CSIR-NIIST

वार्षिक प्रतिवेदन
ANNUAL REPORT
2019 - 2020

National Institute for Interdisciplinary Science & Technology
(Council of Scientific & Industrial Research)
Thiruvananthapuram

राष्ट्रीय अंतर्विषयी विज्ञान तथा प्रौद्योगिकी संस्थान
(वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद्)
तिरुवनंतपुरम

CSIR-NIIST

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सी एस आई आर - राष्ट्रीय अंतर्विषयी विज्ञान तथा प्रौद्योगिकी संस्थान

CSIR-National Institute for Interdisciplinary Science & Technology (NIIST)

(वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद्)

(Council of Scientific & Industrial Research)

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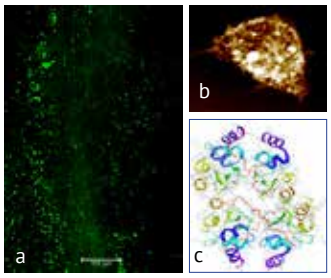

a. Confocal image showing the green fluorescent protein (GFP gene)-tagged *Pokkaliibacter plantistimulans* strain L1E11T colonizing the root of a 7 days old Pokkali rice seedlings in presence of the natural seawater.

b. AFM image of A549 cell treated with HY-ISO-VIII

c. Crystal structure of protein 1OXN

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डॉ ए अजयघोष
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प्रस्तावना

2019-20 अवधि के लिए सीएसआईआर-एनआईआईएसटी की वार्षिक रिपोर्ट प्रस्तुत करना मेरे लिए खुशी और सौभाग्य की बात है। इस रिपोर्ट में सीएसआईआर-एनआईआईएसटी द्वारा अंत:विषय आरएंडडी पर किए गए महत्वपूर्ण योगदानों का विवरण, सीएसआईआर और केंद्र और राज्य सरकारों, सार्वजनिक और निजी क्षेत्र, उद्योगों और शिक्षाविदों से प्राप्त अन्य हितधारकों का निरंतर समर्थन, प्राप्त उपलब्धियों और प्रशंसा, उच्च प्रभाव प्रकाशनों और आईपी पीढ़ी, मानव संसाधनों का विकास, प्रमुख गतिविधियों और रिपोर्टिंग अवधि के दौरान आयोजित कार्यक्रम शामिल है। सीएसआईआर के मिशन और विजन को पूरा करने वाले विभिन्न विषयों के तहत कार्यक्रम संस्थान द्वारा किए जा रहे हैं, जो ज्ञान सृजन और अनुवाद संबंधी अनुसंधान के बीच एक समान संतुलन बनाए रखते हैं।

रिपोर्टिंग वर्ष सीएसआईआर के वित्त पोषण से किया हुआ परियोजनाओं यानी एनसीपी (निचे क्रिएटिंग प्रोजेक्ट्स), एफबीआर (फोकस्ड बेसिक रिसर्च), एफटीटी (फास्ट ट्रैक ट्रांसलेशनल), एफटीसी (फास्ट ट्रैक व्यावसायीकरण) और मिशन मोड योजनाएँ निम्न विषयों के तहत: 1 खनन, खनिज, धातु और सामग्री 2. रसायन (चमड़ा और पेट्रोकेमिकल्स सहित) 3. ऊर्जा (पारंपरिक और गैर-पारंपरिक) और ऊर्जा उपकरण 4. पारिस्थितिकी, पर्यावरण, पृथ्वी विज्ञान और जल 5. कृषि, पोषण और जैव प्रौद्योगिकी और 6. हेल्थकेयर के सफल समापन को चिह्नित किया गया।

संस्थान वर्ष की अपनी कुछ प्रमुख सफलताओं की रिपोर्टिंग करने में गर्व महसूस करता है: त्रिवेंद्रम में एयरपोर्ट अथॉरिटी ऑफ इंडिया के साथ 500 किलोग्राम / दिन कचरा प्रबंधन का सफल आयोजन। एक साल के ऑपरेशन के बाद, पूरी तरह से कार्यात्मक संयंत्र जनवरी 2020 में त्रिवेंद्रम हवाई अड्डे को सौंप दिया गया था। फिर भी एक और सफलता की कहानी पायलट-पैमाने पर प्रदर्शन और बायोडिग्रेडेबल कॉयर-आधारित शहतूत की चटाई का उत्पादन था, जो आर्थिक रूप से एनसीआरएमआई द्वारा समर्थित है। कई महत्वपूर्ण संस्थागत परामर्श परियोजनाओं को सफलतापूर्वक ग्राहकों की आवश्यकता को पूरा किया गया है जिसमें मेसर्स मार्गोसा बायोगो इंडिया प्राइवेट लिमिटेड के लिए गिबरेलिक एसिड के व्यावसायिक उत्पादन के लिए एक बायोप्रोसेस विकास शामिल है; मेसर्स त्वरित फ्रीज सुखाने कं लिमिटेड के लिए डेयरी उत्पादों के लिए स्टार्टर संस्कृतियों का विकास; मेसर्स एपिकॉर फार्मास्युटिकल प्राइवेट लिमिटेड और मेसर्स ओम जीन लाइफ सइंसेस प्राइवेट लिमिटेड के लिए दवा मध्यवर्ती लक्षण वर्णन और पुष्टीकरण; मैसर्स मोमेंटिव परफॉरमेंस मैटेरियल्स लिमिटेड के लिए सिलिकॉन और सिलिकॉन डेरिवेटिव का लक्षण वर्णन; मैसर्स कालीसवारी मेटल पाउडर प्राइवेट लिमिटेड के लिए गुरुत्वाकर्षण कास्टिंग और निचोड़ कास्टिंग द्वारा प्रकाश धातु मिश्र धातु प्रसंस्करण; और मैसर्स टेरुमो पेनपोल प्राइवेट लिमिटेड के लिए पीवीसी शीट का लक्षण वर्णन।

इस रिपोर्ट की अवधि के दौरान सीएसआईआर-एनआईआईएसटी ने विभिन्न अनुसंधान एजेंसियों और मंत्रालयों द्वारा समर्थित अनुदान-सहायता परियोजनाओं की महत्वपूर्ण संख्या के साथ बुनियादी अनुसंधान और प्रौद्योगिकी विकास के क्षेत्र में अपनी संतुलित प्रगति जारी रखी। संस्थान में कई प्रतिष्ठित द्विपक्षीय कार्यक्रमों के तहत महत्वपूर्ण परियोजनाएं भी हैं; इंडो-यूके ग्रांट चैलेंज, इंडो-ऑस्ट्रेलियन स्ट्रेटेजिक रिसर्च फंड प्रोजेक्ट, इंडो-फ्रेंच सेंटर फॉर द प्रमोशन ऑफ एडवांस रिसर्च (सी ई एफ आई पी आर ए) जो निष्पादन के विभिन्न चरणों में हैं। समीक्षाधीन अवधि के दौरान उद्योगों द्वारा प्रायोजित परियोजनाओं की संख्या में लगातार वृद्धि जारी रही। संस्थान ने गेल से 2 वर्षों की अवधि के लिए दूसरी बार 229 लाख रुपये में "टीईजी और टीईसी मोड में वर्धित प्रदर्शन के साथ थर्मोइलेक्ट्रिक मॉड्यूल के विकास" नामक एक परियोजना हासिल की। सीएसआईआर-एनआईआईएसटी ने अनुसंधान और विकास, प्रौद्योगिकी हस्तांतरण, पेटेंट लाइसेंसिंग और आईपी लाइसेंसिंग के लिए निजी उद्योगों की एक अच्छी संख्या के साथ सहयोग समझौतों में प्रवेश किया। सीएसआईआर-एनआईआईएसटी ने एसयूएसपीआई, स्विट्जरलैंड के साथ साझेदारी करके सौर वास्तुकला और बिल्डिंग इंटीग्रेटेड सोलर एनर्जी (बीआईईएस) सिस्टम पर ज्ञान साझा किया।

मुद्रा के लिए सुरक्षा सामग्री के विकास, निदान के लिए हाथ में रमन स्पेक्ट्रोफोटोमीटर और छानबीन और शोधन के लिए सिरेमिक झिल्ली और 2 जी जैव इथेनॉल उत्पादन जैसी महत्वपूर्ण गतिविधियां जारी हैं। पर्यावरण प्रभाव मूल्यांकन (ईआईए) और डाइऑक्सिन निगरानी पर्यावरण संरक्षण और संबंधित गतिविधियों में मदद कर रहे हैं।

इंडस्ट्री मीट, कौशल विकास कार्यक्रम, जिज्ञासा, विज्ञान दिवस, प्रौद्योगिकी दिवस, सीएसआईआर स्थापना दिवस, सीएसआईआर-एनआईआईएसटी स्थापना दिवस आदि इस अवधि के दौरान आयोजित कुछ महत्वपूर्ण कार्यक्रम थे। इन अवसरों पर सार्वजनिक और निजी क्षेत्र के उद्योगों, अकादमिया और आम जनता से भी भारी प्रतिक्रियाएँ मिलीं।

केरल राज्य का बड़ा हिस्सा बड़े पैमाने पर बाढ़ से तबाह हो गया, जिससे लगातार दूसरे साल भी जान-माल की व्यापक क्षति हुई। सीएसआईआर-एनआईआईएसटी के कर्मचारी और छात्र इस अवसर पर पहुंचे और प्रभावित क्षेत्रों में तत्काल जरूरतमंदों तक पहुंचने के लिए भोजन, पानी और चिकित्सा की कमी की समस्याओं से निपटने में महत्वपूर्ण योगदान दिया। मैं उन सभी को धन्यवाद देता हूं जिन्होंने मदद की है, विशेषकर सीएसआईआर-एनआईआईएसटी के छात्र समुदाय ।

सीएसआईआर-एनआईआईएसटी ने एक टीम के रूप में अच्छा प्रदर्शन किया है और मैं एक और सभी सीएसआईआर-एनआईआईएसटी को धन्यवाद देने का अवसर लेता हूं जिन्होंने अपने समर्पित समर्थन के माध्यम से संस्थान की प्रगति में योगदान दिया था। मैं भारत सरकार, राज्य सरकारों, कई ग्राहकों, सहयोगियों और शुभचिंतकों, मीडिया और अंत में सीएसआईआर का भी धन्यवाद करता हूं, जिन्होंने सीएसआईआर-एनआईआईएसटी को एक जीवंत संगठन में बदलने में योगदान दिया है और प्रत्येक गुजरते साल के साथ हमारे प्रदर्शन को बेहतर बनाने के लिए तत्पर हैं।

ए अजयघोष

CSIR-NIIST

FOREWORD

It is my pleasure and privilege to present the Annual Report of CSIR-NIIST for the period 2019-20. The report encompasses details of significant contributions made by CSIR-NIIST on interdisciplinary R&D, with the continued support from CSIR and other stake holders comprising of Central and State Governments, public and private sector, industries and academia, the achievements and accolades received, details of high impact publications and IP generation, development of human resources, major activities and programs organized during the reporting period. Programs under various themes, meeting the mission and vision of CSIR are being carried out by the Institute maintaining a uniform balance between knowledge generation and translational research.

The reporting year marked successful completion of projects from CSIR under NCP (Niche creating projects), FBR (Focused Basic Research), FTT (Fast Track Translational), FTC (Fast Track Commercialization) and mission mode schemes under the following themes: 1.Mining, Minerals, Metals and Materials (4M Theme) 2. Chemicals (including leather and Petrochemicals) (CLP Theme) 3. Energy (Conventional and non-conventional) and Energy devices (E2D Theme) 4. Ecology, Environment, Earth Sciences and Water (E3OW Theme) 5. Agri. Nutrition and Biotechnology (ANB Theme) and 6. Healthcare (HT). The Institute takes pride in reporting some of its major success stories of the year: The successful commissioning of the 500 Kg/day waste management with Airport Authority of India at Trivandrum. After one-year operation, the fully functional plant was handed over to Trivandrum Airport in January 2020. Yet another success story was the Pilot-scale demonstration & production of biodegradable coir-based mulching mats, financially supported by NCRMI. Several important institutional consultancy projects have been successfully completed meeting the requirement of the customers which includes a bioprocess development for the commercial production of Gibberellic acid for M/s. Margosa Biogrow India Pvt. Ltd.; development of starter cultures for dairy products for M/s. Accelerated Freeze Drying Co. Ltd.; drug intermediate characterization and confirmation for M/s. Apicore Pharmaceutical Pvt. Ltd. and for M/s. Omgene Life Sciences Pvt. Ltd.; characterization of silicone and silicone derivatives for M/s. Momentive Performance Materials limited; light metal alloy processing by gravity die casting and squeeze casting for M/s. Kaliswari Metal Powders Pvt. Ltd. and characterization of PVC sheets for M/s. Terumo Penpol Pvt. Ltd.

During the period of this report CSIR-NIIST continued its balanced progress in the area of basic research and technology development with significant number of grant –in-aid projects supported by various funding agencies and Ministries. The Institute is also having important projects under several prestigious bilateral programmes namely; Indo-UK Grant Challenge, Indo-Australian Strategic Research fund project, Indo-French Centre for the Promotion of Advances Research (CEFIPRA) which are under various stages of execution. The steady upsurge in the number of projects sponsored by Industries continued during the reporting period. The Institute bagged a project entitled "Development of thermoelectric modules with enhanced performance in TEG and TEC modes" from GAIL for the second time for 229 lakhs for a duration of 2 years. CSIR-NIIST entered into collaboration agreements with a good number of private industries for Research and Development, Technology transfer, Patent licensing and IP licensing. CSIR-NIIST entered into Partnership with SUPSI, Switzerland to share knowledge on solar architecture and Building Integrated Solar Energy (BISE) systems.

Important activities such as development of security materials for currency, handheld Raman Spectrophotometer for diagnostics and quality check, ceramic membranes for filtration and purification and 2G bio-ethanol production are in progress. Environmental Impact Assessment (EIA) and Dioxin monitoring are helping in the environment protection and related activities.

The Industry Meet, Skill Development Programs, Jigyasa, Science Day, Technology Day, CSIR Foundation Day, CSIR-NIIST Foundation Day etc were some of the important programs conducted during this period. There was overwhelming responses from public and private sector Industries, Academia and also from the common public on these occasion.

Major part of the State of Kerala was devastated by massive flood causing extensive damage to life and property for the second consecutive year. The staff and students of CSIR-NIIST rose to the occasion and contributed in a substantial way dealing with food, water and medical shortage problems reaching out to the needy immediately in the affected areas. I thank all those who have helped, particularly the student community of CSIR-NIIST.

CSIR-NIIST has performed well as a team and I take this opportunity to thank one and all of CSIR-NIIST who had contributed to the progress of the Institute through their dedicated support. I also thank the Government of India, State Governments, numerous clients, collaborators and well-wishers, media and finally CSIR, who have all contributed in transforming CSIR-NIIST into a vibrant organization and look forward to improving our performance with each passing year

A. Ajayaghosh

महत्वपूर्ण उपलब्धियां 2019 - 2020

2019-20 की अवधि के दौरान, सीएसआईआर-एनआईआईएसटी ने केंद्र, राज्य सरकार की संस्थानों, शैक्षिक संस्थानों, सार्वजनिक और निजी क्षेत्रों के हितधारकों से महत्वपूर्ण निवेश के साथ वैज्ञानिक, तकनीकी और जनशक्ति विकास पर निरंतर वृद्धि हासिल करना जारी रखा है। औद्योगिक, निजी और सार्वजनिक क्षेत्रों और प्रौद्योगिकी के हस्तांतरण में शामिल नए सहयोगों में बदलाव से बाहरी स्रोतों से राजस्व उत्पन्न करने में काफी वृद्धि हुई है। 2019-20 की अवधि के दौरान सीएसआईआर के वित्त पोषण का समर्थन के साथ-साथ बाहरी धन में लगातार बढ़ोतरी के कारण सीएसआईआर-एनआईआईएसटी ने अनुवादकीय अत्याधुनिक अनुसंधान और प्रौद्योगिकी विकास के साथ-साथ उच्च गुणवत्ता वाले प्रकाशन पर ध्यान केंद्रित किया है।

2019-20 की अवधि के दौरान विभिन्न वित्त पोषण एजेंसियों द्वारा वित्त पोषित 131 परियोजनाएं थीं। सीएसआईआर के वित्त पोषण से 21 परियोजनाओं, एनसीपी (आला बनाने प्रोजेक्ट्स), एफबीआर (फोकस्ड बेसिक रिसर्च), एफटीटी (फास्ट ट्रैक ट्रांसलेशनल), एफटीसी (फास्ट ट्रैक व्यावसायीकरण) और मिशन मोड योजनाएँ निम्न विषयों के तहत: 1 खनन, खनिज, धातु और सामग्री 2. रसायन (चमड़ा और पेट्रोकेमिकल्स सहित) 3. ऊर्जा (पारंपरिक और गैर-पारंपरिक) और ऊर्जा उपकरण 4. पारिस्थितिकी, पर्यावरण, पृथ्वी विज्ञान और जल 5. कृषि, पोषण और जैव प्रौद्योगिकी और 6. हेल्थकेयर के सफल समापन किया। छह प्रौद्योगिकी हस्तांतरण और अच्छी संख्या में निजी उद्योग के साथ सीएसआईआर - एनआईआईएसटी ने आर एंड डी सहयोग समझौतों में प्रवेश किया।

सीएसआईआर-एनआईआईएसटी एनएबीईटी श्रेणी ए परामर्शदाता संगठन है जो दो क्षेत्रों में पर्यावरण प्रभाव आकलन अध्ययन (ईआईए) करने के लिए मान्यता प्राप्त है, 1) खनन और 2) बंदरगाह और हार्बर। परियोजनाओं की वैधानिक मंजूरी के लिए सरकारी और निजी क्षेत्र द्वारा अनिवार्य ईआईए सेवाओं का उपयोग किया जाता है। सीएसआईआर-एनआईआईएसटी की टेस्टिंग एंड एनालिसिस लेबोरेटरी सुविधा एन ए बी एल द्वारा ISO / IEC 17025: 2005 के अनुसार जल, अपशिष्ट जल, डाइऑक्सिन, फुरान और पॉली क्लोरीनयुक्त बाइफिनाइल (पीसीबी) के विश्लेषण के लिए मान्यता प्राप्त है। इसके अलावा, पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय (मोईएफसीसी), भारत की सरकार द्वारा सीएसआईआर-एनआईआईएसटी को पर्यावरणीय मंजूरी के लिए डाइऑक्सिन विश्लेषण के लिए एक रेफरल प्रयोगशाला के रूप में सिफारिश की गई है।

मैटेरियल साइंस डिवीजन के बहुलक समूह ने बायोडिग्रेडेबल कॉयर-आधारित मल्चिंग मैट के निर्माण के लिए सफलतापूर्वक जैव-आधारित बांधने की मशीन का निर्माण किया। वर्तमान में, प्लास्टिक मल्चिंग मैट का उपयोग किया जाता है जो खरपतवारों के विकास को दबा सकता है, वाष्पीकरण के कारण अतिरिक्त पानी के नुकसान को रोकता है और इसलिए आर्द्रता और स्वस्थ पौधों को नियंत्रित करता है। परियोजना के भाग के रूप में, 55 x 55 मिमी 2 के कॉयर-आधारित शहतूत के पहले प्रोटोटाइप को रिकॉर्ड समय में विकसित किया गया है। कॉयर-आधारित मल्चिंग मैट आधिकारिक तौर पर केरल के माननीय वित्त मंत्री, डॉ। टी। एम। थॉमस इसाक तथा वी.एस. सुनील कुमार, माननीय कृषि मंत्री, द्वारा कृषि भवन, त्रिवेंद्रम में लॉन्च किया गया था।

सीएसआईआर-एनआईआईएसटी द्वारा विकसित कॉम्पैक्ट खाद्य अपशिष्ट बायोगैस संयंत्र को मौजूदा 50 किलोग्राम / दिन के स्तर से 500 किलोग्राम / दिन की क्षमता तक बढ़ाया गया था। एयरपोर्ट अथॉरिटी ऑफ इंडिया (एएआई) और एक निजी उद्योग के साथ एक संयुक्त परियोजना में, मेसर्स। स्वैच फ्यूचर एनर्जी सॉल्यूशन (एनआईआईएसटी प्रौद्योगिकी लाइसेंसधारी) त्रिवेंद्रम अंतर्राष्ट्रीय हवाई अड्डे पर 500 किलोग्राम खाद्य अपशिष्ट-बायोगैस-बिजली इकाई स्थापित की गई थी। इस परियोजना को पूरी तरह से एएआई द्वारा वित्त पोषित किया गया था, स्केल-अप डिजाइन एनआईआईएसटी द्वारा प्रदान किया गया था, जबकि निर्माण और स्थापना उद्योग द्वारा किया गया था। संयंत्र से हर दिन लगभग 90-100 क्यूबिक मीटर बायोगैस उत्पन्न होने की उम्मीद है, जिसे ~ 110-120 kWh बिजली में परिवर्तित किया जाएगा जो वर्तमान में तिरुवनंतपुरम अंतर्राष्ट्रीय हवाई अड्डे पर सफलतापूर्वक चल रहा है।

संस्थान के पास एक उन्नत उन्नत विश्लेषणात्मक सुविधा है जिसका उपयोग उच्च गुणवत्ता वाले बुनियादी और अनुवाद अनुसंधान के लिए पूर्ण क्षमता के लिए किया जा रहा है, इसके अलावा उद्योग और अकादमियों से नमूनों के परीक्षण से राजस्व उत्पन्न किया जा रहा है। सीसीआईआर-एनआईआईएसटी ने सीएसआईआर कौशल के माध्यम से विभिन्न खंडों के तहत लघु अवधि के पाठ्यक्रम पेश किए। पहल कार्यक्रम। संस्थान हर साल 30 से अधिक पीएचडी प्रदान करते हुए उच्च गुणवत्ता वाले मानव संसाधनों का पोषण करना जारी रखता है। एनआईआईएसटी उच्च प्रभाव कारक पत्रिकाओं में हर साल 200 से अधिक पत्र प्रकाशित करता है और एक मजबूत पेटेंट पोर्टफोलियो है।

समीक्षाधीन अवधि के दौरान, केरल राज्य लगातार दूसरे वर्ष बाढ़ की आपदा से बुरी तरह प्रभावित हुआ। सीएसआईआर-एनआईआईएसटी के कर्मचारी और छात्र इस अवसर पर पहुंचे और प्रभावित क्षेत्रों में जरूरतमंदों तक पहुंचने के लिए भोजन, पानी और चिकित्सा समस्याओं से निपटने में महत्वपूर्ण योगदान दिया।

इस पृष्ठभूमि के खिलाफ, 2019-2020 की अवधि के लिए वार्षिक रिपोर्ट सीएसआईआर-एनआईआईएसटी द्वारा किए गए नवाचार, उपलब्धियों, प्रगति और प्रभाव को सामने लाती है, जो कि फ्रंटलाइन रिसर्च के गतिशील और चुनौतीपूर्ण अंतःविषय वातावरण में अपनी योजनाओं के साथ संरेखित करती है।

यह सब और अधिक रोमांचक कहानियां वार्षिक रिपोर्ट 2019-20 में सामने आई हैं।

Significant Achievements 2019-2020

During the period 2019-20, CSIR-NIIST continued to achieve sustained growth on Scientific, Technological and manpower development with significant investment from stake holders comprising of central, state government agencies, educational institutes, public and private sectors. The upsurge in new collaborations involving industrial, private and public sectors and technology transfers translated to a substantial increase in generating revenue from external sources. The funding support from CSIR during the reporting period along with a steady rise in external funding, have helped CSIR-NIIST focus on translational cutting edge research and technology development along with high-quality publications.

There were 131 projects funded by various funding agencies during the period 2019-20. The year also marked the successful completion of 21 projects from CSIR under NCP (Niche creating projects), FBR (Focused Basic Research), FTT (Fast Track Translational), FTC (Fast Track Commercialization) and mission mode schemes under the following themes: 1. Mining, Minerals, Metals and Materials 2. Chemicals (including Leather and Petrochemicals) 3. Energy (Conventional and non-conventional) and Energy devices 4. Ecology, Environment, Earth Sciences and Water 5. Agri. Nutrition and Biotechnology and 6. Healthcare. There were six technology transfers and a good number of private industries with which CSIR-NIIST entered into R & D collaboration agreements.

CSIR-NIIST is a NABET accredited, Category A consultant organisation with accreditation in two areas Viz., 1) Mining and 2) Ports & Harbour for carrying out Environment Impact Assessment Studies (EIA). The mandatory EIA services are used by government and private sector for statutory clearance of projects. The Testing and Analysis Laboratory facility of CSIR-NIIST is accredited by NABL as per ISO/IEC 17025: 2005 for analysis of Water, Waste water, Dioxins, Furans and Poly Chlorinated Biphenyls (PCBs). In addition, CSIR-NIIST has been recommended by Ministry of Environment, Forest and Climate Change (MoEFCC), Govt. of India as a referral laboratory for Dioxin analysis for environmental clearances.

