजिल सिंथेसिस ऑफ़ इंडानोनेस, एंडनोल्स एंड साइक्लोपेन्टेन्स	डॉ के वी राधाकृष्णन	केरल
17	शोल्ली क्लेयर जॉर्ज	पैलेडियम एंड ओर्गानोकैटलाइज़ेड ट्रांसफोर्मेशन्स ऑफ़ इसतयलिडेन्स एंड 8, 8-डाइसयानो हेप्टाफुल्वेन	डॉ के वी राधाकृष्णन	केरल
18	राजश्री के पी	$\beta$ -ग्लूकोसिडसेस फ्रॉम एस्पेर्जिलस उन्गुइस NII 08123: मॉलिक्यूलर कैरेक्टराइजेशन, प्रॉपर्टीज एंड अप्लिकेशन्स	डॉ राजीव के सुकुमारन	कुसट
19	अखिल के नायर	डिज़ाइन ऑफ़ मेटल आर्चिटेक्टर्स- सिंथेसिस एंड स्टडी ऑफ़ देयर फोटोफिसिकल एंड बायोमॉलिक्यूलर रिकग्निशन प्रॉपर्टीज	डॉ डी रामय्या	कुसट



20	बेट्सी एम	डिज़ाइन ऑफ़ फंक्शनलाइज़ेड पोरफ़ीरिस फॉर फोटोडायनामिक थैरेपी एंड स्टडी ऑफ़ देयरर फोटो फिजिकल, फोटोबायोलॉजिकल एंड सेल्फ-असेम्ब्ली आस्पेक्ट्स	डॉ डी रामय्या	केरल
21	रम्या ए आर	डिज़ाइन एंड डेवलपमेंट ऑफ़ एफिशिएंट फोटो सेंसिटिज़ेर्स फॉर Ln3+ऑयन्स बेस्ड ओन एरोमेटिक कार्बोक्सीलेट्स	डॉ एम एल पी रेड्डी	केरल
22	शारिका शिवकुमार	डिज़ाइन एंड डेवलपमेंट ऑफ़ एफिशिएंट लाइट कन्वर्शन मॉलिक्यूलर डिवाइसेस बेस्ड ओन लान्थनाइड कार्बोक्सीलेट्स	डॉ एम एल पी रेड्डी	केरल
23	शफीक के एम	सिंथेसिस ऑफ़ सम नोवेल स्कुरैन डाइज एंड एक्सप्लोरेशन ऑफ़ देयरर एप्लीकेशन अस सेंसर्स एंड सेंसिटिज़ेर्स	डॉ सुरेश दास	केरल
24	अब्दुल रहीम	डिज़ाइन, सिंथेसिस एंड स्टडी ऑफ़ सम नोवेल स्कुरैन डाइज फॉर अप्पलिकेशनस इन सोलर सेल्स	डॉ सुरेश दास	केरल
25	दीपक डी प्रभु	डिज़ाइन, सिंथेसिस एंड स्टडी ऑफ़ फोटोफिजिकल एंड सेल्फ असेम्बलिंग प्रॉपर्टीज ऑफ़ सम नावेल सी3-सिमेट्रिक डोनर - अक्सेप्टर मोलेक्युल्स	डॉ सुरेश दास	केरल
26	संध्या के एस	डिज़ाइन एंड स्टडी ऑफ़ होमोजेनस आरयु(II) पिन्सेर हाइब्रिड एंड ओक्टाहेड्रल मेटल हाइब्रिड कोम्प्लेक्सेस फॉर हाइड्रोजन प्रोडक्शन फ्रॉम वाटर एंड अल्कोहल	डॉ सी एच सुरेश	केरल
27	नीता मोहन	मॉलिक्यूलर इलेक्ट्रोस्टाटिक्स फॉर प्रोबिंग हाइड्रोजन बांड्स, हलोजन बांड्स एंड लोन पेअर पीआई - इंटरक्शनस एंड डिज़ाइन ऑफ़ रिसेप्टर्स फॉर लोन पेअर बेअरिंग मोलेक्युल्स	डॉ सी एच सुरेश	कुसट
28	जैमी के बी	नैनो क्रिस्टलाइन विज़िबल लाइट एक्टिव सोल जेल टाइटेनियम डाइऑक्साइड कैटलिट्स एंड कोटिंग्स फॉर फंक्शनल अप्पलिकेशनस	डॉ के जी के वार्यर/ डॉ एस के घोष	केरल
29	स्मिता वी एस	सोल जेल फोटोकैटलिटिक टाइटेनियम ऑक्साइड मल्टीफंक्शनल नैनो कंपोजिट्स एंड कोटिंग्स	डॉ के जी के वार्यर/ डॉ एस के घोष	कुसट



## अनुसंधान परिषद् के सदस्य

### अध्यक्ष

#### डॉ दिपंकर बनर्जी

पदार्थ इंजिनियरिंग प्रभाग  
भारतीय विज्ञान संस्थान  
बंगलुरु - 560 012

### सदस्य

#### प्रो जी डी यादव

कुलपति एवं आरटी मोदी  
प्रतिष्ठित प्रोफेसर  
रसायनिक प्रौद्योगिकी संस्थान,  
मातुंगा, मुंबई - 400 019

#### प्रो एम के मैथ्यू

झिल्ली जैव भौतिकी प्रयोगशाला  
राष्ट्रीय जीवविज्ञान केन्द्र  
टाटा मूलभूत अनुसंधान संस्थान  
जीकेवीके, बेल्लारी रोड, बंगलुरु - 560 065

#### प्रो विक्रम जयराम

सामग्री इंजीनियरिंग विभाग  
भारतीय विज्ञान संस्थान  
बंगलुरु - 560 012

#### प्रो गुणशेकरन

कुलपति  
तिरुवल्लुवर विश्वविद्यालय  
सेरक्काड, वेल्लोर - 632 115

#### डॉ पी जी राव

तकनीकी सलाहकार एवं पूर्व निदेशक  
सीएसआईआर- एनईआईएसटी  
जोरहाट - 785 006

#### श्री ए सी सरोफ़

अध्यक्ष तथा प्रबंध निदेशक  
एक्सेल इंडस्ट्रीज लिमिटेड  
184-87, एस वी रोड,  
जोगेश्वरी (वेस्ट), मुंबई - 400 102