The polymer group from Material Science Division successfully developed a bio-based binder formulation for the fabrication of biodegradable coir-based mulching mats. Currently, plastic mulching mats are used which can suppress the growth of weeds, prevent excess water loss due to evaporation and hence control humidity and healthy plants. As part of the project, the first prototype of the coir-based mulching mats of 55 x 55 mm^2 is developed in a record time. The coir-based mulching mats was officially launched by the Honourable Finance Minister of Kerala, Dr. T. M.Thomas Isaac, along with Shri. V.S. Sunil Kumar, Honourable Minister for Agriculture, Govt of Kerala at Krishi Bhavan, Thiruvananthapuram.

The compact food waste biogas plant developed by CSIR-NIIST was scaled up to 500 kg/day capacity from the existing 50 kg/day level. In a joint project with Airport Authority of India (AAI) and a private industry, M/s. Swatch Future Energy Solution (the NIIST technology licensee) a 500 kg food waste-biogas-power unit was installed at Thiruvananthapuram International Airport. The project was fully funded by AAI, the scale-up design was provided by NIIST, while the fabrication and installation was done by the industry. The plant is expected to generate around 90-100 cubic meter biogas every day, which will be converted into ~110-120 kWh of electricity is currently running successfully at Thiruvananthapuram International Airport.

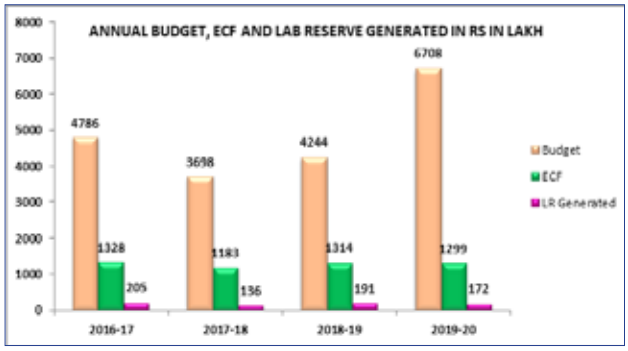
Institute has a full-fledged advanced analytical facility which is being utilized to the full capacity for high quality basic and translation research, besides generating revenue from testing of samples from industry and academia. CSIR-NIIST introduced short term courses under various segments through CSIR Skill Initiative programme. The Institute continues to nurture high quality human resources, awarding over 30 PhDs every year. NIIST publishes over 200 papers every year in high impact factor journals and has a robust patent portfolio.

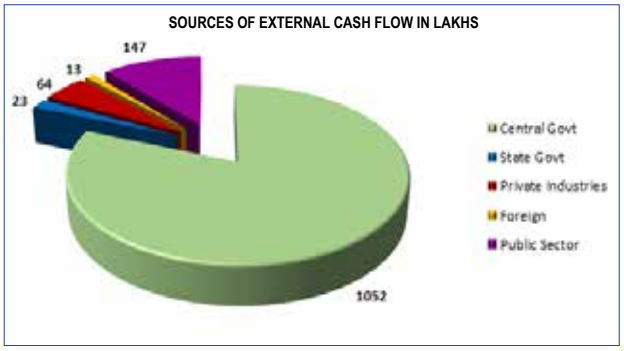
During the reporting period, the State of Kerala was severely affected by flood calamity for the second consecutive year. The staff and students of CSIR-NIIST rose to the occasion and contributed in a substantial way dealing with food, water and medical problems reaching out to the needy in the affected areas.

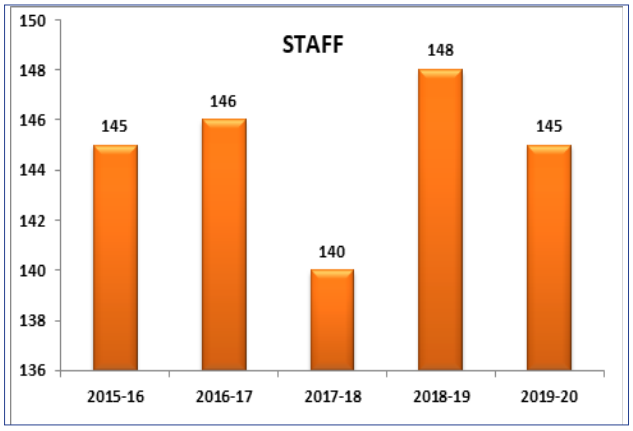
Against this backdrop, the Annual Report for the period 2019-2020 sets out the innovation, achievements, progress, and impact made by CSIR-NIIST aligning with its plans in a dynamically mutating and challenging interdisciplinary environment of frontier research.

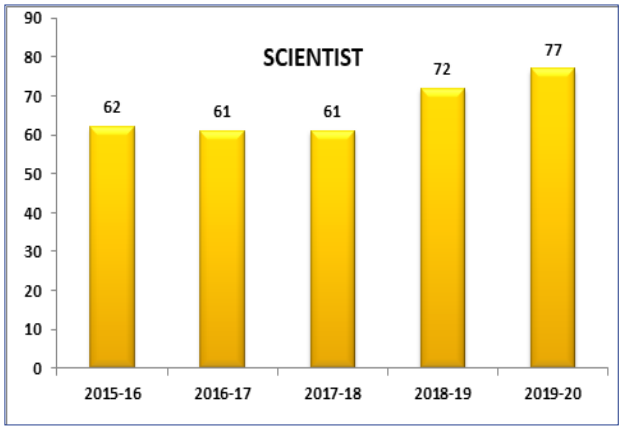
All this and more exciting stories unfold in the Annual Report 2019-20

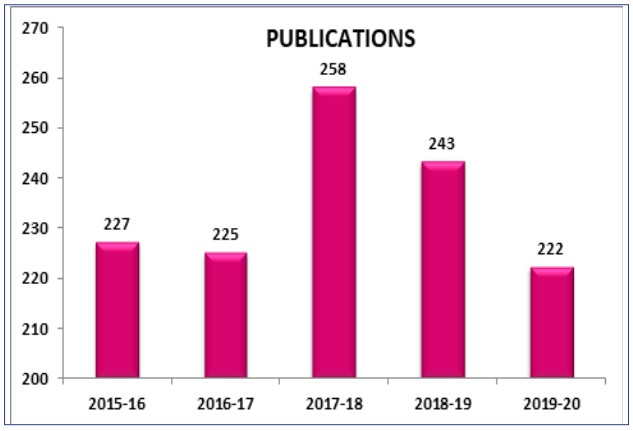
Resource Base Output Statistics 2019-20

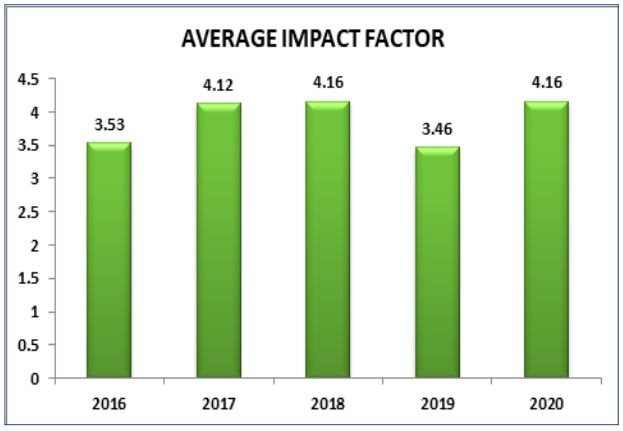








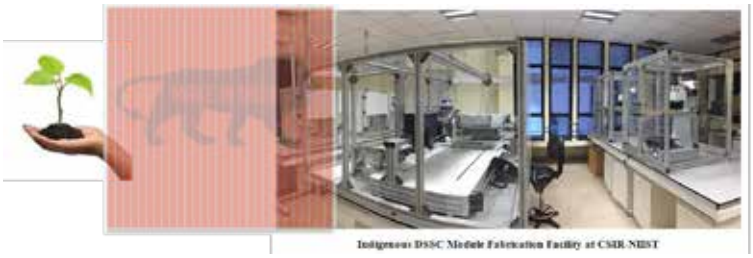




Technology Transfers 2019-20

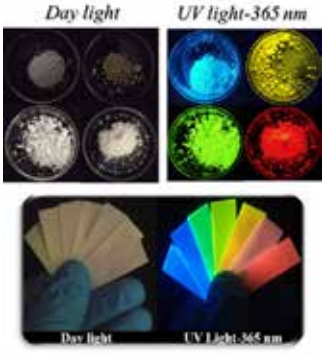
Indigenous large area dye-sensitized solar module fabrication equipment's for indoor photovoltaics

- Dye Sensitized Modules are currently imported and expensive
- Accomplished total 'Indigenization' by developing semi-automatic fabrication equipment
- The current set up can partly meet the requirements of the smart city programme of Govt of India through energy generating/saving smart constructions
- Capability development for harvesting indoor light for generating energy for IoT devices
- Achieved efficiencies >30% from indoor light (CFL/LED) using cost-effective homemade organic dyes
- Successfully licensed the knowhow to Elixir Technologies, Bangalore for commercialization on 31 October 2019



Know-how transfer of synthesis of nine fluorescent molecules and corresponding pigments

- CSIR-NIIST has developed materials with appropriate fluorescence characteristics for security printing as per industrial standards and requirements.
- The products consist of white/off-white powders under day light which glow with different colors (blue, green, yellow, red etc.) on exposure to ultraviolet (UV) light.
- When coated on various substrates, these materials remain invisible to naked eyes but emits brilliant colors under UV light.
- A license agreement was signed with HueBright Colors Private Ltd., Bengaluru on 28 November 2019 for transferring the know-how.



Top panel shows the photographs of the materials under day light (left) and UV light (right). Bottom panel shows the photographs of the materials coated on paper under day light (left) and UV light (right).

- This is the first indigenous know-how on fluorescent markers and their process chemistry for security printing.
- This know-how transfer will support the 'Import substitution' and Make-in-India' initiatives of the government.
- More importantly, it has high strategic and socio-economic relevance in terms of national requirements.

A device for the biological treatment of wastewater containing biodegradable solids

- The buoyant filter bioreactor - BFBR – (US Patent 6,592,751; Indian Patent No. 242196), is a unique system for the high rate anaerobic treatment of complex wastewaters.
- The reactor contents i.e., complex waste and microbial biomass are in well-mixed condition, using proven automated gas purging system.
- BFBR performance in dealing with industrial effluent:
- The BFBR achieves 95% COD removal (fat content 60% of COD) (dairy/ice-cream factory effluent)
- COD removed is completely converted to methane. Loading rate 7 kg COD/(m3d)
- BFBR installation was done in various sector, i.e., Rice mills, ice-cream factories, fish meal processing Units, Hospitals Sewage, Kottarakkara Temple etc.
- Patent licence transfer to M/s Victoria Innovative LLP, Ernakulam, for commercialization on 6th December 2019

Wheat barn based edible and biodegradable cutleries and plates

- Replacement of plastic with biodegradable products is the need of the hour globally
- Process suitable for development of biodegradable cutleries in the form of plates from various agro residues
- Utilization of various agro residues as alternative material to single use plastics- immense opportunities for MSME
- Developing biodegradable products like cutleries, like plates, cups, spoon, fork, take away units etc

AURA EXIM

Edible & biodegradable
Good strength & stiffness
Good water retention Heat resistant
Microwave friendly
Low cost single use
Shelf life of one year at room temperature

NIIST Onsite Wastewater Treatment System (NOWA)

- The NOWA is a modular type, onsite treatment system for recovering reuse quality water and biogas from organic rich wastewater.
- The major highlights of the system include compact size, recovery of water and biogas, capable of treating high strength wastewater, no secondary sludge production, low CAPEX and OPEX.
- The unit successfully integrates anaerobic and aerobic microbial process with specially developed microbial system.
- The unit is already installed in field (up to 10 KLD).
- Patented Technology.

CSIR-NIIST

SATYAM ENVIRO PVT LTD

White pepper production from Black pepper

- White Pepper Production from black/green pepper is a WIPO Gold medal winning technology which is cost effective, time saving and produce high value white pepper from black pepper.
- The technology is suitable for mass production of white pepper from black pepper and uses environment friendly, microbial /enzyme mediated process that significantly reduces the process time required and generates bio-gas as a by-product (Zero Waste Process). The product is also more hygienic compared to the traditional retting process that takes a longer duration

Advantages

- Value addition to black pepper and increase in farmer income
- Superior product quality and pollution free
- Conversion require much shorter time in comparison to traditional retting
- Easy scalability and low infrastructure cost
- Value recovery from waste- Bio-gas, Bio-manure
- Low water discharge
- Successful transfer of know how to several MSMEs and entrepreneurs/farmers

CSIR-NIIST

Synthite

Success stories

CSIR-NIIST Biogas Plant at Trivandrum Airport

NIIST project on 500 Kg/day waste management with Airport Authority of India completed successfully. After one year operation, the fully functional plant handed over to Trivandrum Airport in Jan 2020.

Custom-built spray booth unit: Pilot-scale demonstration & production of biodegradable coir-based mulching mats

Budget: 202.2 Lakhs

Budget: 63.3 Lakhs

Raw Materials	• Needle-felt coir/baby fibers • Bio-based binder
Cost	• Rs. 60 /m2 Vs. Rs. 160 /m2 (latex-based) • Varies depending on fiber quality
Bio-degradation	• Eco-friendly material • Longer life than plastic films • Add value to soil upon degradation

Mulching mat

Geotextile

Biodegradable mulching mats using coir/polymer systems for modern farming

Launching of coir-based mulching mats by Honourable Finance Minister, Dr. T.M Thomas Isaac, along with Shri. V.S. Sunil Kumar, Honourable Minister of Agriculture, Govt of Kerala at Krishi Bhavan, Trivandrum.

Agro Processing and Technology Division

DIVISIONAL DETAILS

Scientists: Eleven	Technical staff: Three	Students: Thirty-Four
Projects: Twenty-Three	Research Publications: Sixteen	Ph. D. awarded: Two

Expertise:

Post-Harvest Technologies
Product development in food sector
Bioactives for life-style disorders
Crop protection.

Facilities:

Pilot Plant Facilities for Evaporation
Distillation and Drying
Liquid Chromatography- Mass Spectrometry /Mass Spectrometry (LC-MS/MS)
High Performance Liquid Chromatography (HPLC)
Gas chromatography–mass spectrometry (GC-MS)
Flow Cytometer
Real-Time Polymerase Chain Reaction (RT-PCR)
Lyophiliser
Multi-mode Plate Reader
High content bioimager - BD Pathway TM 855
Inverted florescent microscope.

कृषि प्रसंस्करण तथा प्रौद्योगिकी प्रभाग

कृषि-प्रसंस्करण और प्रौद्योगिकी प्रभाग प्रक्रिया पर मुख्य ध्यान केंद्रित करने के साथ एक बहुपक्षीय केंद्र है (शेल्फ लाइफ एन्हांसमेंट, स्टोरेज, वैल्यू एडिशन) और उत्पाद विकास (न्यूट्रास्युटिकल्स, फंक्शनल फूड, डाइटरी सप्लीमेंट्स, फाइटोफार्मास्युटिकल्स, बायो-फर्टिलाइजर्स और बायो पेस्टिसाइड्स, बायोडिग्रेडेबल कटलरीज) कृषि और संयंत्र संसाधनों पर जोर देते हैं। डिवीजन के जोर क्षेत्र में से एक वैज्ञानिक और तकनीकी हस्तक्षेप और नवाचार के माध्यम से अपनी उपज के उच्च रिटर्न के माध्यम से किसानों के सामान्य कल्याण में सुधार है। इस प्रभाग में कृषि-प्रसंस्करण के क्षेत्र में पायलट संयंत्र सुविधाएं और प्रयोगशालाएँ हैं। कृषि-प्रसंस्करण और प्रौद्योगिकी प्रभाग भी इस क्षेत्र में प्रचुर मात्रा में पारंपरिक ज्ञान की उपलब्धता और विभाजन में उपलब्ध जैव विविधता की खोज, न्यूट्रास्यूटिकल्स और फाइटोफार्मास्यूटिकल्स के विकास और सत्यापन में शामिल है। एंडोफाइटिक रोगाणुओं से जैव-उर्वरकों और जैव-कीटनाशकों का विकास, मसाले और फलों से सक्रिय तत्व अलगाव के लिए औद्योगिक रूप से महत्वपूर्ण कई एंजाइमों का उत्पादन करने में सक्षम उपन्यास स्वदेशी माइक्रोबियल उपभेदों का खनन भी रुचि के क्षेत्र में से एक है। यह विभाजन यौगिकों के इन विट्रो स्क्रीनिंग और मधुमेह, हृदय, कैंसर और गैर-अल्कोहल फैटी लिवर रोगों के लिए तंत्र आधारित अध्ययन के लिए सुविधाओं से सुसज्जित है। हाल ही में इको-फ्रेंडली और बायोडिग्रेडेबल कटलरी के विकास के लिए कृषि अपशिष्ट का उपयोग शुरू किया गया है। डिवीजन आपसी लाभ के लिए उत्पाद विकास और प्रौद्योगिकी हस्तांतरण के लिए विभिन्न एम एस एम ई के साथ भी काम करता है। प्रभाग में उद्योगों और शिक्षा संस्थानों की जरूरतों को पूरा करने के लिए खाद्य विज्ञान और जैव चिकित्सा विज्ञान के क्षेत्र में मानव संसाधन विकास के लिए अकादमिक कार्यक्रम (पीएचडी) हैं।

हाइलाइट

- आर एंड डी, उत्पाद और प्रक्रिया विकास, प्रौद्योगिकी उन्नयन और स्वास्थ्य लाभ के वैज्ञानिक सत्यापन के लिए उद्योग इंटरफेस कार्यक्रम (प्रायोजित और परामर्श)
- चयापचय संबंधी विकार और कैंसर के लिए पौधों से जैव सक्रिय यौगिकों का औषधीय विकास
- देशी रोगाणुओं से औद्योगिक रूप से महत्वपूर्ण एंजाइमों के माध्यम से सक्रिय घटक निष्कर्षण के लिए वनस्पति के जैव-प्रसंस्करण
- एंडोफाइटिक जीवों पर विशेष जोर देने वाले रोगाणुओं से जैव-उर्वरक और जैव-कीटनाशक
- प्राकृतिक उत्पादों के साथ ट्राइफेनिलोफोसोनियम के संयुग्मन के माध्यम से माइटोकॉन्ड्रियल एंटीऑक्सिडेंट का विकास
- चयापचय बढ़ाने के रूप में एग्री / खाद्य प्रसंस्करण खर्च की गई सामग्री से आहार फाइबर
- खाद्य और शमन रणनीतियों में एक्रिलामाइड
- गैर-डेयरी पेय और पोषण और जैव सक्रिय घटकों के लिए वितरण प्रणाली
- पारंपरिक अनाज और कम फल और सब्जियों से मूल्य वर्धित उत्पाद
- आयुर्वेद में नियोजित विशिष्ट उपचार रेजिमेंट के जैव रासायनिक, सेलुलर और आणविक स्तर सत्यापन अध्ययन
- पर्यावरण के अनुकूल और बायोडिग्रेडेबल कटलरी के विकास के लिए कृषि अपशिष्ट का उपयोग
- जग्गीरी प्रसंस्करण इकाइयों, ताड़ के नीरा प्रसंस्करण इकाइयों जैसे विभिन्न मूल्यवर्धन कार्यक्रमों के माध्यम से पारंपरिक क्षेत्रों को पुनर्जीवित करने की गतिविधियाँ जो जैव विविधता को बनाए रखने और ग्रामीण आबादी के लिए रोजगार प्रदान करने में मदद करती हैं।

Agro Processing &Technology Division

Agro Processing & Technology Division is a multifaceted centre with main focus on process (shelf life enhancement,storage,value addition) and product development (nutraceuticals, functional foods, dietary supplements, Phytopharmaceuticals, bio-fertilizers & bio pesticides, biodegradable cutleries) emphasizing agri produce & plant resources. One of the thrust area of division is improvement of general welfare of farmers through high returns of their produce via scientific and technological intervention and innovation. This division has pilot plant facilities and laboratories in the area of agro-processing. APTD is also involved in the development and validation of nutraceuticals and phytopharmaceuticals exploring rich biodiversity, availability of abundant traditional knowledge in this region and available expertise in the division. The development of bio-fertilizers & bio-pesticides from endophytic microbes, mining of novel indigenous microbial strains capable of producing industrially important multiple enzymes for active ingredients isolation from spices and fruits are also one of the area of interest. This division is also equipped with facilities for in vitro screening of compounds and mechanism based studies for diabetes, cardiovascular, cancer and non-alcoholic fatty liver diseases. Utilization of agri waste for development of eco-friendly and biodegradable cutleries has been initiated recently. Division also work with various MSME for product development and technology transfer for mutual benefits. The division has academic programmes (Ph. D) for human resource development in the field of food science and biomedical sciences for meeting the needs of industries and academics institutes.

Highlights

- R&D, Industry interface programmes (sponsored & consultancy) for product and process development, technology up-gradation and scientific validation of health benefits
- Pharmacological evolution of bioactive compounds from plants for metabolic disorder and cancer
- Bio-Processing of botanicals for active ingredient extraction through industrially important enzymes from native microbes
- Bio-fertilizers and bio-pesticides from microbes with special emphasis on endophytic organisms
- Development of mitochondrial antioxidant through conjugation of triphenylphosphonium with natural products
- Dietary fibre from agri/food processing spent materials as metabolic enhancers
- Acrylamide in foods and mitigation strategies
- Non-dairy beverages and delivery systems for nutritional and bioactive components
- Value added products from traditional grains and underutilised fruits and vegetables.
- Biochemical, cellular and molecular level validation studies of specific treatment regiments employed in Ayurveda.
- Utilization of agri waste for development of eco-friendly and biodegradable cutleries.
- Activities for reviving traditional sectors like Jaggery processing units, palm neera processing units through various value addition programs which help in sustaining the biodiversity and providing employment for rural population.

Role of Methylglyoxal in the onset and progression of metabolic disturbances in HepG2 Cells

Methylglyoxal (MG) is a highly reactive cellular metabolite that acts as a precursor for advanced glycation end products (AGEs) formation. MG has been implicated in several pathologies including diabetes, cardiovascular diseases, kidney disorders, aging and cancer. It also induces liver toxicity. The present study deals with the effect of MG on physiological and cellular functions of HepG2 cells. For this HepG2 cells were incubated with different concentrations (10μM, 50μM, 100μM, 500μM and 1mM) of MG for 24hr. Cells were subjected to various biochemical and cellular studies. Glucose uptake, ROS generation, lipogenesis, and ATP content were studied. Glucose uptake was found to increase significantly along with the expression of GLUT1 protein (Fig 1). There is also a significant increase in the deposition of lipid droplets (Fig 2) and increase in the expression of fatty acid synthase (FASN) in the cells treated with methylglyoxal (MG)(Fig 3). It was also noted that there

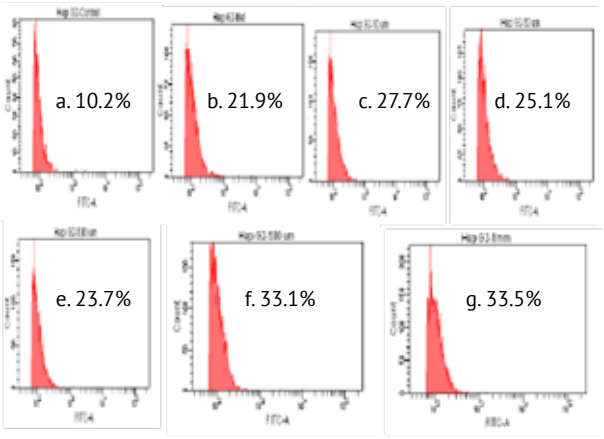


Fig 1. Effect of Methylglyoxal (MG) in glucose uptake in HepG2 cells: Flowcytometry analysis for a) Control, b) Metformin (1000μM), c) MG (10μM),d)MG (50μM), e) MG (100μM), f) MG (500μM) and g) MG (1mM).

is a significant decrease in ATP production. MG also increased ROS generation. Glyoxalase, a metabolizing enzyme of MG, also got impaired significantly in the presence of MG in HepG2 cells. The increase in glucose uptake and de novo lipogenesis with MG reveals the role of the same in the promotion of cancer cell growth. And increased expression of GLUT 1 indicates towards the involvement of hypoxia. But this has to be confirmed with detailed study. Overall results show that MG is a potent toxic metabolite with pleotropic effects affecting HepG2 cells adversely.

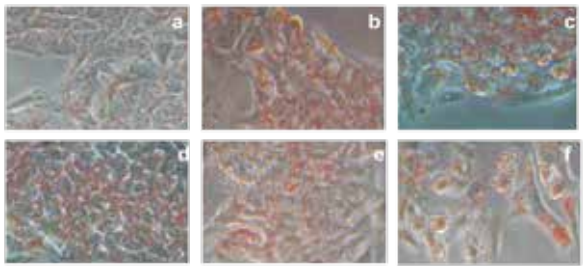


Fig.2. Methylgglyoxal induced lipid accumulation : Microscopic images of HepG2 cells with Oil red-O-staining from different experimental groups under phase contrast microscope (Magnification 40X). (a) Control (b) MG (10μM), (c)MG (50μM), (d) MG (100μM), (e) MG (500μM) and (f) MG (1mM).