#### डॉ के एस दासगुप्ता

निदेशक  
भारतीय अंतरिक्ष विज्ञान संस्थान  
वलियमला पी.ओ  
तिरुवनन्तपुरम - 695 547

#### एजेंसी प्रतिनिधि

डॉ आर बृकस्पति  
वैज्ञानिक जी  
विज्ञान तथा इंजीनियरिंग अनुसंधान बोर्ड  
5 एंड 5ए, लोवर ग्राउंड फ्लोर  
वसन्त स्वायर माल, सेक्टर - बी  
पॉकट-5, वसन्त कुंज, नई दिल्ली - 110 070

#### महानिदेशक की नामिति

डॉ विवेक वी रानडे  
प्रधान, कटैलिसीस, रिएक्टर तथा सेपरेटर यूनिट  
सीएसआईआर- राष्ट्रीय रासायनिक प्रयोगशाला  
पुणे - 411 008

#### सहोदर प्रयोगशाला

डॉ विजयमोहनन के पिल्लै  
निदेशक  
केन्द्रीय विद्युतरासायनिक अनुसंधान संस्थान  
कारैक्कुडी, तमिलनाडु - 630 006

#### क्लस्टर निदेशक

डॉ एम ओ गर्ग  
निदेशक  
भारतीय पेट्रोलियम संस्थान (आईआईपी)  
पी ओ आईआईपी, मोहकमपुर,  
देहरादून - 248 005

#### निदेशक

डॉ सुरेश दास  
निदेशक  
राष्ट्रीय अंतर्विषयी विज्ञान तथा प्रौद्योगिकी संस्थान  
तिरुवनन्तपुरम - 695 019

#### स्थायी आमंत्रित

प्रधान या उनके द्वारा नामांकित व्यक्ति  
योजना तथा निष्पादन प्रभाग (पीपीडी)  
वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद्  
अनुसंधान भवन, 2, रफी मार्ग  
नई दिल्ली - 110 001

#### सचिव

डॉ ए सुन्दरेशन  
मुख्य वैज्ञानिक  
राष्ट्रीय अंतर्विषयी विज्ञान तथा प्रौद्योगिकी संस्थान  
तिरुवनन्तपुरम - 695 019



## प्रबंधन परिषद् के सदस्य

### अध्यक्ष

निदेशक, एनआईआईएसटी

### सदस्य

डॉ विजयमोहनन के पिल्लै, निदेशक, सीईसीआरआई, कारैकुडी

डॉ ए अजयघोष, वैज्ञानिक, एनआईआईएसटी (विशेष आमंत्रित)

डॉ गंगन प्रताप, वैज्ञानिक, एनआईआईएसटी (विशेष आमंत्रित)

डॉ सी चन्द्रशेखर भट्ट, वैज्ञानिक, एनआईआईएसटी

डॉ एम वसुंधरा, वैज्ञानिक, एनआईआईएसटी

डॉ ई भोजे गाउड, वैज्ञानिक, एनआईआईएसटी

डॉ के माधवन नंपूतिरि, वैज्ञानिक, एनआईआईएसटी

श्री एम ब्रह्मकुमार, प्रिंसिपल तकनीकी अधिकारी, एनआईआईएसटी

श्री एम एम श्रीकुमार, प्रधान, आरपीबीडी, एनआईआईएसटी

श्री टी वी शंकरन, वित्त एवं लेखा नियंत्रक, एनआईआईएसटी

### सदस्य सचिव

प्रशासन अधिकारी, एनआईआईएसटी



## 31.03.2015 को कर्मचारियों की सूची

निदेशक का कार्यालय	
डॉ गंगन प्रताप	कार्यकारी निदेशक
डॉ सुरेश दास	निदेशक (28/2/2015 को सेवानिवृत्त)
श्री एस सुरेशकुमार	मुख्य वैज्ञानिक (31/5/2014 को सेवानिवृत्त)
श्री टी एस शशिकुमार	निजी सचिव (30/11/2014 को सेवानिवृत्त)
श्रीमती श्रीलता नायर	निजी सचिव
श्रीमती एलिजबेथ थोमस	वरिष्ठ आशुलिपिक( एमएसीपी)
श्री ए कृष्णनकुट्टी	प्रयोगशाला सहायक (30/11/2014 को सेवानिवृत्त)
श्री पी बी विजयकुमार	प्रयोगशाला सहायक
कृषि प्रसंस्करण तथा प्राकृतिक उत्पादन प्रभाग	
डॉ ए सुन्दरेशन	मुख्य वैज्ञानिक तथा प्रधान
श्री एम एम श्रीकुमार	मुख्य वैज्ञानिक तथा प्रधान, आरपीबीडी
डॉ बी एस दिलीपकुमार	प्रिंसिपल वैज्ञानिक
डॉ के जी रघु	प्रिंसिपल वैज्ञानिक
श्री वी वी वेणुगोपाल	वरिष्ठ वैज्ञानिक
श्रीमती एम वी रेश्मा	वरिष्ठ वैज्ञानिक
डॉ (श्रीमती) पी निशा	वैज्ञानिक
डॉ पी जयमूर्ती	वैज्ञानिक
डॉ(श्रीमती) प्रिया एस	वैज्ञानिक
डॉ (श्रीमती) बीना जोय	प्रिंसिपल तकनीकी अधिकारी
श्री डी आर शोभन कुमार	वरिष्ठ तकनीकी अधिकारी
जैवप्रौद्योगिकी प्रभाग	
डॉ अशोक पाण्डेय	मुख्य वैज्ञानिक तथा प्रधान
डॉ के माधवन नंपूतिरि	प्रिंसिपल वैज्ञानिक
डॉ राजीवकुमार सुकुमारन	वरिष्ठ वैज्ञानिक
डॉ पी बिनोद	वैज्ञानिक