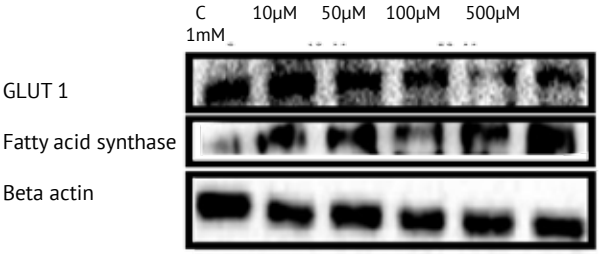
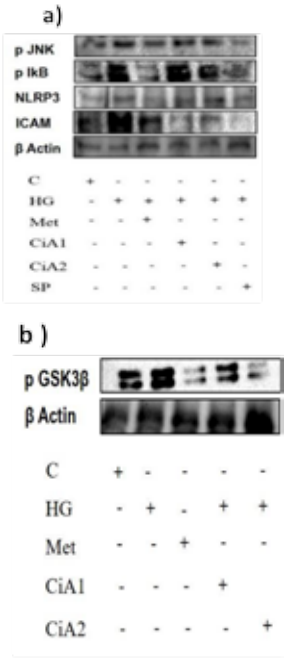


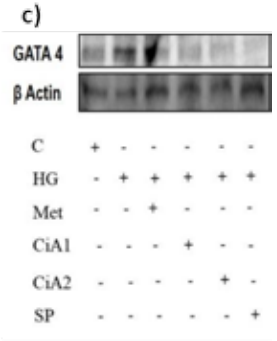
Fig 3. GLUT1 and Fatty acid synthase protein expression modulation in HepG2 cells.:HepG2 cells were treated with different concentrations of methylglyoxal for 24 hours. Cell lysates were examined for protein expression of GLUT1 and Fatty acid synthase by western blot analysis with actin as loading control. Lane 1-control cells; 2- 10μM MG; 3 – 50μM MG, 4-100μM MG, 5-500μM MG & 6- 1mM

Elucidation of inflammatory mechanisms during hyperglycemia in H9c2 cells and possible amelioration with Cinnamic acid

Cardiovascular diseases are one of the most common cause of mortality and morbidity in the world. Diabetic cardiomyopathy (DCM) refers to changes that occur in the myocardium during diabetes. DCM is associated with structural and functional changes in the myocardium like hypertrophy, fibrosis, apoptosis and systolic and diastolic dysfunction. It usually occurs independent of other cardiac risk factors like coronary artery disease and hypertension. Inflammation is usually associated with metabolic syndromes like obesity and T2DM. Several

inflammatory signalling pathways are triggered upon an inflammatory stimulus. It is the action of these pathways that signal the release of various proinflammatory mediators like cytokines, chemokines and adhesion molecules. Cardiac inflammation is also likely to be caused by the activation of toll like receptors (TLRs) and NLRP3 inflammasome complexes. NLRP3 inflammasome is now considered to be a novel marker in the pathogenesis of DCM. GATA-4 belongs to a zinc finger family of transcription factors with an essential role in cardiac hypertrophy. They bind to a sequence of DNA called GATA, which is seen in the promoter region of many genes including cardiac troponin, alpha-MHC, ANP. In this study there was an upregulation of the protein in high glucose (HG) treated H9c2 cells(Fig a & c). However, GATA-4 levels are negatively regulated by GSK-3B(Fig b). Phosphorylation of GSK-3B results in the nuclear import of GATA-4 protein. The present study showed higher levels of p-GSK3B in HG treated H9c2 cells suggesting that GATA4 proteins are translocated into the nucleus. Cinnamic acid (CiA) is a phenolic acid present in a wide variety of fruits and vegetables including blueberry, cherry, apple, plum, potato and coffee. They are reported to exhibit antioxidant, antiinflammatory and anticancer activities. This study aim to elucidate in detail about the anti-inflammatory property of CiA during diabetic cardiomyopathy.



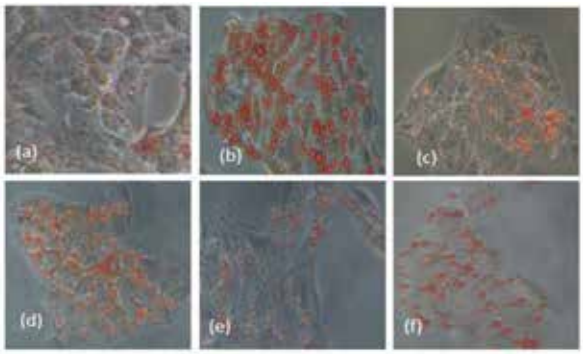


Elucidation of NLRP3, p GSK3B and GATA 4 levels in high glucose treated H9c2 cells and amelioration with cinnamic acid H9c2 cells were treated with high glucose (33 mM) for 48 h in the presence or absence of various concentrations of cinnamic acid, metformin.A) Representative immunoblot of NLRP3, p GSK3B and GATA 4. C - control, HG - high glucose treated group, Met - HG + metformin, CiA1 - HG + cinnamic acid (100 nM), CiA2 - HG + cinnamic acid (500 nM).

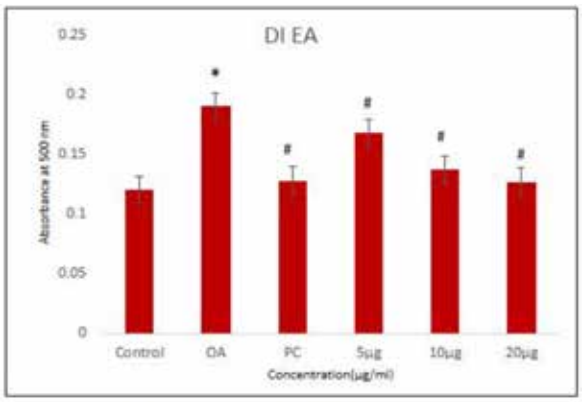
Exploring the antiobesity potential of medicinal plants, *Dillenia indica* and *Ipomoea aquatica*

Obesity is a disorder involving excessive body fat that increases the risk of health problems. Proper medications are not available for obesity; currently available medications exhibits serious adverse effects. Therefore, demands for plant derived anti obesity agent are very high. In this study, we selected two medicinal plants *Dillenia indica* and *Ipomoea aquatica*, which are already reported as anti-dyslipidemic and inhibit excess body fat accumulation. These plants were subjected to extraction and fractionation. The extracts of *Dillenia indica* showed presence of phytochemicals such as elagic acid, chlorogenic acid, quercetin, syringic acid, ferulic acid, p-coumaric acid, myricetin, and cinnamic acid. *Ipomoea aquatica* showed presence of ferulic acid, myricetin, cinnamic acid, syringic acid, and elagic acid. Cytotoxic test of all extracts were done on HepG2 cell lines. Extracts were found to be nontoxic up to 200µg/ml (*I. aquatica* hexane, hydroethanol extract, *D.indica* hydroethanol extract) and nontoxic up to 50µg/ml (*I.aquatica* ethyl acetate extract, *D.indica* hexane and ethyl acetate extract). In order to develop an *in vitro* model of obesity, HepG2 cells were treated with oleic acid (100µM) for 24 hours. Oil red O staining and Triglyceride (TG) assay were done to check the lipid droplet accumulation in treated (75µg/ml and 100µg/ml) HepG2 cells. Oil red O staining shows that *D.indica* ethyl acetate and hydroethanol extract (5µg/

ml, 10µg/ml and 20µg/ml) reduced lipid accumulation in Hep G2 cell lines. TG assay also shows same trend i.e., *D.indica* hydroethanol extract (5µg/ml, 10µg/ml) reduced TG accumulation.



Oleic acid induced lipid accumulation in Hep G2 cells: Control (b) Oleic acid 100µM (c) Oleic acid 100µM(d) Oleic acid +5µg extract (e) Oleicacid+10µg extract (f) Oleic acid +20µg plant extract.



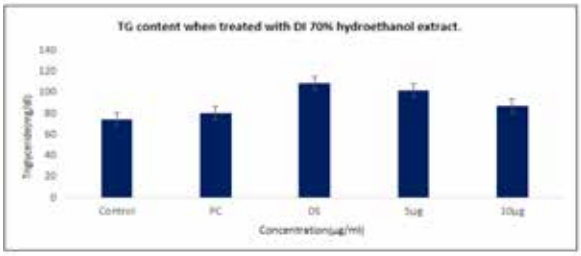
Quantification of oil red o staining of *D.indica* ethyl acetate(DI EA) extract: OA-Oleic acid, PC-Positive control(fenofibrate)

Ipomoea aquatica

Kingdom: Plantae
Order: Solanales
Family:Convolvulaceae
Genus: *Ipomoea*
Species: *I. aquatica*

Dillenia indica

Kingdom: Plantae
Order: Dilleniales
Family:Dilleniaceae
Genus: *Dillenia*
Species: *D. indica*

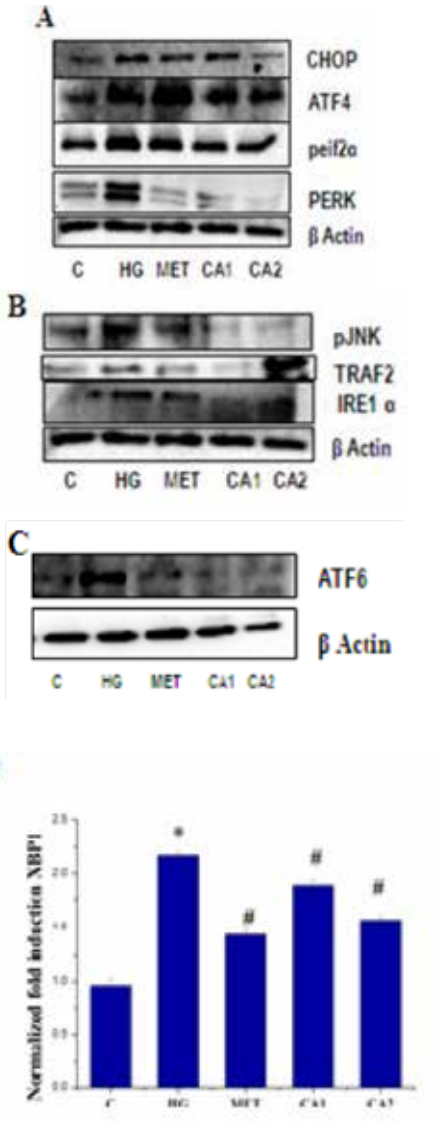


Quantification of TG content of *D.indica* hydroethanol extract, PC-positive control (fenofibrate), DS-Disease condition (treated with oleic acid)

Study of ER Stress and ER phagy during hyperglycemia in heart and possible amelioration with chlorogenic acid

The rapid increase in prevalence of Type 2 Diabetics (T2D) now represents a global pandemic. These patients are at high risk of developing heart failure and dying prematurely, but the prevalence of subclinical cardiac dysfunction and the causes are uncertain. Endoplasmic reticulum (ER) stress plays an important role in diabetic cardiomyopathy (DCM) with controversy in mechanisms and regulatory pathways; however, their roles in this type of injury remain unclear. The present study investigated the roles of ER stress and ER phagy, and their underlying mechanisms in diabetic cardiomyopathy and also the pharmacological benefits of chlorogenic acid (CA) in controlling DCM. Persistent perturbation of ER homeostasis leads to activation of the unfolded protein response (UPR): component of which are protein kinase RNA-like ER kinase (PERK), inositol-requiring enzyme1 (IRE1), activating transcription factor 6 (ATF6), and ultimately induces ER stress. ER phagy, as an adaptive response, was activated by ER stress and alleviated ER stress-induced cell apoptosis during diabetic cardiomyopathy. The study was performed both *in* H9c2 cell. *In vitro* study was conducted in H9c2 cell line which were incubated with 33 mM D-glucose for 48 h. The expression levels of ER stress-related proteins as well ER phagy proteins (PERK, ATF4, CHOP, IRE1, TRAF2) were measured by western blotting. Apoptosis was detected by caspase 3 activity measurement and western blotting. Compared with the control group, high glucose significantly increased PERK, pEIF2α, ATF4, ATF6, CHOP, IRE1, TRAF2, pJNK and caspase-12 expression, increased apoptosis (Fig A-C). Promoting

ER phagy was found in high glucose group by increased the expression of Sec62. CA treatment restores cardiac ER homeostasis by subsiding UPR signalling pathways. Thus the overall result indicates that pharmacological targeting of cardiac ER stress represents a promising therapeutic strategy for DCM.



Fig(A-C) Immunoblot analysis of PERK, PEIF2α, ATF4, IRE1α, TRAF2, pJNK, ATF6β actin;D)mRNA expression of XBP1(a)Control,(b) highglucosetreated group,(c)HG +metformin,(d)HG +chlorogenic acid(10μM),(e) HG+chlorogenicacid(30μM),C-Control(5.5mM glucose),HG-High glucose treated group (33mMglucose),Met–Highglucosetreatedcells+Metformin(1mM),CA1–High glucose treated cells + chlorogenicacid(10μM), CA2- High glucose treated cells+ chlorogenic acid (30μM).Values are expressed as mean±SEM where n =6. *p ⩽0.05 significantly different from the control group.# p ⩽0.05 significantly different from HG treated group.

Hyperglycemia induced alteration in mitochondrial membrane potential and possible amelioration by ferulic acid

Diabetic cardiomyopathy, a diabetic induced heart disease is one of the major causes of mortality. The molecular mechanism behind this is still unknown. Since mitochondrion is the centre of energy metabolism, it is proposed that alteration in mitochondrial function may impart the genesis of diabetic cardiomyopathy. Keeping this in mind, the study evaluated the mitochondrial function during hyperglycaemia (HG) in H9c2 (2-1) cardiomyoblast cells and assessed the beneficial effect of the polyphenolic compound ferulic acid (FA) against it.

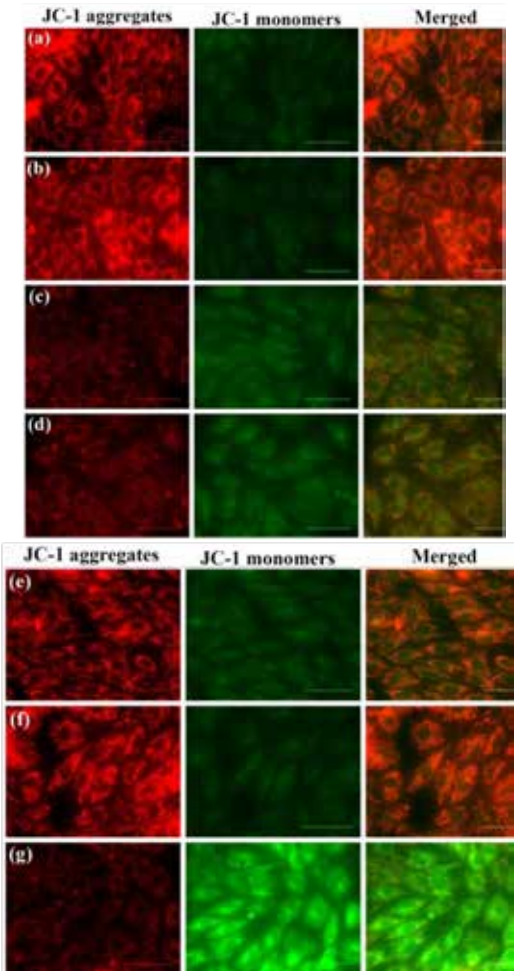


Fig 1. Effect of ferulic acid (FA) on high glucose (HG) induced dissipation of mitochondrial membrane potential (ΔΨm): Confocal bio-imaging of JC1fluorescence. **(a)** C -control- 5.5 mM glucose, **(b)** CF -control + 25 μM FA, **(c)** HG - high glucose - 33 mM glucose, **(d)** HGF1 -high glucose + 10 μM FA, **(e)** HGF2 - high glucose + 25 μM FA, **(f)** HGM -high glucose + metformin (10 μM) and **(g)** Valinomycin treated groups. Scale bar: 50 μm

HG induced dissipation in mitochondrial membrane potential evidenced by the increase in green fluorescence of JC1 monomer, a fluorescent indicator of membrane potential (Fig 1). The treatment with FA maintained the membrane potential significantly ($p < 0.05$) in a dose dependent manner, which is comparable to the standard drug metformin. Valinomycin is used as negative control.

UPR ^{ER} and UPR^{mt} are molecular targets of fructose palmitate induced steatosis in HepG2 cells

Non-alcoholic fatty liver disease encompasses a spectrum of hepatic histopathological changes ranging from intracellular fat deposition to non-alcoholic steatohepatitis (NASH). Exact molecular and cellular events leading to NASH are not known except occurrence of surplus lipogenesis. Many research groups are actively working on various aspects of liver physiology for definite clues on the genesis of NAFLD but no report on research on importance of mitochondrial and endoplasmic unfolded protein response in the genesis of NAFLD are available. Herein the study investigates whether unfolded protein response in endoplasmic reticulum (UPR^{ER}) and mitochondria (UPR^{mt}) have any regulatory role in the genesis or acceleration of steatosis in HepG2 cells to link unfolded protein responses to NAFLD. To induce steatosis, HepG2 cells were incubated with high concentrations of fructose (100 mM) and palmitate (100 µM) for about 24 hr. Intracellular lipid and cholesterol overload and activity of HMG-CoA reductase were investigated. The expression of various proteins involved in UPR^{ER}and UPR^{mt} system was analysed by western blot. The results revealed surplus synthesis of intracellular lipids (52.30%) and a significant decrease of lipolysis (86.08%) during steatosis in HepG2 cells. The intracellular cholesterol level was increased (186.66%) (Fig 1) with the activity of HMG CoA reductase (56.99%). The expressions of UPR^{mt} and UPR^{ER} marker proteins ATF6 (79.84%), PERK (26.56%), GRP78 (57.6%), CHOP (43.3%), HSP60 (214.12%), CEBP (96.41%), SIRT3 (46.43%), and BNIP3 (120.91%)(Fig 2) were altered significantly with fructose and palmitate incubation. This reveals the fact that UPR^{mt} and UPR^{ER} play a crucial role in the initiation and progression of steatosis in HepG2 cells thereby revealing their role as new therapeutic targets for exploration.

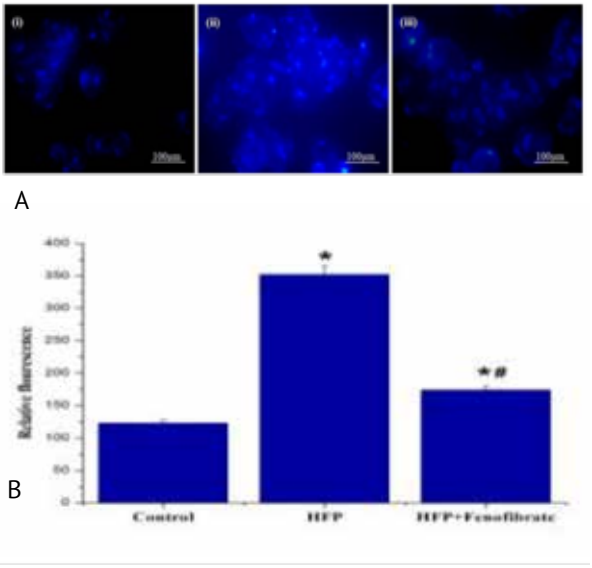


Fig 1 Accumulation of cholesterol inside HepG2 cells in response to HFP treatment. (A)Measurement of intracellular cholesterol droplets accumulation in HFP treated HepG2 cells. (i) Control cells; (ii) Cells treated with HFP; (iii) Cells treated with HFP+Fenofibrate. (B) Absorbance was spectrophotometrically measured at 470 nm. Values are expressed as mean ± SD (n=3). *Mean values are significantly different from the control group ($P \leq 0.05$). #Mean values are significantly different from the HFP treated group ($P \leq 0.05$).

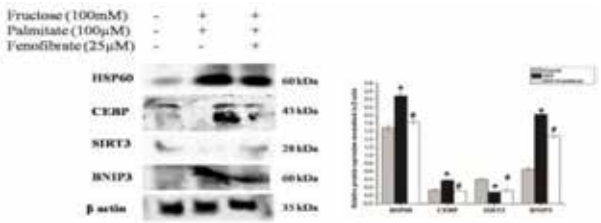


Fig 2. Alteration of UPR^{mt} during NAFLD. The protein expression of HSP60, CEBP, SIRT3, and BNIP3 during HFP condition. Values are expressed as mean ± SD (n=3). *Mean values are significantly different from the control group ($P \leq 0.05$). #Mean values are significantly different from the HFP treated group ($P \leq 0.05$).

Identification of proprotein convertase subtilisin kexin-9 (PCSK-9) inhibitors from medicinal plants

PCSK9 is an enzyme that is encoded to the PCSK9 gene. It binds to the LDL receptor in the liver. When it binds to the LDLR, the receptor is broken down and can no longer remove LDL-C from the blood. They target and inactivate PCSK9 in the liver and dramatically decrease LDL-C. Plant derived natural products have received much attention as new therapeutic agents due to their less toxicity and cost effectiveness. A very few natural compounds i.e. polydatin, curcumin and berberine, lycopene have been screened for their

PCSK-9 inhibitory potentials. This work focussed on the isolation of bioactive compounds from medicinal plants and screening of its efficacy as a PCSK-9 inhibitor for the treatment of hypercholesterolemia in HepG2 cells treated with lipoprotein deficient medium. Active compound (NIIST-PCSK9) was isolated from dried fruits of selected medicinal plant. The compound is identified by HPLC, mass spectra, and cNMR. HepG2 cell lines were grown in OptiMEM (Gibco) media. The results showed that NIIST-PCSK9 reduced the protein expression in a time-dependent and dose dependent manner (Fig 1). Also NIIST-PCSK9 increased the amount of LDLR protein on the HepG2 cells. The data showed that the levels of LDLR on the cell lysate of HepG2 cells were significantly elevated by dose dependent manner in the NIIST-PCSK9-treated cells in the concentrations 2.5, 5 and 10 μM. compared to vehicle control (Fig 2). The detailed analyses suggest that NIIST-PCSK9 administration reduced activity of HNF4α and HNF1α, and there by decreased PCSK9 expression, and ultimately increased hepatic LDLR protein levels, which resulted in decreased circulating LDL levels.

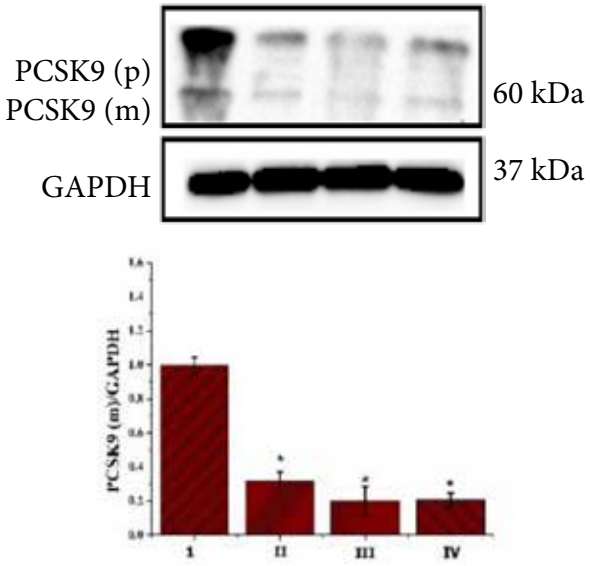
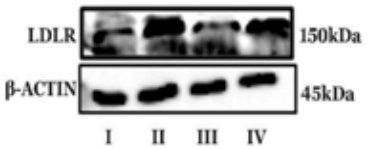


Fig1. The protein expression of PCSK9 in OptiMEM activated HepG2 cells treated with vehicle or NIIST-PCSK9 at different concentrations. The experimental groups are I-vehicle control; II, III, are in the concentrations 5, 10 μM and statin at 10 μM concentrations respectively.



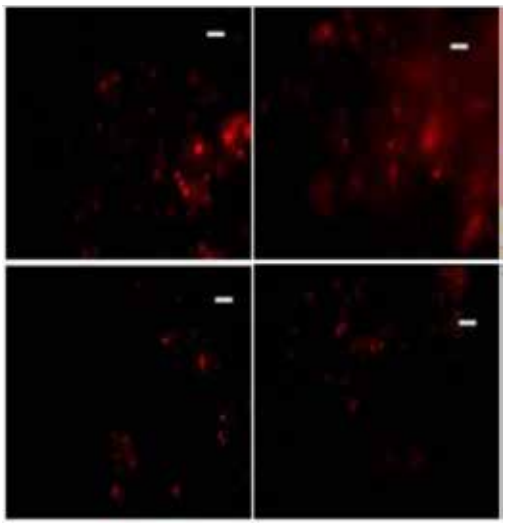


Fig 2. Effect of NIIST-PCSK9 on LDLR expression. The experimental groups are I-vehicle control; II, III, IV are in the concentrations 5, 10 μM and statin at 10 μM concentrations respectively

Downregulation of TLR4/Myd88/p38MAPK pathway in RAW 264.7 by traditional medicinal plant (P1) reveals its beneficial effects in inflammation

Traditional medicinal plants are commonly used in Ayurveda against various ailments. Present study focused on the molecular targets of a known medicinal plant (P1) in lipopolysaccharide (LPS) stimulated RAW 264.7 cells. P1 significantly inhibited the level of pro-inflammatory mediators like NO, IL-6 and TNF-α and upregulated anti-inflammatory cytokine IL-10 level. It targeted upstream elements of the inflammatory cascade by blocking LPS induced activation of TLR4/Myd88 pathway. Consequently, there was a subsequent downregulation of the downstream kinases like p38MAPK, JNK1/2 and PI3K(Fig 1c). The inhibition of LPS induced nuclear translocation of NF-κB via suppressing the phosphorylation of IκBα further confirms the specific inhibition of Myd88 dependent TLR4 pathway by P1(Fig 1b). TLR4 and p38MAPK being much higher in the inflammatory signalling cascade, inhibition of the same can be much effective against inflammatory reactions. The results from this study thus provides strong evidence that P1 exerted its anti-inflammatory effect through modulation of TLR4/Myd88/p38MAPK pathway.