डॉ एन रमेश कुमार	वैज्ञानिक
डॉ मुत्तु अरुमुगम	वैज्ञानिक
श्री एम किरन कुमार	वैज्ञानिक
श्री के एम प्रकाश	वरिष्ठ तकनीशिन 2
<b>रसायन विज्ञान तथा प्रौद्योगिकी प्रभाग</b>	
डॉ ए अजयघोष	उत्कृष्ट वैज्ञानिक
डॉ के आर गोपिदास	मुख्य वैज्ञानिक तथा प्रधान
डॉ टी प्रसादा राव	मुख्य वैज्ञानिक
डॉ (श्रीमती) मंगलम एस नायर	मुख्य वैज्ञानिक
डॉ (श्रीमती) ए जयलक्ष्मी	मुख्य वैज्ञानिक (31/5/2014 को सेवानिवृत्त)
डॉ (श्रीमती) आर लक्ष्मी वर्मा	वरिष्ठ प्रिंसिपल वैज्ञानिक
डॉ के वी राधाकृष्णन	प्रिंसिपल वैज्ञानिक
डॉ सी एच सुरेश	प्रिंसिपल वैज्ञानिक
डॉ के एन नारायणन उण्णी	प्रिंसिपल वैज्ञानिक
डॉ कौस्ताभ कुमार मैती	वरिष्ठ वैज्ञानिक
डॉ बिश्वप्रिया देब	वरिष्ठ वैज्ञानिक
डॉ करुणाकरन वेणुगोपाल	वरिष्ठ वैज्ञानिक
डॉ यूसफ करुवात	वैज्ञानिक
डॉ एल रविशंकर	वैज्ञानिक
डॉ जोशी जोसफ	वैज्ञानिक
डॉ बी एस शशिधर	वैज्ञानिक
डॉ सी विजयकुमार	वैज्ञानिक
डॉ (श्रीमती) जे डी सुधा	प्रिंसिपल तकनीकी अधिकारी
श्रीमती एस विजी	तकनीकी अधिकारी
श्रीमती सौमिनी मैथ्यू	वरिष्ठ तकनीकी अधिकारी
श्री रोबर्ड फिलिप	वरिष्ठ तकनीकी अधिकारी
श्री किरन मोहन	तकनीकी अधिकारी
श्री जे एस किरन	तकनीकी सहायक

**पदार्थ विज्ञान तथा प्रौद्योगिकी प्रभाग**

डॉ एम लक्ष्मीपति रेड्डी	मुख्य वैज्ञानिक तथा प्रधान
डॉ यु श्यामाप्रसाद	मुख्य वैज्ञानिक (31/12/2014 को सेवानिवृत्त)
डॉ एम टी सेबास्टियन	मुख्य वैज्ञानिक (31/05/2014 को सेवानिवृत्त)
डॉ पी प्रभाकर राव	मुख्य वैज्ञानिक
डॉ जोस जेड्म्स	मुख्य वैज्ञानिक
श्री के हरिकृष्ण भट्ट	मुख्य वैज्ञानिक
श्री एम सी षाजी	वरिष्ठ प्रिंसिपल वैज्ञानिक
डॉ यु टी एस पिल्लै	वरिष्ठ प्रिंसिपल वैज्ञानिक
डॉ ए आर आर मेनोन	वरिष्ठ प्रिंसिपल वैज्ञानिक
डॉ मनोज रामावर्मा	वरिष्ठ प्रिंसिपल वैज्ञानिक
डॉ एम रवि	वरिष्ठ प्रिंसिपल वैज्ञानिक
डॉ एस अनन्तकुमार	प्रिंसिपल वैज्ञानिक
डॉ टी पी डी राजन	वरिष्ठ वैज्ञानिक
डॉ एस वी शुक्ला	वरिष्ठ वैज्ञानिक
डॉ यु एस हरीश	वरिष्ठ वैज्ञानिक
डॉ ई भोजे गौड	वरिष्ठ वैज्ञानिक
डॉ ए श्रीनिवासन	वैज्ञानिक
डॉ एम सुन्दराराजन	वैज्ञानिक
डॉ के पी सुरेन्द्रन	वैज्ञानिक
डॉ सजु पिल्लै	वैज्ञानिक
डॉ( सुश्री) एम वसुंधरा	वैज्ञानिक
डॉ के जी निशांत	वैज्ञानिक
श्री एस वेलुसामी	प्रिंसिपल तकनीकी अधिकारी
डॉ वी एस प्रसाद	प्रिंसिपल तकनीकी अधिकारी
श्री एम ब्रह्मकुमार	प्रिंसिपल तकनीकी अधिकारी
श्री के के रविकुमार	प्रिंसिपल तकनीकी अधिकारी(30/11/2014 को सेवानिवृत्त)
श्री पी पेरुमाल	प्रिंसिपल तकनीकी अधिकारी
श्रीमती लूसी पॉल	वरिष्ठ तकनीकी अधिकारी(31/5/2014 को सेवानिवृत्त)



श्री एम आर चन्द्रन	वरिष्ठ तकनीकी अधिकारी 2
श्री ए पीर मोहम्मद	वरिष्ठ तकनीकी अधिकारी
श्री एस शशिभूषणन	वरिष्ठ तकनीशन 2
श्री टी सोमन	वरिष्ठ तकनीशन 2
श्री वी आन्टणी	वरिष्ठ तकनीशन 2
श्री वी श्रीकण्डन	प्रयोगशाला सहायक (30/11/2014 को सेवानिवृत्त)
<b>प्रक्रिया इंजिनियरिंग तथा पर्यावरण प्रौद्योगिकी प्रभाग</b>	
डॉ अजित हरिदास	मुख्य वैज्ञानिक तथा प्रधान
डॉ (श्रीमती) एलिज़बत जेकब	वरिष्ठ प्रिंसिपल वैज्ञानिक
डॉ (श्रीमती) एस सावित्री	वरिष्ठ प्रिंसिपल वैज्ञानिक
डॉ वी बी मणिलाल	वरिष्ठ प्रिंसिपल वैज्ञानिक
श्री जे अंसारी	वरिष्ठ प्रिंसिपल वैज्ञानिक
डॉ (श्रीमती) रुग्मिणी सुकुमार	प्रिंसिपल वैज्ञानिक(31/12/2014 को सेवानिवृत्त)
डॉ एम अंबू	प्रिंसिपल वैज्ञानिक
डॉ बी कृष्णकुमार	वरिष्ठ वैज्ञानिक
श्री बी अब्दुल हलीम	वैज्ञानिक
श्री के रिशि अरविंद	वैज्ञानिक (10/6/2014 को इस्तीफा दे दिया)
डॉ के पी प्रतीश	वैज्ञानिक
श्रीमती विजयाप्रसाद	वरिष्ठ तकनीकी अधिकारी 3
श्री वी के षाजिकुमार	वरिष्ठ तकनीकी अधिकारी
डॉ एस रामस्वामी	वरिष्ठ तकनीकी अधिकारी
श्रीमती पी एम सहरूबा	तकनीकी अधिकारी
श्री टी पी पौलोस	वरिष्ठ तकनीशियन 3
<b>एस एंड टी सेवा प्रभाग</b>	
<b>इंजीनियरिंग एवं सेवा प्रभाग</b>	
श्री आर राजीव	अधीक्षण इंजिनियर
श्री जी चन्द्रबाबु	कार्यपालक इंजिनियर
श्री के प्रसाद	कार्यपालक इंजीनियर (इलेक्ट्रिकल) (30/11/2014 को



श्री बी कार्तिक	सहायक इंजिनियर(सिविल)
श्री पी अरुमुखम	सहायक इंजीनियर(सिविल)
श्री एन सुधिलाल	वरिष्ठ तकनीशियन 3
श्री पी वी तंपी	वरिष्ठ तकनीशियन 2 (31/1/2015 को सेवानिवृत्त)
श्री एम जयदीप	वरिष्ठ तकनीशियन 2
श्री के एस प्रमोद	तकनीशियन 2
श्री के सुरेश कण्णन	तकनीशियन 2
श्री यु धरणीपति	तकनीशियन 2
श्री आर सुकुमारन	प्रयोगशाला सहायक (30/11/2014 को सेवानिवृत्त)
श्री सी पी नारायणन	प्रयोगशाला सहायक
श्री पी सोमन	प्रयोगशाला सहायक
श्री टी वी सतीश	ग्रुप सी गैर तकनीकी( एमएसीपी)
<b>नॉलिज रिसोर्स सेंटर</b>	
श्रीमती पी निशी	वरिष्ठ प्रिंसिपल वैज्ञानिक तथा प्रधान
श्री वी मणी	वैज्ञानिक
श्री एस बी रिबिन जोन्स	वैज्ञानिक
डॉ (श्रीमती) एस मिनि	प्रिंसिपल तकनीकी अधिकारी
श्री एम रामसामि पिल्लै	प्रिंसिपल तकनीकी अधिकारी
श्री एस पुशिकन	तकनीकी अधिकारी
श्री पी एन शिवनकुट्टि नायर	वरिष्ठ तकनीशियन 2
श्री जी नागश्रीनिवासु	वरिष्ठ तकनीशियन 2
श्री पुष्पाकुमार के आर नायर	ग्रुप सी गैर तकनीकी (एमएसीपी)
<b>योजना तथा व्यवसाय विकास</b>	
डॉ वी जी मोहनन नायर	मुख्य वैज्ञानिक
डॉ सी चन्द्रशेखर भट्ट	वरिष्ठ प्रिंसिपल वैज्ञानिक
श्री डी भीमेश्वर	प्रिंसिपल वैज्ञानिक
श्री सी के चन्द्राकान्त	वरिष्ठ वैज्ञानिक
श्री आर एस प्रवीण राज	वरिष्ठ वैज्ञानिक



डॉ एम शंकरानारायणन	प्रिंसिपल तकनीकी अधिकारी
श्रीमती वी जे सरोजाकुमारी	वरिष्ठ आशुलिपिक (एसीपी) (30/9/2014 को सेवानिवृत्त)
श्री के सी चाक्को	गुड सी गैर तकनीकी (एमएसीपी)
<b>प्रशासन</b>	
श्री के मुरलीधरन	प्रशासन नियंत्रक
श्री एन एस राजु	प्रशासन अधिकारी (23/9/2014 को एनआईओ, गोवा में)
श्रीमती एस शोभना	प्रशासन अधिकारी
श्री के एफ जोसफ	अनुभाग अधिकारी(सा)
श्री एम के शिवदासन	अनुभाग अधिकारी(सा)
डॉ आर विजयनाथ	चिकित्सा अधिकारी
श्री टी जे बाबु	सुरक्षा अधिकारी
श्रीमती के एस लतीदेवी	हिन्दी अधिकारी
श्री के पी कृष्णन	सहायक(सा) ग्रेड I
श्री वी मोहनन नायर	सहायक(सा) ग्रेड I
श्रीमती पार्वती राजीवन	सहायक ग्रेड I
श्रीमती ज्योति आर तम्पी	सहायक(सा) ग्रेड I (28/2/2015 को सेवानिवृत्त)
श्रीमती मेर्सी जोसफ	सहायक(सा) ग्रेड II
श्री आर के रमेशकुमार	सहायक(सा) ग्रेड II
सुश्री टी एस लता	सहायक(सा) ग्रेड II (एमएसीपी)
श्रीमती पी एस पद्मिनी	वरिष्ठ आशुलिपिक (एमएसीपी)
श्री बशीर टी एच	वरिष्ठ तकनीशियन 2
श्री बी वेणुगोपाल	वरिष्ठ तकनीशियन 2
श्री एस हरिदासन पिल्लै	वरिष्ठ तकनीशियन 2
श्री प्रवीण कण्णाल	तकनीशियन 2
श्री बी राधाकृष्णन	तकनीशियन 1
श्रीमती शाना एस नायर	स्टाफ नर्स
श्री एम पी वर्की	प्रयोगशाला सहायक
श्रीमती एम गीता	प्रयोगशाला सहायक