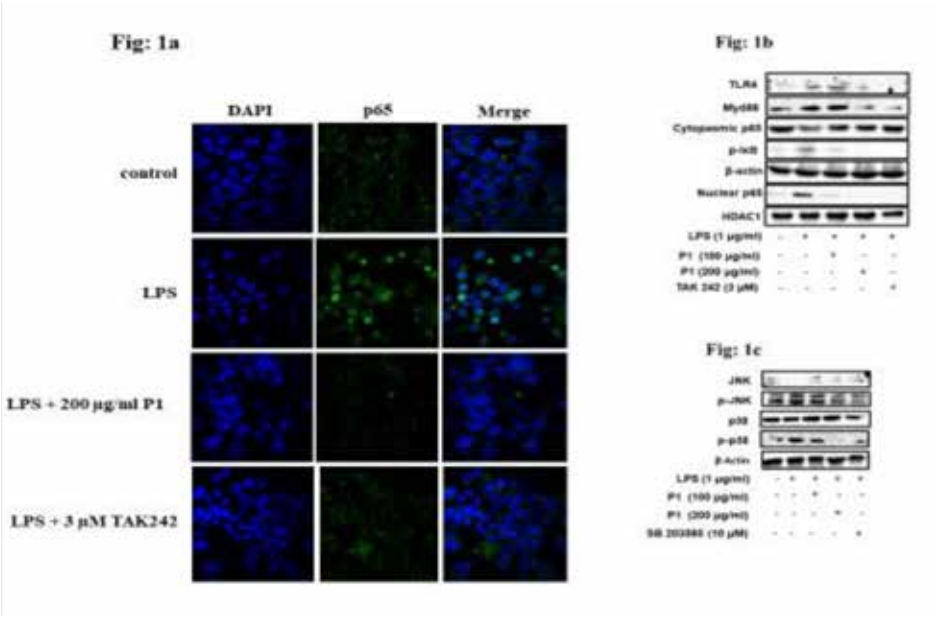
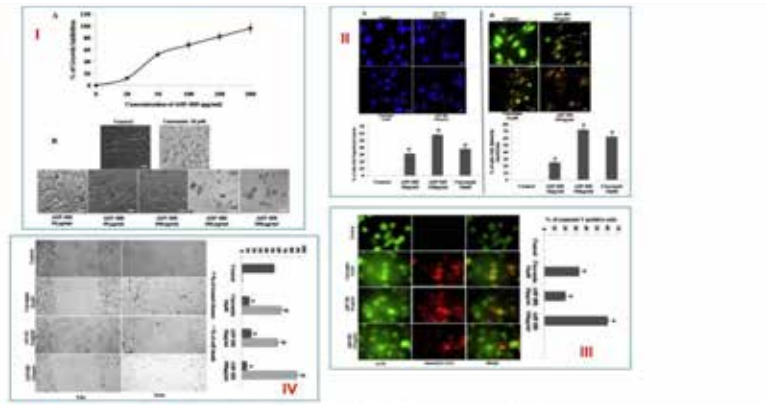


Fig: 1a. Effect of P1 on LPS induced nuclear translocation of p65;
Fig: 1b. Inhibitory effect of P1 on TLR4 signaling;
Fig: 1c. Inhibition of MAPK by P1

Bioactive peptides from amaranth seed protein hydrolysates induced apoptosis and antimigratory effects in breast cancer cells

Pseudocereals are the edible seeds produced by the non-grass family of plants such as amaranth, quinoa and buckwheat. They have a high amount of protein with balanced essential amino acid (EAA) composition and are rich in constituents important for human health, such as dietary fiber, antioxidants, and vitamins. The high nutritional quality and interesting functional properties, make them an alternative to cereals. Pseudocereals are considered as one of the promising foods of the future, due to their high protein content and absence of gluten. *Amaranthus caudutus* L. is one of the gluten free pseudocereals and its protein contains a well-balanced composition of EAA. Bioactive peptides are short chains of amino acids with positive health effects and food proteins are an important source of bioactive peptides. We have isolated the proteins from amaranth seeds and the protein hydrolysates (rich in bioactive peptides) were prepared by simulated gastrointestinal digestion. The bioactive peptides released from the heat



I (A)- MTT assay I(B)-Morphological analysis by phase contrast imaging
II (A)- DAPI Staining, II(B)-Acridine oranage/ethidium bromide staining for membrane integrity
III- Annexin V staining for phosphatidyl serine translocation
IV- Scratch wound assay for cellular migration

denatured proteins of amaranth seeds were studied for their apoptosis and antimigratory effects in breast cancer cells. The results indicated that the digested sample was capable of inhibiting cell growth with a GI50 value of 48.3±0.2 µg/ml. The protein hydrolysates also induced DNA fragmentation, membrane integrity loss, phosphatidylserine translocation and caspase 3 activity in the treated cells. It inhibited cell migration across an artificial wound created in the cell monolayer. Therefore, amaranth is a good source of bioactive peptides with promising anticancer activity.

In vitro evaluation of antidiabetic potential of Hesperidin and its aglycone Hesperetin under oxidative stress in skeletal muscle cell line

This study investigated the *in vitro* antidiabetic and antioxidant potential of Hesperidin and Hesperetin under oxidative stress induced in L6 myotubes. Also, the study attempted to reveal the effect of glycosylation (Hesperetin) on the biological activities of Hesperidin. Oxidative stress is the leading cause of complications associated with diabetes. Both Hesperidin and Hesperetin reduceed oxidative stress directly by scavenging Intracellular reactive oxygen species (ROS) and by up-regulating natural antioxidant defense system like Glutathione. Hesperidin & Hesperetin at 10µM inhibited the non-enzymatic glycation of proteins (65.57 and 35.6%, respectively), the critical reaction involved in the formation of advanced glycation end products (AGE's) which has a significant role in the pathogenesis of diabetes. Additionally, these compounds induced glucose uptake in L6 myotubes following acute and chronic treatment. The percentage 2-NBDG uptake shown by both the compounds were comparable with that of the antidiabetic drug, Rosiglitazone (30.4%). Both the compounds downregulated PI3 Kinase activity whereas GLUT4; IRS and AKT were upregulated in L6 myotubes pointing to the possible overlapping with the insulin signaling pathway.

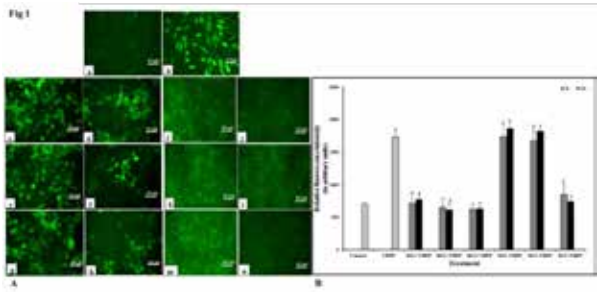


Fig 1A: Effect on Intracellular Reactive oxygen species on pretreatment with Hesperidin and Hesperetin for 3h and 24 h
Figures (a), (b), (c), (d), (e), (f), (g) , (h), (i),(j), (k), (l), (m) & (n). represents fluorescence images of Untreated cells, cells induced with TBHP (100 µM), and cells pretreated with Hesperidin & Hesperetin -1, 10 & 100 µM, respectively, for 3h and 24 h. Scale bar corresponds to 87 µM. (B) Relative fluorescence intensity analysis of different groups by BD Image Data Explorer software. Each value represents mean ± SD of triplicate measurements (n=3). Significance test between various groups was determined by using one way ANOVA followed by Duncan's multiple range test and the significance accepted at P≤0.05; * P≤0.05 verses Control; # P≤0.05 verses TBHP.

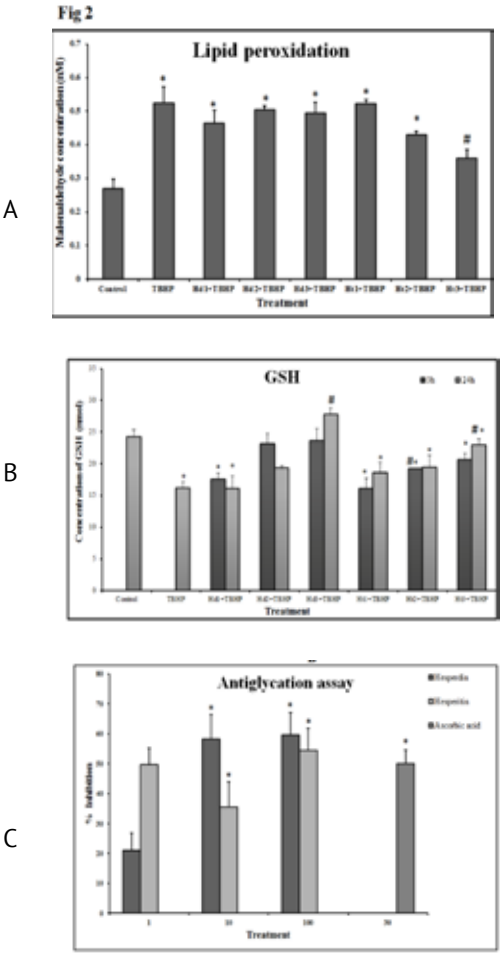
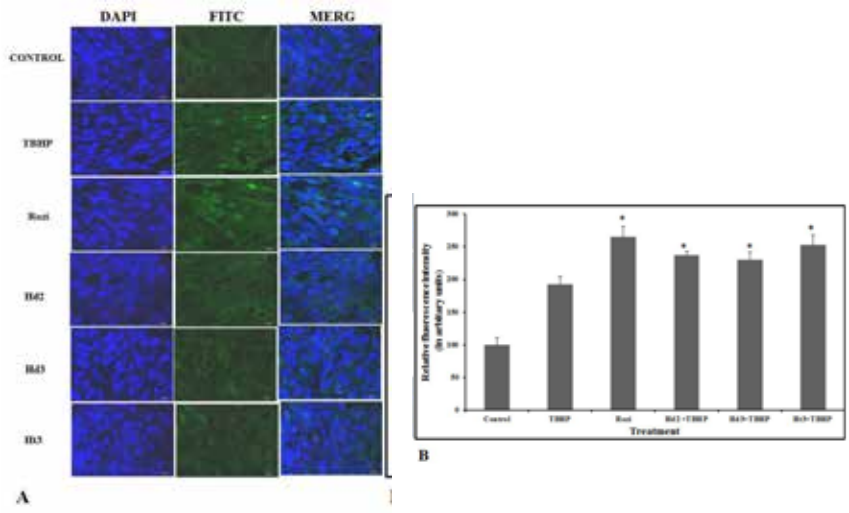


Fig 2. (A) Analysis of Lipid peroxidation in L6 myoblast. Pretreatment of Hesperidin & Hesperetin at three different concentrations (1, 10 & 100 µM) reduced malonaldehyde level compared to that of TBHP treated group. Each value represents mean ± SD of triplicate measurements (n=3). Significance test between various

groups was determined by using one way ANOVA followed by Duncan's multiple range test and the significance accepted at P≤0.05; * P≤0.05 versus Control; # P≤0.05 versus TBHP.**(B) Estimation of Glutathione level in L6 myoblast.** Each value represents mean ± SD of triplicate measurements (n=3). Significance test between various groups was determined by using one way ANOVA followed by Duncan's multiple range test and the significance accepted at P≤0.05; * P≤0.05 versus Control; # P≤0.05 versus TBHP. **(C) Antiglycation activity of Hesperidin & Hesperetin.** Antiglycation activity of at three different concentrations (1, 10 & 100 µM). Ascorbic acid was used as a standard. Each value represents mean ± SD of triplicate measurements (n=3). Significance test between various groups was determined by using one way ANOVA followed by Duncan's multiple range test and the significance accepted at P≤0.05; * P≤0.05 versus Ascorbic acid.

Fig 3: Effect of pretreatment on GLUT4 receptors.

(A) Immunofluorescence assay revealed upregulation of GLUT4 in differentiated L6 myoblast. High resolution confocal images (40X) of Untreated L6 myotubes, L6 myotubes treated with TBHP, Rosiglitazone (100 nM), Hesperidin & Hesperetin (100 µM, 24 h). Scale bar corresponds to 10µM. **(B)** Relative fluorescence intensity analysis of different groups by BD Image Data Explorer software. Each value represents mean ± SD of triplicate measurements (n=3) Significance test between various groups was determined by using one way ANOVA followed by Duncan's multiple range test; * P≤0.05 verses Control; # P≤0.05 verses TBHP.



FOOD SCIENCES AND TECHNOLOGY

Technology development for preservation & value addition of matured coconut water:

Matured Coconut water (MCW) is a by-product in all coconut related industries, which is rich in energy sources and can be consumed as a drink. There are plenty of coconut producing companies in Kerala where many value added products are manufactured but the coconut water generated is currently being disposed without sales realization, which creates environmental issues. In this context a sponsored project was undertaken through financial support from Coconut Development Board to develop technologies for in situ preservation and value addition of coconut water. A pre-processing and rapid chilling mechanism was developed by design and installation of a prototype unit through which the coconut water can be filtered and make turbid free and then cooled to 4 0C by and preventing rapid spoilage. A variety of value added products were also being developed using this water such as coconut water concentrate, concentrate mix with fruit juices, ready to drink powder based on coconut water etc. The process

was demonstrated before some user industries for commercialization.

Setting up of fruit & vegetable processing unit for HOTICORP, Govt of Kerala

Technologies were developed and optimized for the shelf life enhancement and preservation of indigenous fruits and vegetables as part of the ongoing research project funded by Govt of Kerala. As the outcome of this project, the developed technology is in commercialization stage, by undertaking a turnkey execution of a 500 kg per day processing unit for dehydration, preservation and value addition of regional fruits & vegetables during peak harvest season. The project is in implementation stage and the plant is owned by HORTICORP, Govt of Kerala.

Technology development for value addition of millets

Many formulated nutritional products were developed based on traditional millets of the state as a part of the Government of Kerala sponsored project on 'value addition of indigenous agri crops'. Various ready to prepare tradition breakfast products, snack products and health foods were prepared under this programme. The process for commercial production is optimized and the products are ready for commercialization. As an outcome, a new Initiative, as part of a sponsored project with Directorate of Agriculture Dept , Kerala is currently taken up for setting up a pilot scale processing facility for millets and herbs which can be explored before new entrepreneurs for nucleating their ideas for innovative product development and test marketing. An MoU has been signed with Govt of Kerala for the programme.

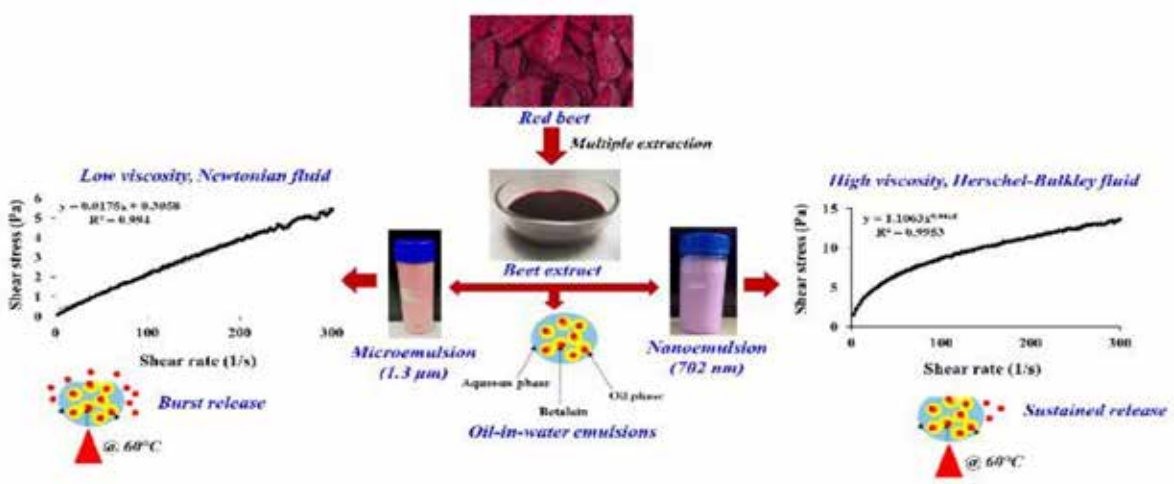
Industrial linkages for process/ product development & technology upgradation:

The divisional activities for strengthening the industrial linkages were successful and many industrial projects were envisaged during the year 2019-20 in connection with the process / product development activities, technology/ product fine tuning, quality assessment etc. Some of the programmes are:

1. Development / fine tuning of innovative products in Ayurvedic Sector through pilot scale optimization & quality evaluation (Sponsored by M/s Pankajakasthuri Herbals Pvt Ltd & M/s AVP Coimbatore)
2. Technical solutions for processing related issues in coconut oil refining and developing analytical protocols for adulteration of coconut oil for industries (Sponsored by M/s KSE Ltd Thrissur & M/s KLF Nirmal, Thrissur)

Micro- and Nano emulsions of beetroot as natural food colorant with enhanced stability

Betalains (E 162) are water-soluble compounds present in the beetroot juice that impart natural red color to food products and is widely used in low-temperature foods as betalain are unstable at high temperatures. An attempt has been made to enhance the thermal stability of betalain by transforming it into a colloidal form, to overcome this bottleneck. This was accomplished by applying the emulsification-based encapsulation approach. The oil-in-water betalain microemulsions and nanoemulsions were prepared using betalain multiple extract and sunflower oil with whey protein concentrate (WPC) as the emulsifier, using appropriate technology and were evaluated and compared for particle size, morphology, zeta potential, encapsulation efficiency and color release, color parameters (L^*, a^*, b^*), and surface tension. The Fourier transform infrared spectra (FTIR), thermal behaviour (DSC) and rheological behaviour of the micro and nanoemulsions were also studied. The storage stability of the emulsions was evaluated for 15 days at refrigeration temperature (4±1°C), room temperature (30±5°C), 40 ± 1°C, and 100±1°C. The results indicated that the nanoemulsions exhibited better stability and encapsulation efficiency compared to the microemulsions. The higher thermal stability of betalain nanoemulsion compared to its microemulsion and un-encapsulated betalain multiple extract counterparts was also evident from the DSC thermograms. The results revealed the higher physicochemical, thermal and storage stability of the beet extract nanoemulsion compared to the microemulsion, attributes to its nanoscale droplet diameter, high viscosity, and non-Newtonian rheological behaviour.



Acrylamide formation in Indian foods: Mitigation strategies

Acrylamide (2-propenamide), a neurotoxin and probable human carcinogen (World Health Organization, 2002), is formed in foods when subjected to high temperature processing such as baking, frying, deep-frying and microwaving (above 120°C). As a part of the ongoing activities on data generation of acrylamide in pan Indian food products under CSIR mission project 'FOCUS', the occurrence of acrylamide in baked food products were assessed. A LC-MS/MS based analytical method was optimized for the estimation. The acrylamide content of market samples of biscuits, bread and cakes (75 no) were found to range between 10.32 - 85.76 ppm. As the processing temperature and time plays major role in acrylamide formation, a modified baking oven was designed and fabricated to reduce the acrylamide formation in baked foods. Processing conditions were optimized for bread, biscuits and cakes based on acrylamide formation and sensory acceptability. Baking at optimized conditions in the newly designed oven resulted in 73.3, 67.9 and 69.29 % reduction in acrylamide formation in biscuits, cakes and bread respectively, as compared to the conventional baking.

Isolation and technological characterization of foaming agents from spent coffee grounds

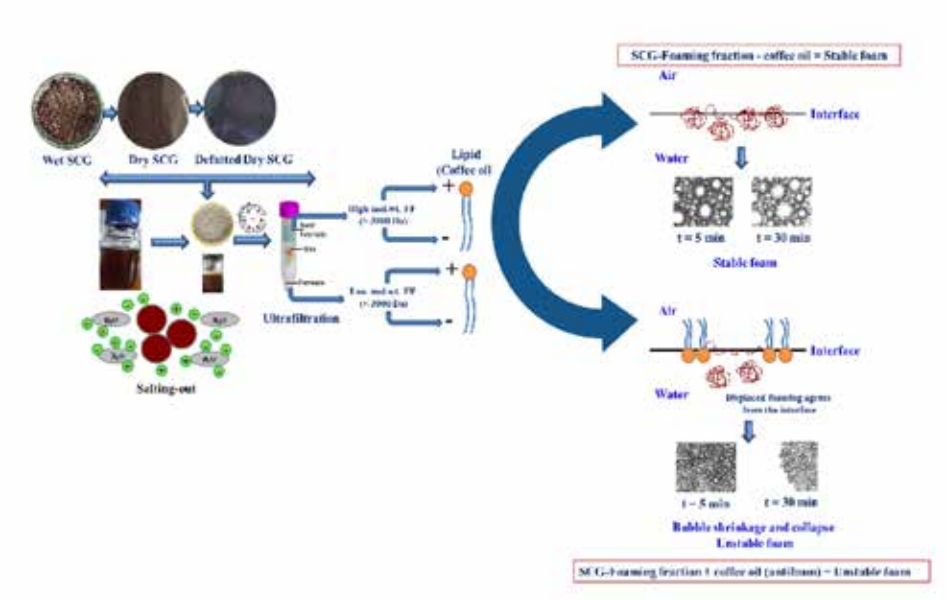
The development of plant-based foaming agents is of relevance to the food industry. Present work aims at

the isolation of foaming fractions from spent coffee grounds (SCG) and their technological characterization, including foam ability, foam stability, surface activity and evolution kinetics of foam structure. SCG are the main solid residues (45%) generated by the instant coffee manufacturing industry, cafes, and public. Evidence is available on the presence of surface-active chemical constituents in SCG.

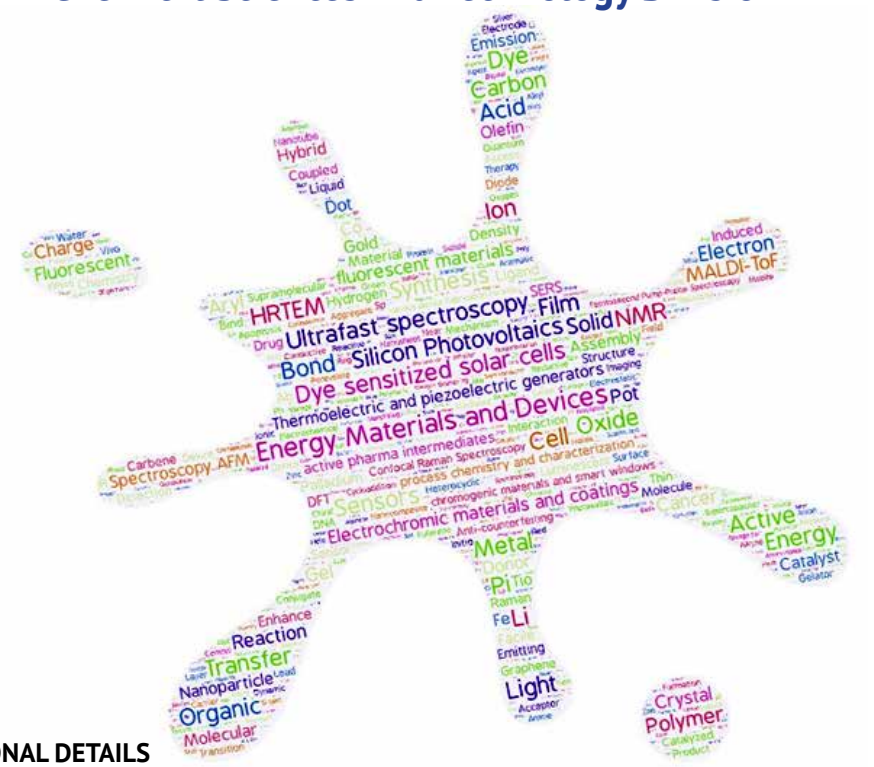
SCG was obtained from the roast and ground *Coffea arabica* and *Coffea robusta* after extraction by the drip filtration method. The high- and low-molecular-weight foaming fractions were obtained from defatted and whole SCG (Arabica and Robusta coffees) after a series of extraction, concentration, and purification steps. The surface activity, foamability, and foam stability of the SCG-based foaming fractions were evaluated in

comparison with synthetic surfactants. The foam structure evolution and molecular fingerprint of foaming fractions were elucidated using light microscopy and infrared spectroscopy, respectively.