श्री के उणिणकृष्णन	ग्रुप सी गैर तकनीकी(एमएसीपी)
श्री शशिधरन	बेयरर(एसीपी)
श्री के मधु	ड्राइवर
श्री ए श्रीकुमारन	वाशबॉय (एसीपी)
<b>वित्त एवं लेखा विभाग</b>	
श्री टी वी शंकरन	वित्त एवं लेखा नियंत्रक
श्रीमती पी वी विजि	अनुभाग अधिकारी(वित्त एवं लेखा)
श्री एम कृष्णकुमार	अनुभाग अधिकारी(वित्त एवं लेखा)
श्रीमती रमणी देवराज	अनुभाग अधिकारी(वित्त एवं लेखा)
श्री के जी पिल्लै	सहायक(वित्त एवं लेखा) ग्रेड I( एमएसीपी)
श्रीमती जी.गीता	सहायक(वित्त एवं लेखा) ग्रेड I
श्री संजीव सदानन्दन	सहायक (सा)ग्रेड I
श्रीमती कोमला सोमन	सहायक(वित्त एवं लेखा) ग्रेड II
श्री एस राजु	वरिष्ठ आशुलिपिक (एमएसीपी)
श्री पी परमेश्वरन पिल्लै	ग्रुप सी गैर तकनीकी (एमएसीपी) (12/8/2014 को निधन)
श्रीमती आर रमादेवी	रेकॉर्ड कीपर (30/11/2014 को सेवानिवृत्त)
<b>भण्डार एवं क्रय</b>	
श्री एम आर देवासीस	भण्डार एवं क्रय अधिकारी
श्री संजय सुमन	अनुभाग अधिकारी( 19/9/2014 को स्थानांतरित)
श्री सी एम कृष्णदास	सहायक(भण्डार एवं क्रय) ग्रेड I
श्री एम अनिलकुमार	सहायक(भण्डार एवं क्रय) ग्रेड I
श्रीमती एल लता	वरिष्ठ तकनीशियन 2
श्री बी अजयकुमार	वरिष्ठ तकनीशियन 2
श्री टी आर सुरेश कुमार	वरिष्ठ तकनीशियन 2
श्री टी के घोष	ग्रुप सी गैर तकनीकी
श्री टीके गोपि	ग्रुप सी गैर तकनीकी( 30/6/2014 को सेवानिवृत्त)
श्री जी भक्तवल्सलम	ग्रुप सी गैर तकनीकी
श्री बी सतीशकुमार	ग्रुप सी गैर तकनीकी



## समारोह

### राष्ट्रीय प्रौद्योगिकी दिवस समारोह

12 मई 2014 को एनआईआईएसटी में राष्ट्रीय प्रौद्योगिकी दिवस मनाया गया। श्री एस सोमनाथ, परियोजना निदेशक, जीएसएलवी एमकेIII, वीएसएससी, तिरुवनंतपुरम समारोह में मुख्य अतिथि थे और उन्होंने “क्रायाजेनिक प्रौद्योगिकी के विकास में आनेवाली चुनौतियों: जीएसएलवी और जीएसएलवी एमके III का अनुभव” पर अपना राष्ट्रीय प्रौद्योगिकी दिवस व्याख्यान दिया।

मुख्य अतिथि ने अपने भाषण में भारत में अंतरिक्ष अनुसंधान की करामाती दुनिया की ओर श्रोतागणों को ले लिया। संस्थान निदेशक ने अतिथि तथा सभा का स्वागत करते हुए राष्ट्रीय प्रौद्योगिकी दिवस के महत्व पर और हमारे देश द्वारा बनायी गयी छलांग पर प्रकाश डाला।



राष्ट्रीय प्रौद्योगिकी दिवस समारोह का उद्घाटन

### कार्बनिक रसायन विज्ञान (टीएफओसी-2014) में ऊभरती सीमायें

सीएसआईआर-एनआईआईएसटी, तिरुवनंतपुरम ने केरल राज्य विज्ञान, प्रौद्योगिकी एवं पर्यावरण परिषद् के साथ सहयोग में (केएससीएसटीई) तथा श्रीनिवास रामानुजन मूल विज्ञान संस्थान, कोट्टयम के सह-प्रायोजन के तहत 09-11, अक्टूबर 2014 के दौरान सीएसआईआर-एनआईआईएसटी, तिरुवनंतपुरम में “कार्बनिक रसायन विज्ञान (टीएफओसी -2014) में उभरती सीमाओं” पर तीन-दिवसीय राष्ट्रीय संगोष्ठी का आयोजन किया गया।

गणमान्य व्यक्तियों, डॉ तुषार कांति चक्रवर्ती (आईआईएससी बैंगलोर), डॉ सुरेश दास, निदेशक, सीएसआईआर - एनआईआईएसटी, प्रोफेसर वीएन राजशेखरन पिल्लई (कार्यकारी उपाध्यक्ष, केएससीएसटीई), डॉ केवी राधाकृष्णन (संयोजक) और डॉ आर लक्ष्मीवर्मा (सह-संयोजक) द्वारा दीप प्रज्वलन के साथ कार्यक्रम शुरू हुआ।

प्रो वीएन राजशेखरन पिल्लै द्वारा मुख्य भाषण दिया गया और बाद में स्मारिका का लोकार्पण हुआ। संगोष्ठी में कार्बनिक रसायन विज्ञान में शोधकर्ताओं से 30 आमंत्रित व्याख्यान, 10 मौखिक प्रस्तुतियाँ, 134 पोस्टर प्रस्तुतियाँ, एक शैक्षिक - औद्योगिक इंटरैक्टिव सत्र तथा एक संक्षिप्त

सांस्कृतिक कार्यक्रम शामिल थे। संगोष्ठी ने कार्बनिक रसायन विज्ञान में हाल के घटनाक्रम पर प्रकाश डाला और औद्योगिक भागीदारी को आकर्षित किया।



## उद्घाटन समारोह के विविध दृश्य



शैक्षिक- औद्योगिक इंटरैक्टिव सत्र (अंतर का ब्रिजिंग) शिक्षाविदों और उद्योग में वैज्ञानिकों के बीच पारस्परिक विचार-विमर्श को प्रतिबंध करनेवाली खामियों की पहचान से संबंधित विषयों पर चर्चा के लिए समर्पित था। इसने अनुसंधान और विकास प्रयासों के माध्यम से सामाजिक विकास में सुधार के लिए अकादमी और उद्योग के बीच के अंतर को पूरा करने या दिशा निर्देश तैयार करने में मदद की।

### “युवा शोधकर्ताओं के लिए पॉलिमरों पर सम्मेलन” (पीसीवाईआर-14)

एसपीएसआई के तिरुवनंतपुरम चैप्टर ने सीएसआईआर-एनआईआईएसटी में 18 अक्टूबर 2014 को, विशेष रूप से युवा शोधकर्ताओं के लिए “पॉलिमर विज्ञान और प्रौद्योगिकी” पर एक दिवसीय

सम्मेलन का आयोजन किया। सम्मेलन का प्रायोजन केरल राज्य विज्ञान, प्रौद्योगिकी तथा पर्यावरण परिषद् (केएससीएसटीई) द्वारा किया गया। सम्मेलन में भारत भर में विभिन्न बहुलक विज्ञान प्रयोगशालाओं में किये जा रहे अनुसंधान विषयों और प्रमुख अग्रिमों पर चर्चा हुई।



स्मारिका की रिलीज



डॉ सुरेश दास, निदेशक, सीएसआईआर-एनआईआईएसटी, तिरुवनंतपुरम द्वारा सेमिनार का उद्घाटन किया गया और डॉ ए अजयाघोष (सीएसआईआर- एनआईआईएसटी), डॉ सी.पी. रघुनंदन नायर (वीएसएससी, त्रिवेंद्रम), प्रो टीएस अनिरुद्धन (केरल विश्वविद्यालय) तथा डॉ. जे.डी सुधा (सीएसआईआर- एनआईआईएसटी) ने इसकी अध्यक्षता की। सम्मेलन, छात्र समुदाय के लिए चर्चा और अपने निष्कर्षों का आदान-प्रदान करने के लिए और उनके शोध के कार्यक्षेत्र का विस्तार करने के लिए एक उत्कृष्ट मंच था।

## 8 वीं एशियाई फोटो रसायनविज्ञान सम्मेलन, 10-13 नवम्बर, 2014



सीएसआईआर - एनआईआईएसटी और आईआईएसआईआर, तिरुवनंतपुरम द्वारा संयुक्त रूप से कोवलम में 10-13 नवम्बर, 2014 के दौरान 8 वीं एशियाई फोटो रसायनविज्ञान सम्मेलन आयोजित किया गया। सम्मेलन (एपीसी-2014) ने दुनिया भर में फोटो रसायनविज्ञान में हाल के घटनाक्रमों और संबंधित क्षेत्रों के विकास का प्रदर्शन किया। एपीसी-2014 के वैज्ञानिक सत्रों में फोटो रसायनविज्ञान से संबंधित अनुसंधान पर जोर दिया गया, जो भौतिक विज्ञान, पदार्थ विज्ञान, इंजीनियरिंग, प्रौद्योगिकी और दवा से जीव विज्ञान तक फैले थे। इस अंतरराष्ट्रीय सभा का प्रमुख उद्देश्य प्रतिभागियों के बीच वैज्ञानिक चर्चा के लिए सुविधा बनाना और अनुसंधान के इस क्षेत्र के वैश्विक मुद्दों के लिए उचित समाधान खोजना था। एपीसी-2014 ने फोटो रसायनविज्ञान में अग्रदूतों के साथ बातचीत करने के लिए युवा शोधकर्ताओं को एक मंच प्रदान किया।

## प्रोफेसर जी एन रामचंद्रन मेमोरियल लेक्चर

आधुनिक दुनिया में क्रिस्टलोग्राफी के महत्व के बारे में पूरी दुनिया में जागरूकता बढ़ाने के क्रम में अंतर्राष्ट्रीय क्रिस्टलोग्राफी संघ (IUCr) के साथ सहमति में संयुक्त राष्ट्र द्वारा वर्ष 2014 को क्रिस्टलोग्राफी (क्रिस्टलोग्राफी का अंतर्राष्ट्रीय वर्ष 2014) का अंतरराष्ट्रीय वर्ष घोषित किया गया। क्रिस्टलोग्राफी का अंतर्राष्ट्रीय वर्ष - 2014 समारोह के भाग के रूप में, प्रख्यात क्रिस्टलोग्राफर प्रोफेसर जी एन रामचंद्रन के सम्मानार्थ सीएसआईआर- एनआईआईएसटी, रसायन विज्ञान की रॉयल सोसायटी (आरएससी), केरल राज्य विज्ञान, प्रौद्योगिकी और पर्यावरण परिषद् (केएससीएसटीई) के संयुक्त तत्वावधान में 29 सितंबर 2014 को प्रो रामचंद्रन स्मारक व्याख्यान आयोजित किया। प्रोफेसर जी एन रामचंद्रन प्रशिक्षण से एक भौतिक विज्ञानी हैं और उन्होंने पेप्टाइड संरचना को समझने के लिए रामचंद्रन प्लोट विकसित किया और पहली बार एक्स-रे विवर्तन का उपयोग कर कोलेजन की संरचना के लिए एक ट्रिपल हेलिकल मॉडल प्रस्ताव किया।

प्रख्यात स्ट्रक्चरल रसायनज्ञ और अंतर्राष्ट्रीय क्रिस्टलोग्राफी संघ के तत्काल विगत उपाध्यक्ष प्रोफेसर गौतम आर देशिराजु, भारतीय विज्ञान संस्थान, (आईआईएससी) बंगलुरु ने “विज्ञान के उस पार क्रिस्टलोग्राफी” पर स्मारक व्याख्यान दिया। मेजबान संस्थान तथा आसपास के विभिन्न शैक्षणिक और अनुसंधान संस्थानों से छात्रों और संकायों ने व्याख्यान में भाग लिया।



प्रोफेसर गौतम आर देशिराजु, भारतीय विज्ञान संस्थान, (आईआईएससी) बंगलुरु व्याख्यान देते हुये