Among the eight different SCG-based foaming fractions, the high molecular weight fraction obtained from defatted *robusta*-SCG exhibited higher surface excess concentration (Γ: 1.68 mol/1000 m2), comparable foam stability (FS: 51.52 ± 8.38%), and greater foamability (FA: 165 ± 29.27%) than polysorbate-80, a commonly used synthetic surfactant (Γ: 1.19 mol/1000 m2; FS: 83.38 ± 20.78%; FA: 127.5 ± 22.98%). The coffee oil present in the whole SCG was found to play the role of antifoam, with bubble breakage and shrinkage as its major foam destabilization mechanisms. Infrared spectra of the foaming fractions suggested that their composition is a combination of polysaccharides and melanoidin-like proteins that are products of Maillard reactions.



Chemical Sciences and Technology Division



DIVISIONAL DETAILS

Scientists: Twenty-one Technical staff: Five Students: One hundred and eleven
Projects: Thirty-eight Research Publications: Seventy-three Ph. D. awarded: Eleven

Expertise: Energy Materials and Devices: Dye sensitized solar cells, Silicon Photovoltaics, Thermoelectric and piezoelectric generators, Electrochromic materials and coatings, Storage materials, chromogenic materials and smart windows, Nanomaterial synthesis and applications, Functional materials and coatings, Ultrafast spectroscopy, Photo-catalysis, and computational chemistry Synthetic Organic Chemistry: Phytochemical Isolation and semi-synthetic modification, active pharma intermediates, process chemistry and characterization

Sensors: Anti-counterfeiting, diagnostics, fluorescent materials for sensors, surface enhanced Raman markers and platforms for diagnostics

Facilities: HRTEM (High Resolution Transmission Electron Microscopy), NMR (Nuclear Magnetic Resonance) Spectroscopy AFM (Atomic Force Microscopy), MALDI-ToF, Confocal Raman Spectroscopy, Femtosecond Pump-Probe Spectroscopy, Various Device Fabrication Facilities.

रसायन विज्ञान तथा प्रौद्योगिकी प्रभाग

रासायनकि वज्ञिान और प्रौद्योगकिी प्रभाग वभिन्नि उपकरण प्लेटफॉर्म और प्रोटोटाइप में अणुओं के कार्यात्मक सामग्रियों और उनके अनुप्रयोग के वकिास पर ध्यान केंद्रति कर रहा है। संस्थान के तीन प्राथमकिता वाले क्षेत्रों को प्रभाग द्वारा समन्वति कयिा जाता है - (1) कार्बनकि और संकर इलेक्ट्रॉनक्सि (ऊर्जा उत्पादन और भंडारण, क्रोमोजेनकि कोटगि्स, ठोस राज्य प्रकाश व्यवस्था, कम्प्यूटेशनल रसायन वज्ञिान); (2) फ्लोरोसेंट सामग्री (सुरक्षा अनुप्रयोगों, नदिान और इमेजगि जांच और अल्ट्राफास्ट कैनेटीक्स); (3) फाइटोकेमकिल्स और ड्रग इंटरमीडएिट (औषधीय पौधों और उन्नत दवा मध्यवर्ती का जैव मूल्यांकन)। डवीिजन संस्थान स्तर पर सी एस आई आर की वभिन्नि वषियगत गतविधियिों जैसे ऊर्जा (पारंपरकि और गैर-पारंपरकि) सामग्री और उपकरण, हेल्थकेयर और रसायन का नेतृत्व करता है। इसके अलावा, प्रभाग दो सीएसआईआर मशिन मोड परयिोजनाओं में एक प्रमुख भागीदार रहा है - (1) स्वास्थ्य देखभाल अनुप्रयोगों और (2) न्यूट्रास्युटकिल्स मशिन के लिए नैनोबायोजर्स और माइक्रोफ्लुइडक्सि। प्रभाग ने वभिन्नि सरकारी एजेंसयिों और उद्योगों द्वारा वत्तिपोषति बड़ी संख्या में महत्वपूर्ण परयिोजनाएं भी शुरू की हैं। वभिन्नि प्रौद्योगकिी वकिास के अलावा, प्रभाग ज्ञान सृजन में भी बहुत सक्रयि है क्योंकि उच्च प्रभाव वाले कारक 2019-20 के साथ अंतरराष्ट्रीय स्तर पर प्रतष्ठिति पीयर-समीक्षा वाली पत्रकिाओं में 100 प्रकाशनों से इसका सबूत है। वभिाजन ने इस अवधि के दौरान बड़ी संख्या में पेटेंट भी दायर कयि हैं। वर्ष 2019-20 के दौरान डवीिजन की गतविधियिों और उपलब्धियिों पर प्रकाश डाला गया है, साथ ही महत्वपूर्ण घटनाक्रमों के संक्षप्ति सार नीचे दयि गए हैं।

हाइलाइट

- लाइसेंस समझौते पर ह्यू ब्राइट कलर्स प्रा। लमिटिड, बैंगलोर को 25 फ्लोरोसेंट + जीएसटी और 2% रॉयल्टी की राशि के लिए नौ फ्लोरोसेंट अणुओं और इसी वर्णक के संश्लेषण को स्थानांतरति करने के लिए।
- एलक्सिरि टेक्नोलॉजीज के साथ लाइसेंस समझौते पर हस्ताक्षर डीएसएससी मॉड्यूल के लिए उपकरण डजिाइन और नरि्माण के ज्ञान-हस्तांतरण को स्थानांतरति करने के लिए रुपये की राशि के लिए। जीएसटी सहति 5 लाख।
- संवेदन और सुरक्षा अनुप्रयोगों के लिए स्व-इकट्ठे फ्लोरोसेंट led self सस्टिम का वकिास।
- प्रतविर्ती एक्सफोलएिशन और नयिंत्रति जीवाणु वृद्धि के लिए आयनकि सहसंयोजक कार्बनकि नैनोशीट में सुपरमॉलेक्युलर सतह चार्ज वनियिमन।
- ब्लू-एमटिगि फ्यूज्ड हेटेरोसायकल-आधारति रंगों के वकिास के लिए उपन्यास सथिटकि मार्ग।
- चरिल अतथि मान्यता के लिए तर्कसंगत रूप से डज़िाइन कए गए बाध्यकारी साइटों के साथ पेचदार सुपरमॉलेरकिल पॉलमिर का वकिास।
- फलि्म नरि्माण, आकारकी, परविहन गुणों, फोटोफजिक्सि और सथिटकि वर्सेटाइल डीपीपी - आधारति सुपरमॉलेरकिल पॉलमिर के इलेक्ट्रॉनकि प्रोफाइल पर जोड़ तोड़ नयिंत्रण का प्रदर्शन कयि
- हाइब्रडि A3Bi2I9 प्रकार के पर्कोव्साइट जैसी सामग्री में ढांकता हुआ कारावास को नयिंत्रति करना (A एक कार्बनकि सीसी है)
- अल्ट्राफास्ट हेम छूट गतकिी का अध्ययन लपिोसोम द्वारा प्रेरति साइटोक्रोम के अनफोल्डेड स्टेट्स की जांच करके कयि गया है
- नए फाइटोकेमकिल संस्थाओं द्वारा माइटोकॉन्ड्रयिा-मध्यस्थता वाले आंतरकि एपोप्टोससि की खोज करके फेफड़े और मेलेनोमा कैंसर कोशकिाओं पर साइकोक्रोम गतशिीलता
- मेटास्टैटकि मेलेनोमा के खलिाफ एसईआरएस - नरि्देशति फोटोकैमोथेरेपी के लिए एक लक्षति तीन-इन-वन-थेरानटिकिानोएनल्यूपूले के रूप में बायोजेनकि क्लस्टर-एनकॉन्ड गोल्ड नैनोरोड्स
- फ्लुओसेन्ट सलि्वर नैनोकल की असेंबली के लिए अनुक्रम प्रोग्राम डीएनए थ्री-वे जंक्शन
- अत्यधकि कुशल अत्यधकि कुशल लुमनिसिंट सौर संकेंद्रक के लिए उपन्यास रंजक का डजिाइन और वकिास
- जहरीले धातु आयनों के कोलीमेट्रकि का पता लगाने के लिए स्मार्टफ़ोन आधारति प्रणाली
- स्वचालति ऑनसाइट परीक्षण अनुप्रयोगों के लिए कम लागत वाले रमन स्पेक्ट्रोमीटर का वकिास
- डाई-सेंसटिाइज़्ड सौर कोशकिाओं के लिए वकिसति ट्रपिल बॉन्ड ने एन्थ्रेसीन-ट्राइफेनलिेमाइन सेंसटिाइज़र को कठोर बनाया
- डी-ए---वभिन्नि दाता और स्वीकर्ता और डाई-संवेदीकृत सौर कोशकिाओं पर इसके प्रभाव के साथ सायनोपायरडिीन डाई
- फ्लोरोसेंट ऑर्गेनकि लाइट-एमटिगि डायोड्स में एक्साइटोनकि से एक्जमिर एमशिन में रविर्सबिल शफि्ट का उपयोग करके कलर ट्यूनगि की संभावनाएं
- स्परिोज़ैरडिनि का डायस्टेरोसलेक्टवि सथिेससि

Chemical Sciences and Technology Division

The Chemical Sciences and Technology Division has been focusing on the development of molecules and functional materials and their application in various device platforms and prototypes. Three priority areas of the Institute are coordinated by the Division – (1) Organic and Hybrid Electronics (Energy generation and storage, chromogenic coatings, solid state lighting, computational chemistry); (2) Fluorescent Materials (Security applications, diagnostics and imaging probes and ultrafast kinetics); (3) Phytochemicals and Drug Intermediates (Bio-evaluation of medicinal plants and advanced pharmaceutical intermediates). The Division leads various thematic activities of CSIR at the institute level, such as Energy (conventional and non-conventional) Materials and Devices, Healthcare and Chemicals. In addition, the division has been a major participant in two CSIR Mission Mode projects – (1) Nanobiosensors and microfluidics for healthcare applications and (2) Nutraceuticals Mission. The Division has also undertaken a large number of important projects funded by various government agencies and industries. In addition to various technology development, division is also very active in knowledge generation as evidenced from 73 publications in internationally reputed peer-reviewed journals with high impact factor in 2019-20. The division has also filed a large number of patents during this period. The highlights of the activities and achievements of the Division during the year 2019-20 along with brief abstracts of important developments are given below

Highlights

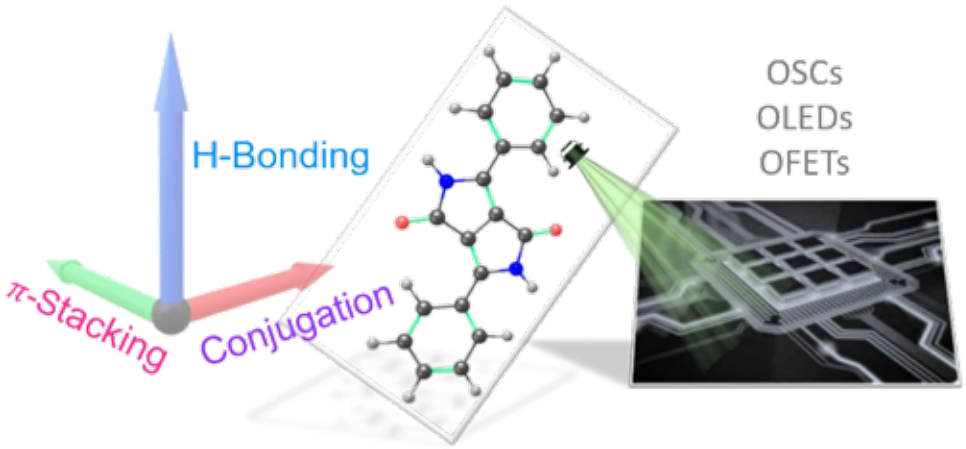
- License agreement signed with HueBright Colors Pvt Ltd, Bangalore for transferring the synthesis know-how of nine fluorescent molecules and corresponding pigments for a sum of 25 Lakhs + GST and 2% Royalty.
- License agreement signed with Elixir Technologies for transferring the know-how of equipment design and fabrication for DSSC modules for a sum of Rs 5 lakhs including GST.
- Development of self-assembled fluorescent π-systems for sensing and security applications.
- Supramolecular surface charge regulation in ionic covalent organic nanosheets for reversible exfoliation and controlled bacterial growth.
- Novel synthetic route for the development of blue-emitting fused heterocycle-based dyes.
- Development of helical supramolecular polymers with rationally designed binding sites for chiral guest recognition.
- Demonstrated the manipulative control over film formation, morphology, transport properties, photophysics and electronic profile of synthetically versatile DPP-based supramolecular polymers.
- Controlling the dielectric confinement in in hybrid A3Bi2I9 type perovskite-like material(A is an organic cation).
- Ultrafast heme relaxation dynamics studied by probing the Unfolded States of cytochrome c induced by liposomes.
- Cytochrome c dynamics on lung and melanoma cancer Cells studied by exploring mitochondria-mediated intrinsic apoptosis by new phytochemical entities.
- Biogenic cluster-encased gold nanorods as a targeted three-in-one theranostic nanoenvelope for SERS-guided photochemotherapy against metastatic melanoma.
- Sequence Programmed DNA Three-Way Junctions

for Templated Assembly of Fluorescent Silver Nanoclusters.

- Design and development of novel Dyes for Highly Efficient Luminescent Solar Concentrators.
- Smartphone based system for the colourimetric detection of toxic metal ions.
- Development of low-cost handheld Raman Spectrometer for automated onsite testing applications.
- Triple bond rigidified anthracene-triphenylamine sensitizers developed for dye-sensitized solar cells.
- D–A–π–A based cyanopyridine dyes with varied donor and acceptors and its effect on dye-sensitized solar cells.
- Demonstrated colour tuning possibilities using reversible Shift from Excitonic to Excimer Emission in Fluorescent Organic Light-Emitting Diodes.
- Diastereoselective synthesis of Spiroaziridines.

Organic and Hybrid Electronics

Diketopyrrolopyrrole-based Functional Supramolecular Polymers: Next Generation Materials for Optoelectronic Applications

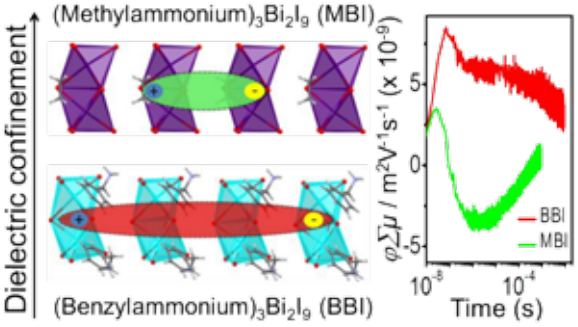


Simultaneous with the advancement in the supramolecular chemistry of π-conjugated systems and the devulgent evolution of organic semiconductor materials, several dyes and pigments have emerged as potential candidates for contemporary optoelectronic devices. Out of all the major pigments, diketopyrrolopyrrole (DPP) better known as the "Ferrari Pigment" and its derivatives have emerged as a major class of organic functional dyes that find varied applications in fields such as industrial pigments, organic solar cells, organic field effect transistors and in bioimaging. Supramolecular self-assembly of DPP-based small molecules and oligomers have offered a new paradigm for the realization of optoelectronic devices with enhanced performance. The manipulative control over film formation, morphology, transport properties, photophysics and electronic profile of synthetically versatile DPP-based supramolecular polymers amalgamated with complaisant device architecture has made these self-assembled soft materials highly attractive for semiconductor applications. Supramolecular self-assembly offers an alternative strategy for the realization of semiconductor materials with fine-tuned properties without the need for extensive chemical modifications in the structural

backbone of monomers and oligomers (*Mater. Today* Chem. **2020,** 16**, 100242,** *Invited Article*).

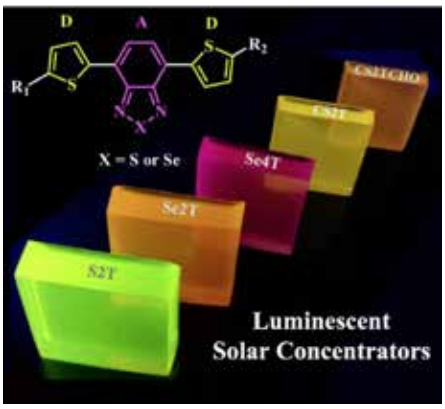
Dielectric Confinement and Photoconductivity in Bismuth based Zero-Dimensional Perovskite Material.

Bismuth based perovskite-like materials are considered as promising alternate for lead based perovskites for optoelectronic applications. However, the major drawbacks of these materials are high exciton binding energy and poor charge carrier separation efficiency. These issues are attributed to the strong quantum and dielectric confinements associated with these materials. In this work, we have used a simple methodology to reduce the dielectric confinement in hybrid A3Bi2I9 type perovskite-like material (A is an organic cation) to improve the charge carrier separation efficiency. For that, the electronically inert methyl ammonium (MA) was replaced with a polarizable benzylammonium (BA) cation in the well-studied MA3Bi2I9 (MBI) structure. The single crystal XRD and UV-vis absorption



spectroscopy analysis suggested similar quantum confinement in both (BA)3Bi2I9 (BBI) and MBI materials. This enabled us to precisely investigate the role of polarizable benzylammonium cations on the dielectric confinement in BBI. Flash-photolysis time-resolved microwave conductivity study revealed about 2.5 fold enhancement of φΣμ (the product of charge carrier generation quantum yield and the sum of charge carrier mobilities) for BBI when compared to that of MBI, which is attributed to the low dielectric confinement in the former (Chem. Mater. 2020, 32, 2647-2652).

Large Stokes' Shifts Engineered Dyes for Highly Efficient Luminescent Solar Concentrators.



Building-integrated phototovoltaics (BIPV) is an emerging area of technology having huge potential for meeting energy demand in urban settings where the roof-top installations are insufficient. Compared to other solar cell techniques, luminescence solar concentrators (LSC) are promising candidates for BIPV, due to their low cost, aesthetics, and ease of integration to building facades. The heart of these devices is a fluorescent material embedded in a high refractive index transparent matrix wherein the absorbed radiations are down converted and directed towards the edges and a thin solar cell convert this radiation to electricity. Herein we have developed a few π-conjugated donor-acceptor (D-A) systems. Their basic motif is a benzothiadiazole unit symmetrically equipped with two thiophene rings (S2T), its variant where sulfur is replaced by selenium (Se2T), extended four thiophene framework (Se4T), system with N-carbazole donor moiety at one end (CS2T) stronger and (ii) a D'-D-A-D system having a and a D'-D-AD-A' array with a further acceptor carbonyl unit at the other extremity (CS2TCHO). The rationale of the design was to engineer the system with large Stokes' shifts and high fluorescence quantum yield thereby reducing energy losses and improve the overall performance. All of them exhibit intense absorption spectra in the UV-VIS region down to 630 nm, which are fully rationalized by DFT. Emission properties have been studied in CH_2Cl_2 (298 and 77 K) as well as in PMMA and PDMS matrices, measuring photoluminescence quantum yields (up to

98%) and other key optical parameters. The dye-PMMA systems show performances comparable to the present state-of-the-art, in terms of optical and external quantum efficiencies (OQE = 47.6% and EQE = 31.3%, respectively) and flux gain (F = 10.3), with geometric gain close to 90. LSC devices in which the five emitters are embedded in PDMS and their waveguided VIS luminescence feeds amorphous silicon cells have been fabricated and tested. (*Chem. Eur. J.* **2020**, 10.1002/chem.202001210).

Triple Bond Rigidified Anthracene-triphenylamine Sensitizers for Dye-sensitized Solar cells.

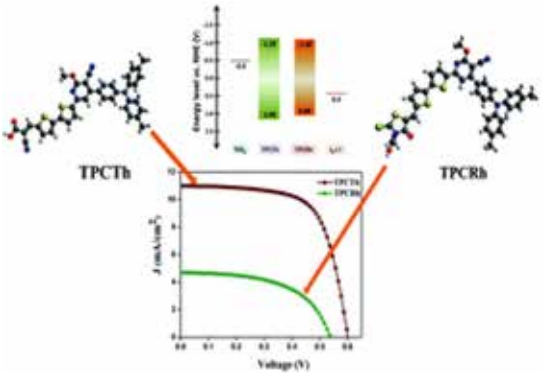
Two anthracene bridged triphenylamine sensitizers TPAA6 and TPAA7 were designed, synthesized and used as potential candidates for dye-sensitized solar cells. Investigations on structure-property relationship, photophysical, electrochemical and device dynamics were explored in detail. Absorption spectra revealed that both the dyes are capable of harvesting light up to 600 nm with properly positioned ground and excited states for efficient electron injection and regeneration. The current density-voltage (*J-V*) characteristics under one sun illumination revealed a power conversion efficiency of 3.56±0.05% for TPAA6 and 4.38±0.1% for TPAA7. IPCE plots were in accordance with the *J-V* data.

Interfacial charge transfer properties of both the dyes were studied employing open circuit voltage decay, charge extraction and detailed impedance spectroscopic analysis. The presence of anthracene units grafted through rigidified triple bond linkages helped TPAA7 in achieving better light harvesting capabilities compared to TPAA6 leading to an improved short circuit current density as clearly supported by the IPCE spectra particularly at higher wavelengths. Additionally, the propeller shaped architecture helped in preventing aggregation for both dyes on TiO_2 surface which helped in eliminating the use of co-adsorbents like CDCA. Even though both dyes were structurally different, it didn't contribute much towards any shift in conduction band. The presence of anthracene units in the periphery helped TPAA7 in efficiently preventing the approach of the oxidized species in electrolyte to come closer to the semiconductor thereby preventing recombination, resulting in better lifetime and open circuit potential for TPAA7. We do strongly believe that both these dyes could serve as potential candidates to be employed with alternative redox electrolytes for indoor light harvesting applications (*Solar Energy*, **2019,** *188*, 55-65).

Variation of the Donor and Acceptor in D–A–π–A Based Cyanopyridine Dyes and its effect on Dye-sensitized solar cells.

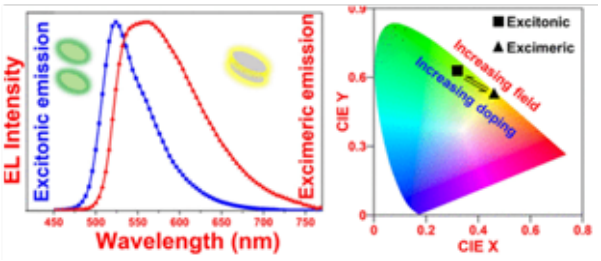
Two metal free organic dyes (TPCTh and TPCRh) with D–A–π–A configuration, having 3-cyanopyridine as an auxiliary acceptor and thiophene p-linkers along with a triphenylamine donor and cyanoacetic acid/rhodanine-3-acetic acid anchoring groups, were successfully synthesized and utilized as sensitizers in the fabrication of dye-sensitized solar cells (DSSCs). The opto-electronic properties of TPCTh and TPCRh were compared with the model sensitizer CCTh having carbazole as the donor and cyanoacetic acid as the anchoring group. Both the dyes showed red shifted absorption spectra compared to the standard CCTh dye. Also, TPCRh showed a broader absorption spectrum with a reduced band gap compared to TPCTh. However, theoretical studies indicate that the unavailability of excited state conjugation over the anchoring group could lead to restricted charge injection for the TPCRh dye, whereas the TPCTh dye exhibits complete conjugation over the entire molecule. The photovoltaic performance of the TPCTh dye was found to be better compared with the standard CCTh sensitizer as a result of better absorption contributed by the lower band gap in TPCTh leading to improved photon-light conversion and thus an improved Jsc of 11 mA/cm^2 over the 7.12 mA/cm^2 of CCTh. In addition, lifetime

measurements corroborated a lower electron lifetime for TPCRh compared to TPCTh and CCTh (*New J. Chem.*, **2019**, 43, 15673).



Reversible Shift from Excitonic to Excimer Emission in Fluorescent Organic Light-Emitting Diodes: Dependence on Deposition Parameters and Electrical Bias.

Organic light-emitting diodes (OLEDs), in general, require multilayer devices and microcavity structures for emission tuning, which increases the complexity and cost of production. Hence, it is imperative to develop techniques for spectral tuning, which employ simplified device structures. In this study, we have selected a tris(8-hydroxyquinolinato)aluminum (Alq3): 10-(2-benzothiazolyl)-2,3,6,7-tetrahydro-1,1,7,7-tetramethyl-1H,5H,11H-(1)benzopyropyrano (6,7-8-i,j)quinolizin-11-one (C545T)-based OLED and investigated the dependence of the OLED emission on various deposition parameters and the electrical bias. The concentration of the dopant in the emissive layer (EML) was varied from 3 to 50%, and the single dopant emitter as a limiting case was also studied along with studies on the varied deposition rates and EML thickness. By varying the deposition parameters, the emission was observed to change from excitonic green to excimeric yellow. With increased doping concentration, reduction in pure exciton emission with an increase in excimer emission was observed, resulting in electroluminescent spectral red shift. Similarly, electroluminescence spectra have shown different levels of broadening, depending on the deposition rate and thickness of the EML. These effects could be reversed with increasing applied electric field. Thus, it is indicated that, by suitably optimizing the deposition parameters of the dopant material, spectral tuning can easily be obtained, which may form the basis of simplified and cost-effective device structures (*ACS Omega* 2020, *5,* 1698–1707).