## संस्थान में सतर्कता जागरूकता सप्ताह मनाया गया

संस्थान में तारीख 27 अक्टूबर से 1 नवंबर 2014 तक सतर्कता जागरूकता सप्ताह आयोजित किया गया। 28 सितंबर से 1 नवंबर तक स्टाफ सदस्यों एवं अनुसंधान छात्रों के लिए निबंध लेखन, कार्टून चित्रण, वाद-विवाद, वक्तृता जैसी प्रतियोगितायें चलाई गयीं। श्री रिशि राज सिंह, आईपीएस, मुख्य सतर्कता अधिकारी, केएसईबी ने सतर्कता दिवस व्याख्यान दिया।

1 नवंबर 2014 को समापन समारोह तथा पुरस्कार वितरण संपन्न हुआ। डॉ. ए.अजयघोष, निदेशक - प्रभारी ने समारोह की अध्यक्षता की और उन्होंने विभिन्न प्रतियोगिताओं के विजेताओं को पुरस्कार वितरित किया।



सतर्कता दिवस व्याख्यान देते हुये श्री रिशि राज सिंह, आईपीएस, मुख्य सतर्कता अधिकारी, केएसईबी समापन समारोह/ पुरस्कार वितरण के विविध दृश्य



## सीएसआईआर स्थापना दिवस समारोह

सीएसआईआर-एनआईआईएसटी के ओडिटोरियम में 24 सितंबर 2014 को सीएसआईआर स्थापना दिवस समारोह मनाया गया। श्री के.एम. चन्द्रशेखर, उपाध्यक्ष, केरल राज्य योजना बोर्ड, तिरुवनंतपुरम समारोह में मुख्य अतिथि थे। प्रयोगशाला में आम दिवस मनाया गया। दिन का मुख्य आकर्षण प्रख्यात मुख्य अतिथि का सीएसआईआर स्थापना दिवस व्याख्यान था। मुख्य अतिथि ने स्मृति चिह्न, सेवानिवृत्त को सम्मान पत्र तथा उत्कृष्ट छात्रों को छात्रवृत्ति वितरित की।



डॉ. के.एम. चन्द्रशेखर, उपाध्यक्ष, केरल राज्य योजना बोर्ड, तिरुवनंतपुरम समारोह में व्याख्या देते हुये

## एनआईआईएसटी स्थापना दिवस समारोह

15 अक्टूबर 2014 को एनआईआईएसटी स्थापना दिवस समारोह मनाया गया। डॉ. अनिल भरद्वाज, निदेशक, अंतरिक्ष भौतिकी प्रयोगशाला, विक्रम साराभाई अंतरिक्ष केंद्र, आईएसआरओ, तिरुवनंतपुरम समारोह में मुख्य अतिथि थे। डॉ. सुरेश दास, निदेशक, सीएसआआर-एनआईआईएसटी ने मुख्य अतिथि का



स्वागत एवं परिचय कराया। प्रयोगशाला में आम दिवस मनाया गया। बड़ी संख्या में आए आगंतुकों को प्रयोगशाला की अनुसंधान एवं विकास उपलब्धियों और इंस्ट्रूमेंटेशन क्षमताओं का प्रदर्शन किया। दिन का मुख्य आकर्षण “पीएसएलवी और जीएसएलवी की सफलता की कहानी” पर मुख्य अतिथि द्वारा प्रस्तुत सीएसआईआर स्थापना दिवस व्याख्यान था।



डॉ अलि भारद्वाज, निदेशक, अंतरिक्ष भौतिकी प्रयोगशाला, वीएसएससी, तिरुवनंतपुरम स्थापना दिवस व्याख्यान देते हुये

## राष्ट्रीय विज्ञान दिवस

26 फरवरी 2015 को सीएसआईआर इनआईआईएसटी में राष्ट्रीय विज्ञान दिवस मनाया गया। संस्थान में समारोह के दिन को खुला दिन मनाया गया और देश भर से 400 से ज्यादा छात्रों ने अंतर्विषयी प्रकृति के एप्लाइड एवं बुनियादी अनुसंधान के जीवंत अनुभव महसूस करने के लिए संस्थान का दौरा किया। राष्ट्रीय विज्ञान दिवस समारोह के अवसर पर प्रो के एल सेबेस्टियन, एफएनए, आईआईएससी, बैंगलुरु ने नैनो उपकरणों पर राष्ट्रीय विज्ञान दिवस व्याख्यान दिया।



डॉ अलि भारद्वाज, निदेशक, अंतरिक्ष भौतिकी प्रयोगशाला, वीएसएससी, तिरुवनंतपुरम स्थापना दिवस व्याख्यान देते हुये

प्रो के एल सेबेस्टियन ने अपने व्याख्यान में डीएनए मैपिंग की आकर्षक दुनिया से जुड़े अपने काम की प्रारंभिक अवस्था के सुखद अहसास वाले अतीत की स्मृति की ओर दर्शकों को ले चला। प्रोफेसर सेबेस्टियन ने दर्शकों के बीच उपस्थित युवा उम्मीदवारों के लिए एक कैरियर के रूप में अनुसंधान के चयन करने के बारे में एक छोटी सरगर्मी बात दे दी।

## राजभाषा कार्यान्वयन से संबंधित गतिविधियाँ

### 3-डी फोटोग्राफी पर डेमोंस्ट्रेशन कार्यक्रम

विश्व फोटोग्राफी दिवस के अवसर पर यानी 19 अगस्त 2014 को संस्थान में 3 डी फोटोग्राफी पर हिंदी में एक डेमोंस्ट्रेशन कार्यक्रम आयोजित किया गया। डॉ वीजीएम नायर, मुख्य वैज्ञानिक, एनआईआईएसटी तथा अमेरिका की फोटोग्राफिक सोसायटी के सदस्य द्वारा कार्यक्रम का संचालन किया गया। उन्होंने अपने भाषण में सामान्य कैमरे का उपयोग करके पारंपरिक चित्र, 3 डी तस्वीरें लेने की विधि आदि का, सचित्र विवरण प्रस्तुत किया।

उन्होंने 3 डी फोटोग्राफी लेने के विभिन्न तरीके यानि “चा चा” विधि, स्लाइड बार आदि के बारे में विस्तार से बताया और प्रतिभागियों को मार्किट में उपलब्ध विभिन्न प्रकार के 3डी कैमरा जैसे टिवन्नड कैमरा, डिजिटल स्टीरियो कैमरा आदि के बारे में भी जानकारी दी गयी।