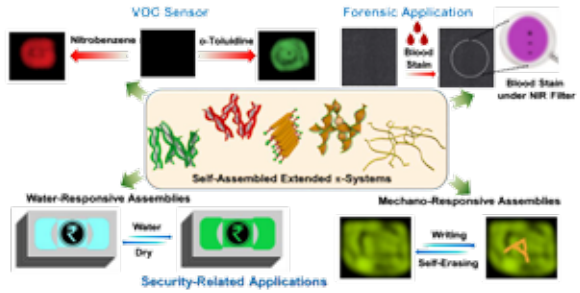


Fluorescent Materials

Self-Assembled Extended π–Systems for Sensing and Security Applications.

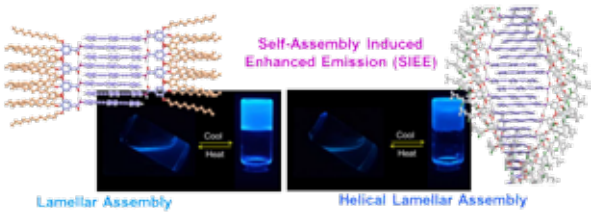
Molecules and materials derived from self- assembled extended π-systems have strong and reversible optical properties, which can be modulated with external stimuli such as temperature, mechanical stress, ions, the polarity of the medium, and so on. In many cases, absorption and emission responses of self-assembled supramolecular π-systems are manifested several times higher when compared with the individual molecular building blocks. These properties of molecular assemblies encourage scientists to have a deeper understanding of their design to explore them for suitable optoelectronic applications. Therefore, it is important to bring in highly responsive optical features in π-systems, for which it is necessary to modify their structures by varying the conjugation length and by introducing donor–acceptor functional groups. Using noncovalent forces, π- systems can be put together to form assemblies of different shapes and sizes with varied optical band gaps through controlling intermolecular electronic interactions. In addition, using directional forces, it is possible to bring anisotropy to the self-assembled nanostructures, facilitating efficient exciton migration, resulting in the modulation of optical and electron-transport properties. In this Account, we mainly summarize our findings with optically tunable self-assemblies of extended π-systems such as *p*-phenylenevinylenes (PVs), *p*-phenyleneethynylenes (PEs), and diketopyrrolopyrroles (DPPs) as different

stimuli-responsive platforms to develop sensors and security materials. These selected examples of the π-system self-assemblies provide an idea of the current status and future opportunities for scientists interested in this field of self- assembly (*Acc. Chem. Res.* 2020, *53*, 496–507).



Enhanced Emission in Self-Assembled Phenyleneethynylene Derived π-Gelators.

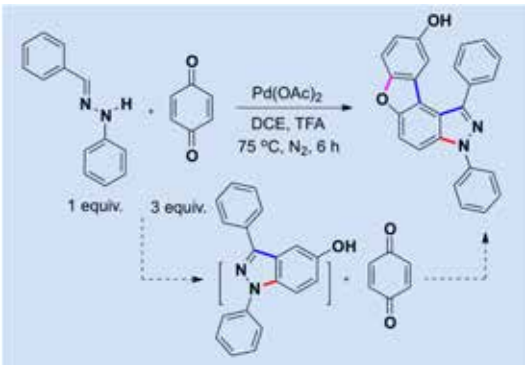
Optical properties of π-systems are of great significance for a wide range of applications in materials and biology. Aggregation and self-assembly induced emission are one of such phenomena. In this work, we report the self-assembly induced modulation of the emission of p-phenyleneethynylene chromophores bearing linear achiral (PE-1) or branched chiral (PE-2) alkoxy chains. Self-assembled structures of both PE-1 and PE-2 from n-decane exhibit enhanced emission with fluorescence quantum yield (ΦF) values of 0.34 and 0.25, respectively, whereas these molecules are less-emissive



in chloroform (Φ_F = 0.02). Transmission electron microscopy and fluorescence microscopy studies reveal the formation of entangled blue-emissive fibers for PE-1 and supercoiled helical blue-emissive fiber bundles for PE-2. At higher concentrations (8.8 mM for PE-1 and 23.6 mM for PE-2) in *n*-decane, intense blue-emitting gels are formed. Significant shift in the emission towards longer wavelength can be seen from solution state to aggregates to the gel state. The wide-angle X-ray scattering and fluorescence data indicate interdigitated lamellar assembly with weaker π-stacking and the resultant restricted rotation of the PE chromophores are responsible for the enhanced emission of the self-assembled gel state (*Adv. Opt. Mater.* 2020, *8*, DOI: 10.1002/adom.202000173. (Part of special issue on 20 years of aggregation-induced emission research).

Synthesis of Hybrid Polycycles Containing Fused Hydroxy Benzofuran and 1H-Indazoles via a Domino Cyclization Reaction.

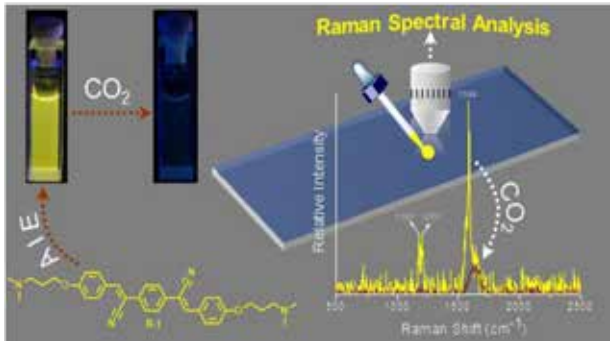
A stoichiometry controlled domino cyclization reaction of hydrazone and *p*-benzoquinone to an angularly fused 3*H*-benzofuro[3,2-*e*]indazole core with an embedded oxygenated dibenzofuran framework under mild reaction conditions is disclosed. The reaction involves palladium catalyzed 5-hydroxy-1*H*-indazole formation followed by trifluoroacetic acid (TFA) mediated [3+2] annulation between the *in situ* formed 5-hydroxy-1*H*-indazole and *p*-benzoquinone. The developed method is attractive because of the concomitant formation of two heterocyclic rings with consecutive multiple bond forming events that include two C–C, one C–N and one C–O bonds. Spectroscopic and theoretical studies of the blue emissive benzofuroindazole derivatives have also been described (*New J. Chem.* 2019, *43*, 10166–10175).



Bimodal Detection of Carbon Dioxide Using Fluorescent Molecular Aggregates.

Owing to the critical role played by CO_2 in environment and health issues, its sensing, storage, and controlled

release are serious challenges to chemists. The analyte-triggered self- assembly or disassembly of self-assembled materials can offer an excellent choice for monitoring the capture and release of CO_2. Furthermore, the introduction of additional sensing modality can increase the sensitivity of the probe. In this context, aggregation-enhanced Raman scattering (AERS) can be exploited as an additional modality for the sensing of analytes, which has an advantage over the hitherto reported single-modality sensors. The aggregation induced emission (AIE) property of the π-conjugated systems and the chemistry of CO_2 with a tertiary amine in an aqueous medium offer an excellent combination to design such sensors. Using this idea, a cyano-substituted phenylenevinylene molecule with terminal tertiary amine moieties (R-1) has been designed and synthesized. This AIE active molecule formed aggregates ($R\text{-}1_{agg}$) in an aqueous medium, as inferred from the changes in the UV-vis absorption spectrum and the Tyndall effect. Dynamic light scattering studies indicated that $R\text{-}1_{agg}$ gets protonated in the presence of CO_2 gas in an aqueous medium, and the larger aggregates of R-1 were converted into a mixture of monomers and smaller aggregates having positively charged R-1. Similarly, upon purging with CO_2 (0.33 mL) a red shift in the sharp absorption band of $R\text{-}1_{Agg}$ at 348 to 364 nm and a 25-fold reduction in the yellow fluorescence of $R\text{-}1_{Agg}$ were observed. Furthermore, aggregation property of R-1 was also explored for AERS as an additional modality for sensing the CO_2. The sample examined after purging the aggregate solution with the CO_2 showed a reduction in the intensity of Raman-active peaks of $R\text{-}1_{Agg}$ to almost baseline, corroborating the usability of this method for the fast and easy detection of CO_2. This sensor system has also been used to monitor the variation of the external CO_2 concentration inside lung adenocarcinoma A549 cells (*Chem. Commun.* 2019, *55*, 6046–6049).



Functional Supramolecular Materials

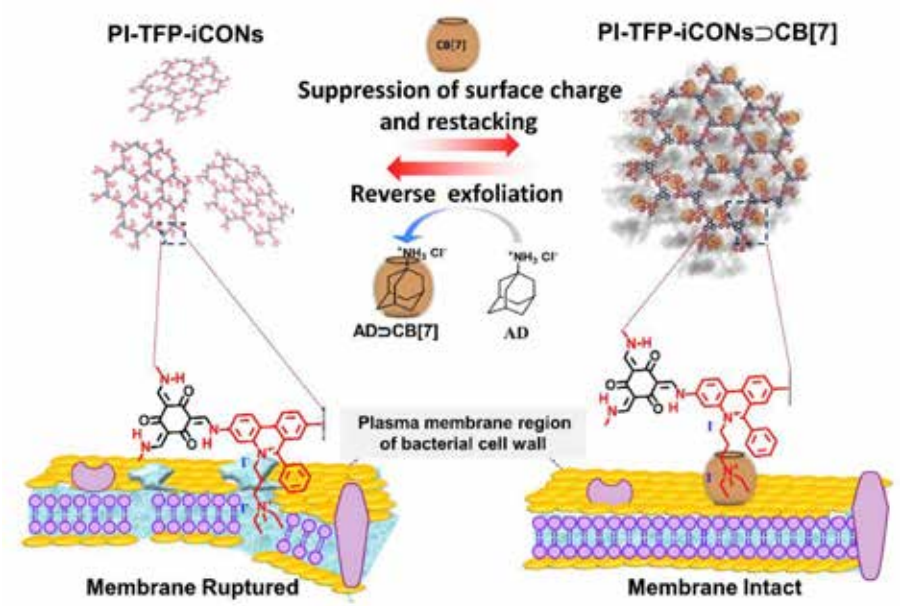
Controlling the Supramolecular Polymerization of Donor-Acceptor π-Systems through Hydrogen Bond Intervention.

Supramolecular polymerization of donor-acceptor type molecules leads to mixed or self-sorted assemblies depending on the donor-acceptor strength and extent of noncovalent interactions between the components. In this work, we discuss how competing hydrogen bonding motifs control the supramolecular polymerization pathway of a two-component molecular π-system of oligo(*p*-phenylenevinylene) (OPV-B and OPV-P) donors and perylene bisimide (PBI-B and PBI-A) acceptors. It is shown that among the four different binary combinations (M1–M4) studied, the carboxylic acid/pyridine heterosystem (1:2 molar ratio) in M4 favors the coassembled donor-acceptor stacks with a distinct morphology, whose aggregation pathways in toluene/THF (9/1 v/v) is different from that of the individual components. The nanoscopic molecular arrangement of

OPV-P driven by PBI-A in M4 was found to influence the bulk properties such as, morphology, thermomechanical stability and electrical conductivity. For example, the G' and G" values of M4 is an order of the magnitude higher and exhibited a four-probe electrical conductivity (11.93 Scm^{-1}) higher than that of its individual components. Thus, hydrogen-bond intervention is a powerful strategy to control the supramolecular polymerization of two-component donor-acceptor π-systems. (*ChemPlusChem* 2019, *84*, 1405–1412. (Part of special issue on πConjugated (macro) molecules and their applications supramolecular chemistry, highlighted with a cover page).

Supramolecular Surface Charge Regulation in Ionic Covalent Organic Nanosheets: Reversible Exfoliation and Controlled Bacterial Growth.

Poor control on the exfoliation of covalent organic frameworks (COFs) remains a disadvantage for their application as two-dimensional nanosheets. An equally important problem is the reversible control at the available surface charges on COFs. In this work, a strategy for the reversible exfoliation, re-stacking, and surface-charge control of a propidium iodide based ionic covalent organic framework, PI-

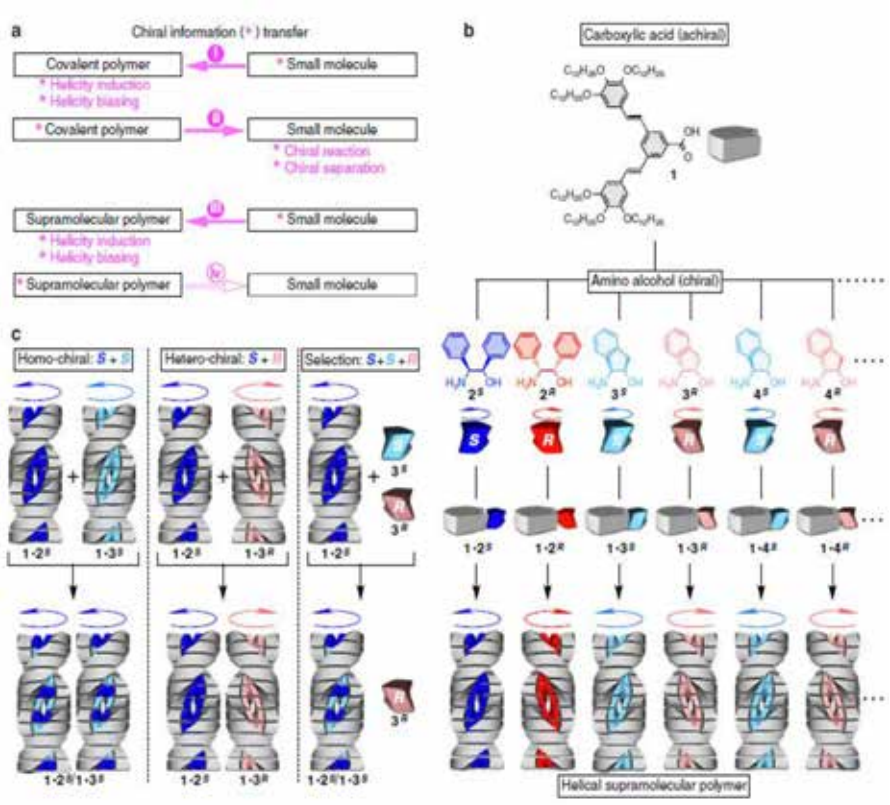


TFP, using cucurbit [7]uril (CB [7]) induced molecular recognition, is reported. The surface charge on PI-TFP facilitates its initial self-exfoliation. However, complexation with CB[7] resulted in re-stacking with concomitant decrease in zeta potential from +28±3.0 to +0.004 ±0.003 mV. Addition of 1-adamantylamine hydrochloride (AD) facilitates decomplexation of PI-TFP from CB[7], resulting in exfoliation and an increase in re-stacking, and the associated regulation of the surface charge zeta potential to +24 ±3.0 mV. Such control on the exfoliation, in PI-TFP was exploited for controlling bacterial growth. Thus, the activity of *E. coli* and *S. aureus* bacteria obtained with the self-exfoliated PI-TFP could be reversibly controlled by the the CB [7]/AD pair. (*Angew. Chem., Int. Ed.* 2020, *59*, 8713-8719, VIP Article).

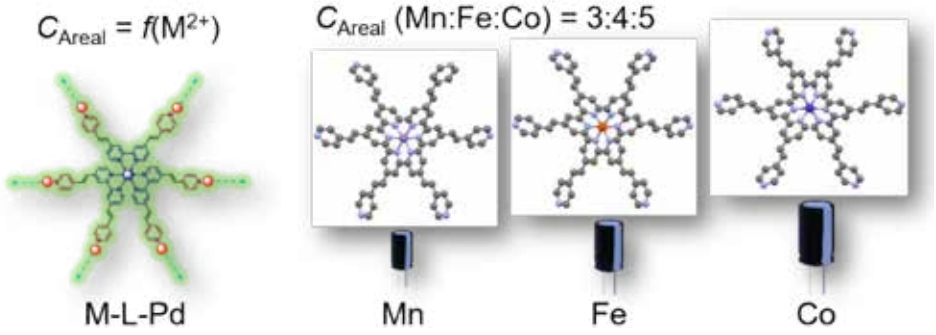
Helical Supramolecular Polymers with Rationally Designed Binding Sites for Chiral Guest Recognition.

Since various helical supramolecular polymers became available, their application to molecular chirality recognition have been anticipated but not extensively studied. So far, only a few examples of chiral reactions have been reported, but none for chiral separation.

In this work, we report the application of a helical supramolecular polymer to the enantio-separation of chiral guest molecules. The monomer of this supramolecular polymer is the salt-pair of a dendritic carboxylic acid with an enantiopure amino alcohol. In an apolar solvent, this salt-pair stacks *via* hydrogen bonds to form a helical polymer. In conjunction with this carboxylic acid, various amino alcohols afford supramolecular polymers, whose helical handedness is determined by the stereochemistry of the amino alcohols. When two salts with the same chirality are mixed, they undergo copolymerization, while those with opposite chirality do not. Owing to this stereoselective copolymerizability, the helical supramolecular polymer could bias the enantiomeric composition of chiral amino alcohols (*Nature Communication* 2020, *11*, 2311).



Metal Ion Induced Capacitance Modulation in Near-Isostructural Complexes Derived Electrochromic Coordination Polymer.

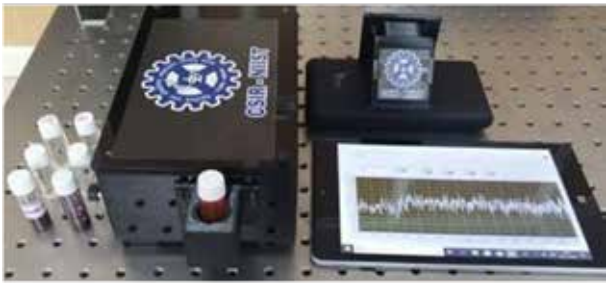


Coordination Polymers obtained from near-isostructural metal bipyridine complexes were used as electrode materials in a symmetric supercapacitor test cell. The variation in the central metal ion (Mn^{2+} vs Fe^{2+} vs Co^{2+}) in these nearly identical coordination complexes was found to dictate the capacitive performance of the coordination polymers obtained via Pd(II) cross-linking. The central metal ion not only influences the porosity, BET surface area (6.5 (Mn), 10.4 (Fe) and 29.7 (Co) $m^2 g^{-1}$) and the areal capacitance, but also the performance parameters such as cycling stability and charge discharge kinetics as well as the charge transfer mechanism. A 3:4:5 ratio for the areal capacitance values corroborates the modulative effect of the metal center. The cycling stabilities of these coordination polymers also followed the same order (*Mater. Today Chem.* 2020, *16*, 100260, Invited Article).

Diagnostics

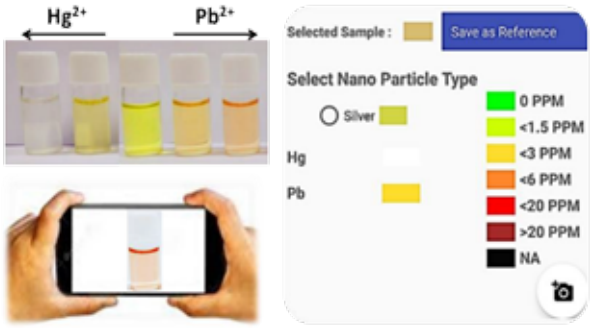
Low-Cost Handheld Raman Spectrometer for Automated Onsite Testing Applications.

Easy analysis of materials for their chemical identity and composition is one of the highly demanding technological problems impacting the day to day activities of human life and many industries. For example, to effectively seize and prevent adulteration and fraudulent activities in drug, food and consumer products require fast and onsite screening of them with respect to the chemicals present and their quantity. In the case of diseases, easy and accurate determination of biomarkers and pathogens can help in providing apt therapeutics in time and thereby saving many lives. Presently, these activities rely on various highly sophisticated and costly equipments. In addition to this, requirement for highly trained professionals, elaborate processes for chemical analysis are both time and resource consuming. Thus, for many of the point of care and onsite analysis requirements it is desirable to have a portable device which is easy to operate and capable of giving instantaneous online results. Raman spectroscopy, which is based on Raman effect, being a light scattering based technique has the advantages of non-destructiveness, ability to analyse samples in their native state. CSIR-NIIST have created a handheld Raman spectrometer which can cater to the need of the point of care testing and diagnostic applications. The hardware features of the device are designed in such a way that it is cost effective, portable, battery operable and highly adaptable. The equipment is equipped with software features for online data processing, analysis and provide rapid Yes or No outputs. Thus, any common person with little knowledge in instruments or data analysis can operate the instrument and get the results in few seconds. Some of the applications that are currently being investigated at the institute are detection of adulteration in edible oil, alcoholic spirits, pharmaceutical products and disease diagnosis.



Enabling Smartphone for the Colourimetric Detection of Toxic Metal Ions.

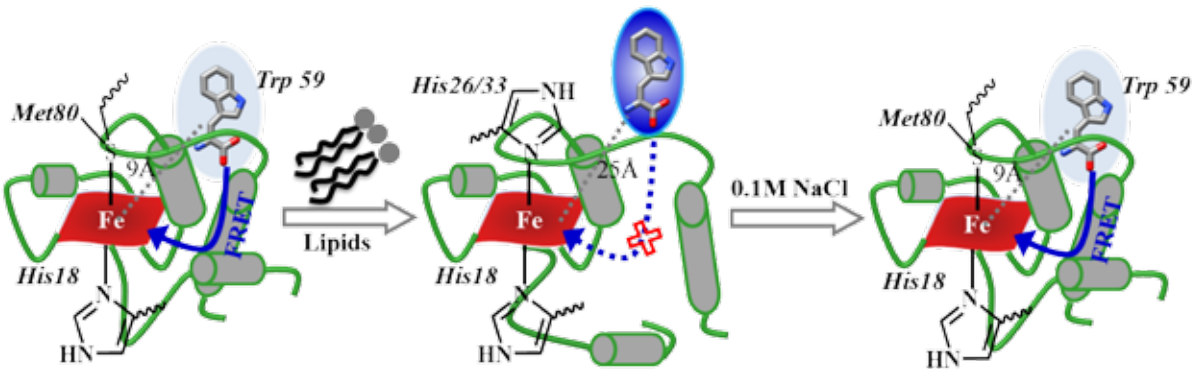
Mercury and lead are the two most toxic heavy metals toxic that pollute aquatic bodies posing serious environmental issue including life-threatening danger to living beings. Presently, their detection relies on sophisticated and costly equipment and there exists an unmet global need for developing portable and cost-effective devices. Herein, we have developed a silver nanoparticle based system exhibiting high selectivity and distinct spectrophotometric behaviour towards these



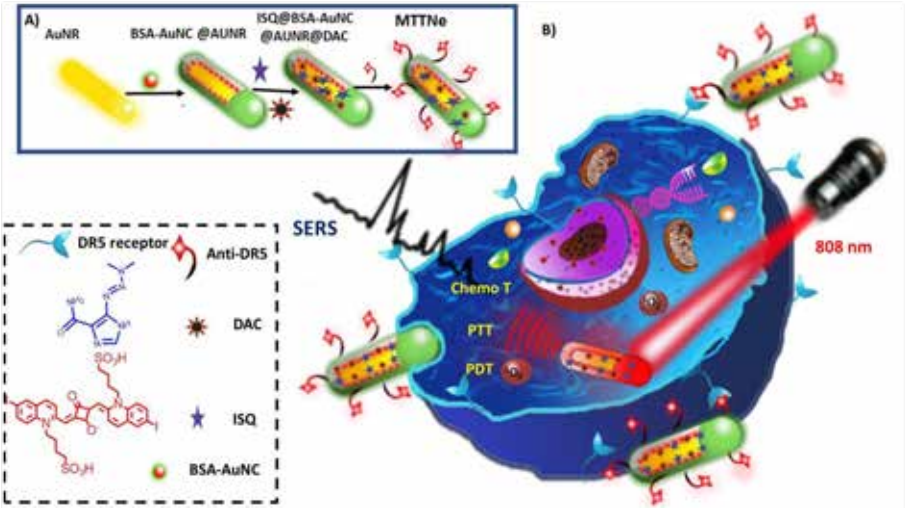
metal ions in the aqueous medium. Precisely, Mercury caused fading of the colour of the nanoparticle solution while the presence of lead induced a colour change from yellow to red. These colour changes are found to fall well within the spectral responses of R, G and B filters of the digital camera which is present in smartphones. By taking advantage of this, we developed an android mobile application that can digitize colour values and extract both qualitative and quantitative information. With the presently developed system we obtained lower detection limits of ~ 0.8 ppm for mercury and ~ 1.5 ppm for lead ions and is consistent with the results obtained through conventional spectrophotometric methods. Thus a new combination of smartphone enabled system with AgNPs was desmonstrated for easy discrimination and quantification of these two metal ions from the aqueous medium (*IEEE Sensor J*, 2020, DOI 10.1109/JSEN.2020.2984580).

Ultrafast Heme Relaxation Dynamics Probing the Unfolded States of Cytochrome c Induced by Liposomes: Effect of Charge of Phospholipids.

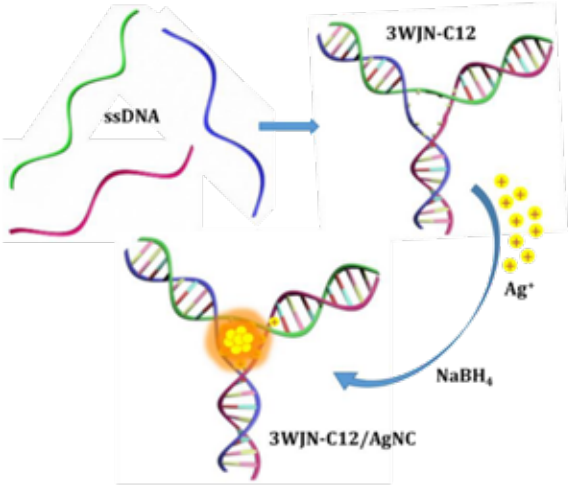
The ubiquitous electron transfer heme protein, Cytochrome c (Cyt c) catalyses the peroxidation of cardiolipin (CL) in the early stage of apoptosis,where Cyt c undergoes conformational changes leading to the partial unfolding of the protein. Here the interaction dynamics of Cyt c with liposomes having different charges [CL: -2, POPG (2-Oleoyl-1-palmitoyl-sn-glycero-3-phospho-rac-(1-glycerol) sodium salt): -1 and POPC (2-Oleoyl-1-palmitoyl-sn-glycero-3-phosphocholine): 0] leading to various degrees of partial unfolding is investigated with steady state optical spectroscopy and femtosecond time resolved pump-probe spectroscopy. The signature of the partial unfolding of the protein was observed in the absorption, fluorescence and CD spectra of Cyt c-liposome complexes with an increase of lipid/protein (L/P) ratio and the protein was refolded by the addition of 0.1 M of NaCl. The femtosecond transient absorption spectra of the complexes were measured by selectively exciting the heme and tryptophan (Trp) at 385 and 280 nm respectively. Though significant changes were not observed in the excited state relaxation dynamics of the heme in liposomes by exciting at 385 nm, the 280 nm excitation exhibited a systematic increase of the excited state relaxation dynamics leading to the increase of lifetime of Trp and global conformational relaxation dynamics with increase of anionic charge of the lipids. This reveals the decrease of efficiency of fluorescence resonance energy transfer from Trp to heme due to the increase of distance between them upon increase of partial unfolding of the proteins by liposomes. Such observation exhibits the Trp as a marker amino acid to reflect the dynamics of partial unfolding of the protein rising from the change in the tertiary structure and axial ligand interaction of the heme proteins in liposomes. The relaxation dynamics of the complexes in the presence of salt are similar to that of the protein alone, reflecting the refolding of the protein and the interactions are dominated by electrostatic interaction rather than the hydrophobic interaction (*J. Phys. Chem. B.*, 2020, 124, 2769–2777).



Biogenic Cluster-Encased Gold Nanorods as a Targeted Three-in-One Theranostic Nanoenvelope for SERS-Guided Photochemotherapy against Metastatic Melanoma.



Effective treatment of malignant melanoma requires an appropriate combination of therapeutic intervention with long-term prognosis as it often survives by monotherapies. Herein, we report a novel melanoma-targeted theranostic nanoenvelope (MTTNe: ISQ@BSA-AuNC@AuNR@DAC@DR5) which has been constructed by assembling a bovine serum albumin (BSA) stabilized gold nanocluster on a gold nanorod (BSA-AuNC@AuNR), a three-in-one theranostic modality, i.e., photothermal therapy (PTT), photodynamic therapy (PDT), and chemotherapy, tethered with a surface-enhanced Raman scattering (SERS) detection technique. The resultant MTTNe was coloaded with the melanoma-specific FDA approved drug dacarbazine (DAC) and a newly synthesized near-infrared (NIR) absorbing squaraine molecule ISQ that served partly as a photosensitizer and multiplex Raman reporter. Finally, a nanoenvelope was anchored with anti-DR5 monoclonal antibodies as a targeting motif for highly expressed melanoma-specific death receptors in malignant cells. Significant phototherapies of MTTNe were initiated upon an 808 nm single laser trigger which showed a synergistic effect of photothermal hyperthermia as well as singlet oxygen ($^1O_2$) driven photodynamic effect in the presence of ISQ followed by on-demand thermoresponsive drug release in the intracellular milieu. Moreover, a multiplex SERS spectral pattern of ISQ (1345 cm−1) and DAC (1269 cm−1) has been utilized for monitoring precise drug release kinetics and target-specific recognition on melanoma cells by Raman imaging. Therapeutic performance of the nanoenvelope was evaluated by in vitro cytotoxicity studies in human melanoma cells (A375) and confirmed the apoptotic phenomenon by molecular-level monitoring of intracellular SERS fingerprints. Finally, to address the biocompatibility of MTTNe, in vivo subacute toxicity was conducted on BALB/c mice. Hence, the current studies mark a footstep of a facile strategy for the treatment of melanoma by synergistic multimodal photothermal/photodynamic/chemotherapy (*ACS Appl. Bio Mater.* 2019, *2*, 1, 588−600).



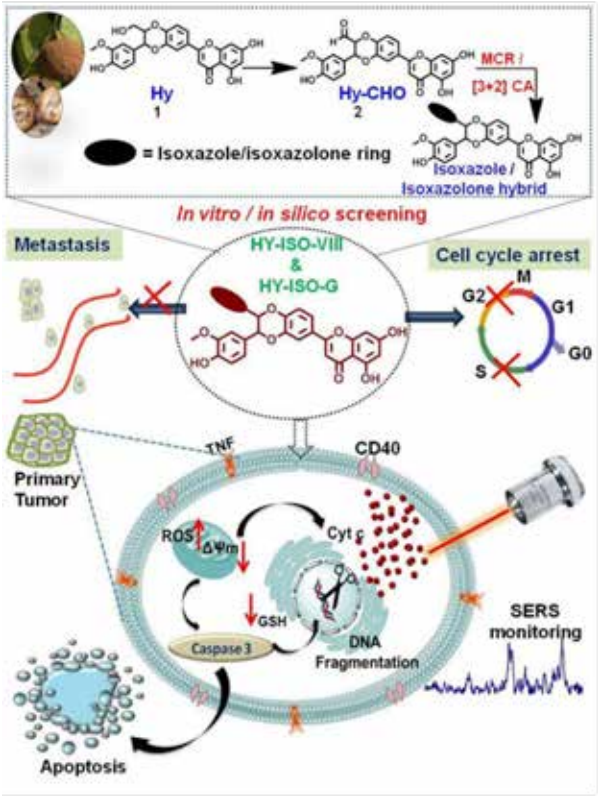
Sequence Programmed DNA Three-Way Junctions for Templated Assembly of Fluorescent Silver Nanoclusters.

Fluorescent silver nanoclusters (AgNCs) templated by DNA are promising label free fluorophores with excellent photostability and tunable optical properties. Most of the reported DNA-nanocluster fluorescent tags comprise of programmed strands for the cluster formation either on the edges as overhangs or as loops on the duplex strands. Herein, we report a design strategy for sequence programmed, DNA three-way junctions (DNA-3WJ), comprising of unhybridized cytosine nucleobases in the 3WJ-center, capable of binding to silver ions and stabilizing the AgNCs. The formation of AgNCs in these DNA-3WJs were confirmed by various spectroscopic and microscopic techniques. 3WJ20-C12 comprising of 12 cytosine bases in the center of the DNA-3WJ, form fluorescent nanoclusters with an emission maximum around 630 nm and 12% fluorescence quantum yield. Control DNA-3WJs with six cytosine bases in the center (3WJ20-C6) and ones without cytosine bases (3WJ20) failed to form fluorescent AgNCs confirming the requirement of central, unhybridized cytosine bases for the stabilization of the nanoclusters. Further, the duplex arms of DNA-3WJs were shown to influence the fluorescent properties of AgNCs by varying the size and stability of the cytosine-loop structure of DNA-3WJs. Metal ion interaction studies shows the selectivity of the 3WJ20-C12/AgNCs towards Hg2+ with sensitivity in the nanomolar range (*J. Photochem. Photobiol. B: Biol.* 2020, 207, 111886).

Organic Chemistry and Medicinal Chemistry

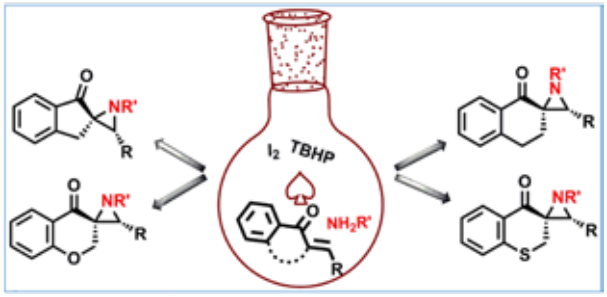
Exploring Mitochondria-Mediated Intrinsic Apoptosis by New Phytochemical Entities: An Explicit Observation of Cytochrome c Dynamics on Lung and Melanoma Cancer Cells.

Hydnocarpin (Hy) is a flavonoid isolated and purified from the seeds of Hydnocarpus wightiana Blume. Herein, we have developed a built-in semi-synthetic modification on Hy by one-pot multi-component reaction and a [3 + 2] cycloaddition strategy to append five membered isoxazole and isoxazolone as new phytochemical entities (NPCEs). Two selected NPCEs viz Hy-ISO-VIII and HyISO-G from the library of 20 newly synthesized derivatives after in vitro screening unveiled promising cytotoxicity and induced caspase-mediated apoptosis against the human lung and melanoma cancer cells which were well supported by virtual screening based on ligand binding affinity and molecular dynamic simulations. As a new insight, we introduced surface-enhanced Raman spectroscopy to identify the chemo-marker molecular fingerprint to confirm the cellular uptake, cytochrome c release, and DNA fragmentation in a label-free manner. The present findings throw up a surfeit of seminal reasons behind the semi-synthetic modification of Hy, stepping forward to cancer chemotherapy (*J. Med. Chem.* 2019, *62*, 8311−8329).



Diastereoselective Synthesis of Spiroaziridines.

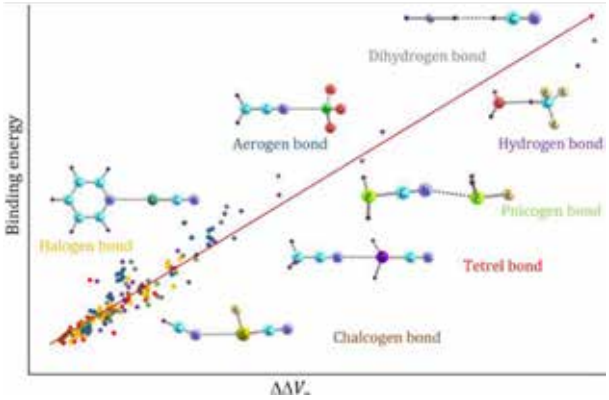
Aziridines have an essential place in the arena of synthetic organic chemistry. The high reactivity imparted by the inherent ring strain makes this three membered nitrogen heterocycle a versatile synthon. The synthetic utility of aziridines to get transformed into useful structural motifs is well established by ring expansion and ring opening reactions. Apart from being an essential building block



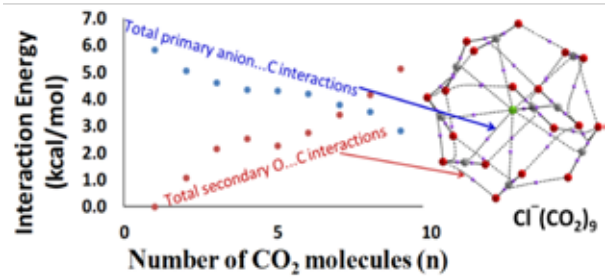
they are substructures of numerous natural as well as unnatural products of biological significance. However, despite the significance of azaspirocycles as emerging drug candidates,synthesis of spiroaziridines has not been well explored so far. In the last two decades significant advancements have happened in the synthesis of aziridines, and the two traditional strategies used for aziridine synthesis are either the transfer of a suitable nitrene to C=C bond or transfer of a carbene to C=N bond. But most of the methods developed relying on these strategies has the drawback of narrow substrate scope in terms of N-substituents. In the light of these observations we have developed an operationally simple I2/TBHP mediated protocol for the diastereoselctive synthesis of N-alkyl spiroaziridines from primary amines and easily accessible α, β-unsaturated ketones. The reaction proceeds under mild condition, does not require pre-functionalization of amines. This utilizes unprotected primary amines as the nitrogen source. This process is compatible for the synthesis of 2-aroylaziridines as well (*Org. Biomol. Chem.*, 2020, 18, 1588-1593).

Computational Chemistry

Supramolecular self-assembly and molecular recognition processes are driven mainly by positive cooperativity in noncovalent interactions. We have reported a large variety of noncovalent bonded dimer and trimer complexes, computed using *ab initio* theory. Significant electron density reorganization occurs in monomers due to noncovalent bond formation which is quantified using the change in molecular electrostatic potential (MESP) at bonded atoms. The change in change-of-MESP at the donor and acceptor atoms involved in bond formation ($\Delta\Delta V_n$) is used as a parameter to assess the extent of electron donor-acceptor (eDA) interaction in dimers and trimers and found that $\Delta\Delta V_n$ is directly proportional to the total binding energy. A cooperativity rule has emerged from this study which states that the electron reorganization in the dimer due to eDA interaction always enhances its donor-acceptor interactive behavior with a third molecule towards the formation of a noncovalent trimer complex.[1]



Cheap and effective carbon dioxide (CO_2) capture and storage (CCS) techniques have to be developed for the isolation, extraction, and storage of CO_2 emitted from various to alleviate the emission of CO_2 into the atmosphere. We have reported a systematic study focusing on the energetics of the formation of clusters of CO_2 around anions *viz.*, F^-, Cl^-, Br^-, CN^-, NO_2^-, OH^-, ClO^-, NC^-, and NH_2^-, using density functional theory. The nature of anion-CO_2 bonding - covalent versus non-covalent and cooperativity of interactions are elaborated in the study. In all the cases, C of CO_2 interacts with the anion. The maximum number of CO_2 molecules (n_{max}) adsorbed



by the anions to saturate the first shell of coordination varies from 8 – 12 in different complexes. The interaction energy (E_{int}) per CO_2 ($E_{int/CO2}$) is nearly a constant for all the non-covalent complexes, even up to n_{max} number of CO_2 adsorbed. The study proves that anions possess a remarkable ability to interact with a large number of CO_2 molecules due to cooperativity resulting from the secondary O...C interactions which compensate for the weakening of the primary anion...C interactions. This property of the anion-CO_2 interactions can be exploited for developing anionic or anion-incorporated materials for CO_2 storage.[2]

The electron-donating strengths of donor (D) moieties, which are encountered as a part of an organic sensitizer molecule in dye-sensitized solar cell (DSSC) applications in donor–π–acceptor systems, have been studied using density functional theory (DFT) calculations. This study shows that the MESP based assessment of the donating strength of donor systems offers a powerful rational design strategy for the development of efficient dyes for DSSC applications.[3] We have reported MESP topography mapping, which is a powerful technique to quantify the localized and delocalized π-electron distribution in a variety of unsaturated hydrocarbon systems, of a variety of conjugated hydrocarbons to understand their π-conjugation features and aromaticity.[4] The study of substituent effect for a series of 5-phenyl tris (8-hydroxyquinolinato) M(III) complexes suggests the use of Stokes shift as an experimental quantity to measure the excited state substituent effect while the MESP at the metal centre or the MESP minimum emerge as theoretical quantities to measure the same.[5]

((1) *J. Phys. Chem. A* 2020, *124*, 2231, (2) *Phys. Chem. Chem. Phys.* 2019, *21*, 23143, (3) *New J. Chem.* 2020, *44*, 7200, (4) *J. Phys. Chem. A* 2019, (5) *J. Comput. Chem.* 2020, *41*, 1497).

Environmental Technology Division

DIVISIONAL DETAILS

Scientists: Nine	Technical staff: Three	Students: Eleven
Ongoing projects: Nine	Research publications: Four	Ph. D. awarded: One

Expertise :

Environmental Impact Assessment
Waste management
Wastewater treatment

Facilities :

NABL accredited laboratory for the analysis of Water Wastewater
Dioxins and PCBs
ICPMS,
Analysis of biodegradability of plastics
Odour measurement
Remote sensing and GIS software
Dust and emission modelling tools etc.
NABET Accredited EIA Consultant Organization

पर्यावरण प्रौद्योगिकी प्रभाग

पर्यावरण प्रौद्योगिकी प्रभाग (ई टी डी) प्रदूषण नियंत्रण, पर्यावरण प्रबंधन और क्षेत्र के प्राकृतिक संसाधनों के मूल्य वर्धन के लिए प्रक्रियाओं और प्रौद्योगिकियों के विकास पर केंद्रित है। प्रभाग की गतिविधियाँ मुख्य रूप से अपशिष्ट प्रबंधन, डाइऑक्सिन अनुसंधान और पर्यावरण प्रभाव आकलन (ईआईए) के क्षेत्रों में हैं। स्थानीय उद्योगों और सरकारी एजेंसियों को खनन और बंदरगाह और बंदरगाह के क्षेत्रों में ईआईए अध्ययन और नई परियोजनाओं की मंजूरी के लिए प्रभाग द्वारा प्रदान की गई पर्यावरण प्रबंधन सेवाओं से लाभान्वित किया जाता है। सीएसआईआर-एनआईआईएसटी एक एनएबीईटी मान्यता प्राप्त है, केरल में एक सलाहकार संगठन है जो खनन और बंदरगाह और बंदरगाह के दो क्षेत्रों में मान्यता के साथ है।

सी आर टी डी एच (कॉमन रिसर्च एंड टेक्नोलॉजी डेवलपमेंट हब) डीएसआईआर, सरकार द्वारा वित्त पोषित एक परियोजना है। भारत की। सी आर टी डी एच एमएसएमई के लिए पर्यावरणीय हस्तक्षेप को सक्षम करने के लिए अनुसंधान एवं विकास और परामर्श सेवाओं के लिए सुविधाएं प्रदान करता है। एमएसएमई से जुड़े पर्यावरणीय मुद्दों को विकास, हस्तक्षेप और तकनीकी समाधान के लिए लिया जाता है। डीआरटीडीएच के तहत संसाधन की खपत को कम करने और संचालन की दक्षता में सुधार करने के लिए नियमों को पूरा करने के लिए तकनीकी सहायता प्रदान की जाती है। सी आर टी डी एच परियोजना के तहत अत्याधुनिक डाइऑक्सिन विश्लेषण सुविधा भी स्थापित की गई है।

ई टी डी की टेस्टिंग एंड एनालिसिस लेबोरेटरी को एन ए बी एल द्वारा ISO / IEC 17025: 2005 के अनुसार जल, अपशिष्ट जल, डाइऑक्सिन, फुरान और पॉली क्लोरीनयुक्त बाइफिनाइल (पीसीबी) के विश्लेषण के लिए मान्यता प्राप्त है। इसके अलावा, पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय (एम ओ ई एफ सी सी), सरकार द्वारा सीएसआईआर-एनआईआईएसटी की सिफारिश की गई है। भारत की पर्यावरणीय मंजूरी के लिए डाइऑक्सिन विश्लेषण के लिए एक रेफरल प्रयोगशाला के रूप में। ई टी डी विज्ञान से इंजीनियरिंग तक प्रौद्योगिकी के लिए संपूर्ण मूल्य श्रृंखला में योगदान देता है।

हाइलाइट

- त्रिवेंद्रम अंतर्राष्ट्रीय हवाई अड्डे पर 500 किलोग्राम / दिन की क्षमता का एनआईआईएसटी कॉम्पैक्ट फूड वेस्ट बायोगैस प्लांट का सफल एक वर्षीय संचालन।
- कैंटीन के अपशिष्ट जल के उपचार के लिए प्रति दिन 2000 लीटर एन आई आई एस टी ऑनसाइट अपशिष्ट जल उपचार प्रणाली (नोवा) एनआईआईएटी परिसर में स्थापित किया गया था।
- नोवा तकनीक मेसर्स सत्यम एनवायरो प्राइवेट लिमिटेड को हस्तांतरित की गई।
- बोयंट फ़िल्टर बायोरिएक्टर (बी एफ बी आर) तकनीक को मेसर्स गैलेक्सी एनवीरों प्राइवेट में स्थानांतरित कर दिया गया था। लिमिटेड और पेटेंट लाइसेंस मेसर्स विक्टोरिया इनोवेटिव एलएलपी को हस्तांतरित किया गया था।
- भारत की पहली गंध परीक्षण प्रयोगशाला सीएसआईआर-एनआईआईएटी के तहत में तकनीकी हस्तक्षेप के लिए डी एस आई आर - सी आर टी डी एच परियोजना और एमएसएमई को विश्लेषणात्मक परीक्षण सहायता प्रदान करने के लिए स्थापित की गई थी।
- डीएओसीएन और पीसीबी पर विश्लेषणात्मक सेवाएं भाभा परमाणु अनुसंधान केंद्र, मुंबई जैसे प्रमुख संगठनों को प्रदान की गईं; सीएसआईआर-नीरी, नागपुर और एमपीईडीए, कोच्चि।
- मैसर्स पंकजकस्थुरी हर्बल्स इंडिया प्राइवेट लिमिटेड द्वारा आपूर्ति की गई आयुर्वेदिक दवा के नमूनों के विनियामक अनुपालन के लिए आईसीपी-एमएस सुविधा का बड़े पैमाने पर उपयोग किया गया था। लिमिटेड हस्ताक्षरित एमओयू के तहत।
- परिवेशी वायु नमूना और अवशिष्ट राख का नमूना 18/02/2020 से 21/02/2020 के दौरान किया गया था, अध्यक्ष, राज्य स्तरीय निगरानी समिति, नेशनल ग्रीन ट्रिब्यूनल द्वारा गठित एक निकाय, अपशिष्ट उपचार संयंत्र के ठोस अपशिष्ट डंप यार्ड में, ब्रह्मपुरम, कोच्चि जहां आग लगी थी।
- नीन्दकारा-कयाकमुल बेल्ट, चावारा, कोल्लम में परमाणु खनिजों के खनन पर ईआईए अध्ययन किया गया।

Environmental Technology Division

The Environmental Technology Division (ETD) focuses on the development of processes and technologies for pollution control, environmental management and for the value addition to the region's natural resources. The activities of the division are mainly in the areas of waste management, dioxin research and Environmental Impact Assessment (EIA). Local industries and government agencies are benefitted by the environmental management services provided by the division for EIA studies and clearances of new projects in the areas of mining and port & harbour. CSIR-NIIST is a NABET accredited, Category A consultant organisation in Kerala with accreditation in the two areas of mining and port & harbour.

CRTDH (Common Research & Technology Development Hub) is a project funded by DSIR, Govt. of India. CRTDH provides facilities for R&D and consultancy services enabling environmental interventions for MSMEs. Environmental issues associated with MSMEs are taken up for development, interventions and technological solutions. Technical support is provided to meet regulations as well as to reduce resource consumption and improve efficiency of operation under DRTDH. The state of the art Dioxin analysis facility has also been established under the CRTDH project.

The Testing and Analysis Laboratory of ETD is accredited by NABL as per ISO/IEC 17025: 2005 for analysis of Water, Waste water, Dioxins, Furans and Poly Chlorinated Biphenyls (PCBs). In addition, CSIR-NIIST has been recommended by Ministry of Environment, Forest and Climate Change (MoEFCC), Govt. of India as a referral laboratory for Dioxin analysis for environmental clearances. ETD contributes across the entire value chain from science to engineering to technology.

Highlights

Major activities of the division during 2019-20.

- Successful one-year operation of 500 kg/day capacity NIIST compact food waste biogas plant installed at Thiruvananthapuram International Airport.
- 2000 litre per day NIIST Onsite Wastewater Treatment System(NOWA) for treating Canteen waste water was set up at NIIST campus.
- The NOWA technology transferred to M/s Satyam Enviro Pvt. Ltd.
- The buoyant filter bioreactor (BFBR) technology was transferred to M/s Galaxy Environ Pvt. Ltd. and patent license was transferred to M/s Victoria Innovative LLP.
- India's first odour testing laboratory was established at CSIR- NIIST under the DSIR- CRTDH project for technological interventions and to provide analytical testing support to MSMEs.
- Analytical services on Dioxins and PCBs were provided to major organizations such as BARC, Mumbai; CSIR-NEERI, Nagpur and MPEDA, Kochi.
- ICP-MS facility was extensively utilized for the regulatory compliance of Ayurvedic drug samples supplied by M/s Pankajakasthuri Herbals India Pvt. Ltd. under the signed MoU.