## संस्थान में हिंदी दिवस एवं हिंदी सप्ताह - 2014 मनाया गया

संस्थान में दिनांक 11 सितंबर 2014 को हिंदी दिवस के रूप में तथा बाद के एक सप्ताह को हिंदी सप्ताह के रूप में अत्यंत जोश एवं उत्साह के साथ मनाया गया। डॉ. सुरेश दास, निदेशक ने उद्घाटन सत्र की अध्यक्षता की। उन्होंने दीप प्रज्वलित करके समारोह के औपचारिक उद्घाटन की घोषणा की और बाद में अपना उद्घाटन भाषण दिया।



डॉ सुरेश दास, निदेशक द्वारा हिंदी दिवस का औपचारिक उद्घाटन

उद्घाटन के बाद हिंदी अधिकारी ने माननीय गृह मंत्री श्री राजनाथ सिंह का हिंदी दिवस संदेश प्रतिभागियों को पढ़कर सुनाया। श्री संजय सुमन, अनुभाग अधिकारी (भंडार व क्रय) तथा सदस्य, आयोजन समिति ने “सीएसआईआर की खरीद प्रक्रिया” पर एक अत्यंत जानकारीपूर्ण व्याख्यान हिंदी में दी।

पूरे सप्ताह के दौरान परियोजना स्टाफ, अनुसंधान छात्र आदि सहित संस्थान के संपूर्ण स्टाफ सदस्यों तथा उनके स्कूल छात्रों के लिए विभिन्न प्रतियोगिताएं आयोजित की गयीं।

समापन समारोह व पुरस्कार वितरण दिनांक 17.9.2014 शाम 4.30 बजे आयोजित किया गया। डॉ. (श्रीमती) तंकमणी अम्मा, कार्यकारी परिषद सदस्या, महात्मा गाँधी अंतर्राष्ट्रीय हिन्दी विश्वविद्यालय, वार्धा समारोह में मुख्य अतिथि थी। उन्होंने अपने भाषण में बताया कि हिंदी को राजभाषा एवं राष्ट्रभाषा बनाना न्यायोचित है।



डॉ (श्रीमती) तंकमणी अम्मा, कार्यकारी परिषद सदस्या, महात्मा गाँधी अंतर्राष्ट्रीय हिन्दी विश्वविद्यालय, वार्धा भाषण देती हुयी

## एसएसबीएम टूर्नामेंट

### 46वाँ शांति स्वरूप भटनागर मेमोरियल टूर्नामेंट (इंडोर जोनल)

सीएसआईआर-एनआईआईएसटी में 19-21 सितंबर 2014 के दौरान 46वाँ शांति स्वरूप भटनागर मेमोरियल टूर्नामेंट (इंडोर जोनल) आयोजित किया। 11 सीएसआईआर प्रयोगशालाओं/कार्यालयों ने इंडोर जोनल्स में भाग लिया। विभिन्न सीएसआईआर संस्थानों / प्रयोगशालाओं से लगभग 180 प्रतिभागियों ने ब्रिज, कैरम्स, शतरंज, टेबल टेनिस और बैडमिंटन जैसे खेलों में एक दूसरे के खिलाफ प्रतियोगिता की।

श्री जेकब पुन्नूस आईपीएस (सेवानिवृत्त पूर्व डीजीपी, केरल) ने 19 सितंबर 2014 को टूर्नामेंट का उद्घाटन किया गया। उद्घाटन के बाद, सीएसआईआर- एनआईआईएसटी में, ब्रिज, कैरम्स, शतरंज जैसे खेल आयोजित किए, जबकि बैडमिंटन और टेबल टेनिस जैसे खेल शंखमुखम इंडोर स्टेडियम में आयोजित किए गए। सभी खेल सीएसआईआर-खेल संवर्धन बोर्ड के सदस्य श्री रणजीत सिंह सोलंकी और श्री बी एन सिंह की देखरेख में आयोजित किये गये। 26-28 फ़रवरी 2015 के दौरान सीएसआईआर-एनसीएल, पुणे में आयोजित किए जाने वाले टूर्नामेंट के लिए प्रत्येक खेल से, दो फाइनलिस्ट्स (व्यक्ति / टीम) को फाइनल्स के लिए चुना गया।



समारोह के मुख्य अतिथि डॉ जेकब पुन्नूस, आईपीएस तथा निदेशक, एनआईआईएसटी गार्ड ऑफ ऑनर स्वीकार करते हुए

### स्वच्छ भारत मिशन की गतिविधियाँ

प्रधान मंत्री के स्वच्छ भारत पहल के तहत 2 अक्टूबर 2014 को संस्थान में गहन स्वच्छता अभियान का आयोजन किया गया। स्टाफ सदस्यों ने प्रयोगशाला के अंदर और संस्थान के परिसर में सफाई की गतिविधियों का संचालन किया। संस्थान में शपथ ग्रहण समारोह और सफाई अभियान आयोजित किए गए।



### ओणम समारोह

सितम्बर 03, 2014 को संस्थान के स्टाफ मनोरंजन क्लब के तत्वावधान में विभिन्न मनोरंजन कार्यक्रमों जैसे अत्तपूक्कलम प्रतियोगिता, ओणपाट्टु प्रतियोगिता, तिरुवातिरा नृत्य, स्टाफ सदस्यों और उनके बच्चों द्वारा गीत गायन, स्किट, सुन्दरिक्कु पोट्टुकुत्तल, कलमुडक्कल जैसे कार्यक्रमों के साथ ओणम त्योहार धूमधाम से मनाया गया। सुश्री नन्दिनी, पार्श्व वगायिका, इस अवसर पर मुख्य अतिथि थी। एक बहुत ही स्वादिष्ट दावत दिन का एक अन्य आकर्षण था। सभी घटनाएं बहुत ही सुखद रहीं और यह एनआईआईएसटी परिवार की एकता का द्योतक था।



समारोह के मुख्य आकर्षण में से कुछ