- Ambient air sampling and residual ash sampling were carried out during 18/02/2020 to 21/02/2020 upon direction from Chairman, State level monitoring committee, a body constituted by National Green Tribunal,at the solid waste dump yard of Waste Treatment Plant, Brahmapuram, Kochi where a fire was broken out.
- EIA studies were carried out on mining of atomic minerals in the Neendakara-Kayamkulam belt, Chavara, Kollam.

Food waste Bioenergy plant at Thiruvananthapuram International airport

500 kg/day food waste biogas plant installed at Trivandrum International airport

CSIR-NIIST, Thiruvananthapuram successfully completed the installation and one-year operation of NIIST technology based food waste-bioenergy plant at Thiruvananthapuram International airport. Thiruvananthapuram airport was generating nearly 500 kg food waste daily. Proper management of the highly putrefying organic waste was a serious problem at the airport. The improper disposal of the food waste can attract scavenging birds around the airport area, that raised much safety concern for the safe landing and take-off of aircrafts. Considering the high social relevance of the problem, and the expertise available in NIIST on anaerobic bioprocess area, NIIST decided to undertake it as an R&D project from Airport Authority of India. Since January 2019, the entire food waste generated at both the domestic and International terminals is treated in this system. The treatment unit at the airport is a scaled up version of the NIIST technology (from 50 kg/day to 500 kg/day).

NIIST digester is a high rate anaerobic digester (organic loading >5 kg volatile solid/cub meter), working on dry digestion (total solid content >20 %) in plug flow type multiple bioreactors operating in parallel. This unique design offers many advantages like its compact size (less space for installation), no need of fresh water addition (conventional plants requires 1-3 time (v/v) fresh water along with food waste), all types of unsorted food waste (both pre-cooked and cooked) was treated in the digester, more biogas yield (180-220 Lit/ kg wet weight of the food), highly stable (odour free) slurry that can be used as organic manure. The methane level in the raw biogas was up to 65%. At its maximum food waste loading capacity, the biogas produced was around 70 cub meter biogas per day, and that was converted into electricity with a biogas generator. On an average around 1.5 Kwh was produced per every cub meter of biogas. The power was used mainly for local lighting and partially operating the biogas plant itself. The

fabrication and installation of the unit was done by Swatch Future Energy Solutions, Pvt. Ltd., one of the licensees of NIIST technology.

NIIST Onsite Wastewater Treatment Technology (NOWA)

As part of CSIR FTT project, CSIR NIIST has developed a modular, onsite wastewater treatment cum resource recovery system. This is a combined anaerobic-aerobic biological treatment system, that will be suitable for treating discharges from small establishment like canteens, small restaurants, hotels, agro based MSMEs, etc. This will also find application in fast growing cities where sewerage network is limited. The pilot plant studies (2000 litre per day) was completed in NIIST campus, treating the organic rich wastewater (COD ~2000 mg/L) from NIIST canteen. The unit recovered biogas and reuse quality water from the wastewater.

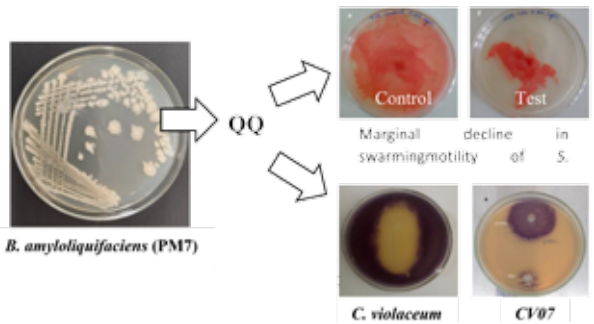
NOWA unit (2000L/day) installed in NIIST campus recovering biogas and reuse quality water from high strength wastewater discharged from NIIST canteen

The major highlights of NOWA technology are (1) it is a Modular treatment system with less space requirement for installation, (2) It can be installed with minimum civil work at the site, (3) Completely biological treatment system, (4) It can recover reuse quality water and biogas as resources, (5) Free from sludge disposal problem, and (6) the system can be retrofitted with existing infrastructure. The NOWA unit is custom designed for treating wastewater from a food processing MSME unit (Jaihari food products pvt ltd.) at Addor in Kerala. The work was undertaken as an industry sponsored project. The unit is presently under trial run. The NOWA technology was recently licensed to Satyam Enviro Pvt Ltd.

Technology transfer of NOWA to the industry (March 16, 2020)

Quorum Quenching Mediated Biofilm Control

The biofilm associated fouling poses serious practical challenge in waste and wastewater sector. The existing physical and chemical approaches to address biofouling have many limitations. On the other hand, interfering the chemical signaling of microorganisms (both intra species and inter species) is a new approach to address biofilm formation, and related problems. In this approach natural (microbial or plant origin) and synthetic molecules (analogues) will be used to interfere (Quorum quenching) the normal functioning of microbial communication (Quorum sensing) molecules like AHL (Acyl Homoserin Lactone), Auto Inducer I, II, etc. The ongoing research in the Environmental



The newly isolated *B. amyloliquifaciens* (strain PM7) exhibited AHL degradation, and its associated phenotypic responses in *S. marcescens* and C. violaceum and the mutant C. violaceum (CV07)

technology division focus on developing microbial Quorum Quenching (QQ) system. Several bacterial strains exhibiting QQ property was isolated, and one of the prominent strain was B. amyloliquifaciens. The QQ property of the novel strain was validated through testing against S. marcescens, Chromobacterium vioaceium and CV 07 (mutant). Studies are progressing to test its efficiency to control biofilm formation in a prototype MBR unit.

High-Rate Anaerobic Reactor Design for Complex Wastewater and its Technology Transfer

The buoyant filter bioreactor - BFBR – (US Patent 6,592,751; Indian Patent No. 242196), is a unique solution to the high rate anaerobic treatment of complex wastewaters. Anaerobic sludge is retained in the reactor by a special low density granular filter system integrally provided in the reactor. Thus the separation of sludge and its retention in the reactor is independent of the settle ability of sludge. The reactor contents i.e., complex waste and microbial biomass are in well-mixed condition, using either proven gas sparging methods or optional mechanical agitators.

- The BFBR provides the performance of an anaerobic membrane bioreactor without the drawbacks of expensive systems and high power costs. The BFBR retains all microflora – settling, dispersed and slow growing– enabling the development of high activity sludge.
- BFBR performance for dairy effluent:
- The BFBR achieves 95% COD removal (fat content 60% of COD) for dairy effluent.
- COD removed is completely converted to methane. Loading rate 7 kg COD/(m3.d).
- BFBR Technology was transferred to M/s Galaxy Environ, and Patent license was transferred to M/s Victoria Innovative LLP, Ernakulam, Kerala.
- The BFBR installation was done in various sector such as
    - Rice mills (6),
    - Ice-cream factories (4),
    - Fish meal processing Units
    - Hospitals Sewage
    - Kottarakkara Temple
- Installation of BFBR in various industries
    - M/s. Keerthy Agro Mills, Kalady, Ernakulam
    - M/s. Valookaran Modern Rice Mills, Kalady, Ernakulam
    - M/s. Merriboy Icecream Factory (3 plants - Kannur, Ernakulam & Trivandrum)
    - M/s. Pappai Icecream Factory, Kanjikkode, Palakkad
    - M/s. Teejan Food Products, Ernakulam

Centralised Effluent Treatment Plant (CETP), Edayar , Kochi, - Effluent from about 150 MSMEs are treated at this facility. Total plant capacity – 2 Lakh litres per day, Plant cost – 3 crores

Setting up of Major Analytical Facility – Odour Monitoring Facility

CSIR- NIIST has established India's first odour testing laboratory under the DSIR- CRTDH project for technological interventions and to provide analytical

testing support to MSMEs in the region. Odours are sensations resulting from the reception of a stimuli by the human olfactory system. To measure a smell, the best instrument remains still the nose. Odour remains at the top of air pollution complaints in many countries, including India. A smell consists of numerous volatile chemical substances. Odour pollution measurement and identification is a key and difficult matter for odour pollution study management and control. However, it is only from human olfactometric measures that a balance of the issues of smells can be drawn up and that the correspondence of the industrial discharges can be controlled.

The Scentroid SS400 Six Station Portable Odour Lab is the world's only portable six (6) panel olfactometer. The compact, flexible form allows for easy transportation and deployment. The connection between panelist stations and the central control pyramid allows the SS400 Six Station Portable Olfactometer to be set up to fit a table within any room layout. Full automation and data processing using Scentroid's Laboratory Information Management software allows any laboratory to be easily certified to ISO17025.

Dynamic Olfactometer-SS400 can be used for the following applications:

- Conduct on-site odour measurements
- Determine odour concentration in OU / m^3, as per the recognized EN13725 standard
- Conduct a hedonic tone (pleasant to unpleasant) assessment of odour emissions
- Conduct panelist training and N. Butanol screening
- Interface to Scentroid Laboratory Information Management Software
- Employ binary, triangular, yes/no, and direct presentation methods

Heavy metal analysis in Ayurvedic formulations/ ingredients/ final products using Inductively Coupled Plasma Mass Spectrometry Facility (ICPMS)

As per the Ayurvedic Pharmacopeia of India published by the Ayush Department, Government of India, all Ayurvedic Drugs (Single/Compound formulation) must comply with the limits for Heavy Metals prescribed in individual Monograph and wherever limit is not given then they must comply with the limits given in WHO publication "Quality Control Methods for Medicinal Plants and Material". CSIR- NIIST has signed a Memorandum of Understanding with M/s. Pankajakasthuri Pvt Ltd, a leading traditional ayurvedic medical college and drug manufacturer based in Kerala, founded by Padmashree Dr. J. Hareendran Nair for carrying out the regulatory compliance monitoring of toxic heavy metal contents in ayurvedic drug formulations/ ingredients and finished products. A state of the art Inductively Coupled Plasma - Mass Spectrometry (ICP- MS) installed at CSIR- NIIST has been employed for the unequivocal ultra-trace level quantification of toxic heavy metals such as arsenic, lead, cadmium and mercury in 250 samples submitted by M/s. Pankajakasthuri Herbals (India) Pvt Ltd.

Panelists conducting odour measurements

Inductively Coupled Plasma Mass Spectrometer (ICPMS) Facility

In addition, the institute facility has been extensively utilized for meeting the requirement of several R & D programmes/ EIA/ Consultancy projects in various divisions of the institute and for other academic/ research organization in Kerala. The revenue generated from the facility during 2019- 20 accounts for more than Rs. 10 Lakhs.

Dioxin Research & Monitoring

The NABL accredited and MoEF & CC recommended dioxin research facility has been extensively utilized by various national and regional R &D/ regulatory / export/ academic and legal bodies in the year 2019-20. Being a unique national facility, NIIST has extended its expertise and service for various important organisations and issue of great importance at war footing. We have received work orders worth Rs. 40 Lakhs during the period 2019-20.

The major projects undertaken are the following.

- Bhabha Atomic Research Institute (BARC), Mumbai has awarded a work order for carrying out dioxins and furans quantification in stack samples collected from their process development of a pilot scale industrial plasma gasifier for solid waste treatment.
- Multiple R & D programmes of CSIR- NEERI on (a) Sampling, analytical method development and evaluation of dioxin emission from sanitary pad incinerator (Green Dispo) (b) Rapid carbonisation unit – Sanchar for sanitary pad destruction and (c) Testing and analysis of dioxins in soil and ambient air from plastic industries as per the requirement of National Green Tribunal (NGT)
- Analysis of export quality fish and shrimp samples for Marine Product Export Development Authority (MPEDA), Kochi and regulatory reporting
- Study of dioxins and PCBs levels in sediment samples collected from Arctic region as part of their PACER-POP project.

In addition, a hugely societally relevant activity was undertaken by CSIR-NIIST on war footing during 18/02/2020 to 21/02/2020 for conducting monitoring of dioxin levels in ambient air and residual ash samples, upon direction from Chairman, State level monitoring committee, a body constituted by National Green Tribunal, at the solid waste dump yard of Waste Treatment Plant, Brahmapuram, Kochi where a fire was broken out. The study was proposed to CSIR- NIIST, in view of its highly informative, scientific and quantitative studies conducted by NIIST during the last few years including the first study report on emission factor of dioxins from open burning of MSWs in Kerala and reporting of dioxins emission during a massive fire hazard occurred at Brahmapuram during 2019. The report submitted by NIIST is under the consideration of NGT and has given directions to the Kochi Corporation and Government of Kerala to take necessary steps to mitigate the huge quantity of MSW dumped at the site.

Sampling of dioxins from sanitary pad incinerator (Green Dispo) developed by CSIR- NEERI

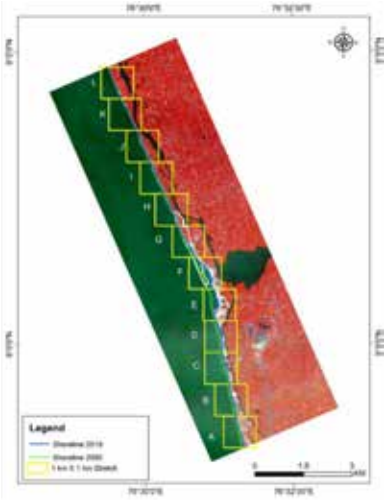
Sampling at Brahmapuram during fire breakout incident occurred during 18/02/2020 to 21/02/2020

Environmental Impact Assessment

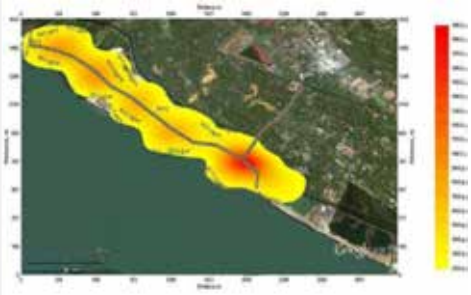
Environmental impact assessment (EIA) is the systematic identification and evaluation of the potential impacts (effects) of proposed projects, plans, programs, or legislative actions, relative to the physico–chemical, biological, cultural, and socioeconomic components of the environment. It is a mandatory process for obtaining Environmental Clearance (EC) for various developmental projects. EIA promotes sustainable development by identifying environmentally sound practice and mitigation measures for developments, it ensures that environmental consequences were taken into account during planning, designing and decision-making process and how the adverse impacts could be avoided or minimized. CSIR-NIIST holds strong position in Environment Impact Assessment and Impact Assessment studies pertaining to the Mining (Non-coal mining) and Port & Harbour sector and other impacts and mitigation studies due to developmental activities. Through our Impact Assessment studies, our commitment towards environment protection and monitoring is adhered to while ensuring our customer's meeting the mandatory EIA requirement. It may be noteworthy that CSIR-NIIST is the first organization in Kerala with NABET/MoEF&CC accreditation as an EIA consultant in category "A" projects.

Environmental Impact Assessment, change detection studies and Natural and community resource augmentation plan for mining areas of Neendakara-Kayamkulam belt

Indian Rare Earths Ltd (IREL) and Kerala Minerals and Metals Ltd. (KMML) has appointed CSIR-NIIST to evaluate the environmental aspects and their possible associated impacts that would arise due to the proposed heavy mineral sand mining operations and to work out environmental management plans and environmental monitoring programme to prevent, control, minimize/ eliminate the adverse environmental impacts envisaged from the mining activity. A purely physical process separates the heavies and no chemicals are used. The Indian Rare Earths Ltd. (IREL) and Kerala Minerals and Metals Ltd. (KMML) are mining atomic minerals which are of strategic importance to the government. NIIST is doing EIA studies for both the government companies indirectly accelerating the process of production/ extraction of atomic minerals in an environmentally sustainable manner. NIIST has also started Natural and Community Resource Augmentation Plan (NCRAP) studies for projects under violation of the EIA notification (2006). It refers to estimation of ecosystem damages and its monetary equivalents. NIIST has carried out a NCRAP study on KMML block-III and worked out the equivalent cost for damages. NIIST has also started change detection studies through Remote sensing and Geographical Information System (GIS) and carried out a change detection study on IREL Block IV (5 km upstream and 5 km Downstream from block IV). The studies conducted by CSIR-NIIST for IREL Block II, IIEE and IV grated environmental clearance based on studies conducted by NIIST. The ongoing projects includes EIA of KMML block III, impact assessment studies for stability of TS canal and impacts on breeding of aquatic fauna. NIIST is also carrying out Land Use Land Cover studies for Jamnagar, Gujarat industrial area.



IREL Block IV change detection studies with high resolution satellite imageries (IRS LISS-IV)



Fugitive Dispersion Model output for PM_{10} concentration

Materials Science & Technology Division

DIVISIONAL DETAILS

Scientists: Twenty	Technical staff: Six	Students: Eighty
Ongoing projects: Thirty-Six	Publications: Ninety-Seven	Ph. D. awarded: Twelve

Expertise:	Metallic materials, Minerals & Industrial solid waste management, High temperature ceramics Electronic & functional materials Polymers and natural fiber composites
Facilities:	XPF, SEM, 2D XRD, PPMS

सामग्री विज्ञान और प्रौद्योगिकी प्रभाग

एम एस टी डी धातु, चीनी मिट्टी की चीज़ें, पॉलिमर, इलेक्ट्रॉनिक और चुंबकीय सामग्री में उन्नत सामग्री के विकास से संबंधित सबसे आधुनिक अनुसंधान और विकास गतिविधियों पर केंद्रित है। अनुसंधान और विकास के परिणामस्वरूप, प्रभाग ने 3.5 से ऊपर एक औसत प्रभाव कारक के एससीआई पत्रिकाओं में 97 पत्र प्रकाशित किए हैं, 13 पीएचडी से सम्मानित किया है, और 2019-20 के दौरान 1 जापानी पेटेंट प्राप्त किया है। विकसित की गई कुछ तकनीकों में कॉयर-मल्चिंग मैट के निर्माण के लिए जैव-आधारित बहुलक बाँध शामिल हैं जो फसल के विकास को बढ़ाते हैं। ये मल्चिंग मैट एकल-उपयोग वाली मल्चिंग फिल्मों के बायोडिग्रेडेबल और पर्यावरण के अनुकूल विकल्प हैं। सॉफ्टवेयर ऑटो कास्ट-एक्स 1 रिलीज़ 11.12.1 को मई-2019 के दौरान रिलीज़ किया गया था, जिसमें पहले जारी किए गए ऑटोकैस्ट - X1 के फ़्लो + मॉड्यूल में एक अतिरिक्त के रूप में सुधार वाला हिस्सा संकोचन सरंध्रता वॉल्यूम गणना शामिल है।

हाइलाइट

- ऑटोमोटिव एयर कंप्रेसर अनुप्रयोगों के लिए हल्के एल्यूमीनियम आधारित क्रैंककेस
- आभासी कास्टिंग सॉल्वर प्रौद्योगिकी के व्यावसायीकरण विवरण
- जंग से सुरक्षा के लिए स्मार्ट नैनोकंटेनर-आधारित एंटीकोर्सिव बायो-कोटिंग्स
- रोगाणुरोधी कोटिंग्स के लिए नीम के अर्क के बायोजेनिक एजी नैनोपार्टिकल्स
- बायोमेडिकल अनुप्रयोगों के लिए Mg मिश्र धातुओं पर सेरियम फॉस्फेट रासायनिक रूपांतरण कोटिंग
- ऊर्जा कुशल भवनों के लिए BiVO4-ZnO जटिल अकार्बनिक वर्णक
- जंग संरक्षण के लिए टिकाऊ हाइड्रोफोबिक कोटिंग
- स्टील पर संयंत्र के अर्क आधारित संकर एंटीकोर्सिव कोटिंग
- पीडी ने नी नैनोवायर को अल्कोहल ऑक्सीकरण प्रतिक्रिया के लिए एक कुशल इलेक्ट्रो-उत्प्रेरक के रूप में संशोधित किया
- क्षार सिलिकेट आधारित उच्च तापमान CO2 कब्जा करने के लिए मिट्टी के दाने
- सघन सक्रियण के माध्यम से जलीय समाधानों से एज़ो प्रतिक्रियाशील रंजक निकालना
- दुर्लभ पृथ्वी सिरेमिक से कार्यात्मक ग्लेज़ कोटिंग
- लचीला प्रकाश अनुप्रयोगों के लिए लाल-नारंगी उत्सर्जक फास्फोर-आधारित कंपोजिट
- कठोर स्थिति माइक्रोवेव परिरक्षण के लिए La0.5Sr0.5CoO3-for फोम का संचालन करना
- दुर्लभ पृथ्वी perovskites Pr2FeMnO6 और Sm2CrMnO6 में चुंबकत्व के उत्क्रमण पर हस्ताक्षर करें
- मोटर वाहन और ऊर्जा उत्पादन के लिए Mn आधारित आरई-मुक्त स्थायी मैग्नेट का विकासकमरे के तापमान चुंबकीय प्रशीतन अनुप्रयोगों के लिए मैग्नेटोकलोरिक सामग्रियों का विकासकैंसर कोशिकाओं के उपचार में प्रयुक्त हाइपरथर्मिया थेरेपी के लिए बायोकेम्पेटेबल चुंबकीय नैनोकणों के स्पिक्ट्रोनिक्स संघों के विकास के लिए अर्ध-धातु फेरोमैग्नेट्स का विकास
- प्रिंट करने योग्य पदानुक्रमित निकल नैनोवायर आधारित सेंसर
- शहरी खनन कचरे से कीमती धातुओं का संवर्धन
- अपशिष्ट जल के लिए कॉयर पिथ को सक्रिय कार्बन में बदलना
- पॉलिमर / कॉयर कंपोजिट: आधुनिक खेती के लिए जैव-अवक्रमित कॉयर मल्चिंग मैट और चादरें
- निर्माण उद्योग के लिए कम घनत्व वाली ध्वनिक सामग्री
- क्षरण नियंत्रण के लिए सड़न-रोधी कॉयर भोजवस्त्र
- पॉलीमर नैनोकम्पोजिट्स: पॉली (oc-lactide) के उन्नत गुणों के लिए स्थायी बहुक्रियाशील नैनोफिलर
- Supramolecular दृष्टिकोण के माध्यम से ब्लॉक कॉपोलीमर डोमेन के भीतर कार्यात्मक दाता-स्वीकर्ता अणुओं की सह-सभा

Materials Science and Technology Division

MSTD is focused on the most modern research and development activities pertaining to the development of advanced materials in Metals, Ceramics, Polymers, Electronic and Magnetic materials. As a result of research and development, the division has published 97 papers in SCI Journals of an average impact factor above 3.5, awarded 13 PhDs, and obtained 1 Japanese patent during 2019-20. Some of the technologies developed include Bio-based polymer binders for the fabrication of coir-mulching mats which enhances the crop growth. These mulching mats are biodegradable and eco-friendly substitute to single-use plastic mulching films. Software AutoCAST-X1 Release 11.12.1 was released during May-2019 which includes improved part shrinkage porosity volume calculations as an addition to the in FLOW+ module of Autocast – X1 released earlier.

Highlights

- Lightweight aluminum based crankcase for automotive air compressor application
- Commercialization of the Virtual Casting Solver Technology
- Smart nanocontainer-based anticorrosive bio-coatings for corrosion protection
- Biogenic Ag nanoparticles of neem extract for antimicrobial coatings
- Cerium phosphate chemical conversion coating on Mg alloys for biomedical applications
- $BiVO_4$–ZnO complex inorganic pigment for energy efficient buildings
- Durable hydrophobic coating for corrosion protection
- Plant extract based hybrid anticorrosive coating on steel
- Pd modified Ni nanowire as an efficient electro-catalyst for alcohol oxidation reaction
- Alkali silicate based ceramics granules for high temperature CO_2 capture
- Removal of azo reactive dyes from aqueous solutions via persulfate activation
- Functional Glaze coatings from Rare Earths Ceramics
- Red-orange emitting phosphor-based composites for flexible lighting applications
- Conducting $La_{0.5}Sr_{0.5}CoO_{3-\delta}$ foams for harsh condition microwave shielding
- Sign reversal of magnetization in rare earth perovskites Pr_2FeMnO_6 and Sm_2CrMnO_6
- Development of Mn based RE-free permanent magnets for automotive and energy generation
- Development of magnetocaloric materials for room temperature magnetic refrigeration application
- Development of Half-metallic Ferromagnets for spintronics applications
- Development of biocompatible magnetic nanoparticles for hyperthermia therapy used in treating the cancerous cells
- Printable hierarchical nickel nanowire based sensors
- Enrichment of precious metals from urban mining wastes
- Conversion of waste coir pith into activated carbon for wastewater treatment
- Bio-degradable coir mulching mats and sheets for modern farming
- Low density acoustic materials for building industry
- Rot-resistant coir bhoovastra for erosion control
- Sustainable multifunctional nanofiller for enhanced properties of poly(L-lactide)
- Co-assembly of functionalized donor-acceptor molecules within the block copolymer domains via supramolecular approach

Development of lightweight aluminum based crankcase for automotive air compressor applications

Crankcase is one of the potential heavy weight components which are mostly made of SG Iron. A suitable alternate lightweight aluminum based crankcase can lead to significant weight reduction to the air compressor brake systems. Aluminum alloys are the potential materials for automotive engine components due to their low density, excellent thermal conductivity, easy fabricability and corrosion resistance. CSIR-NIIST together with WABCO India intends to fabricate aluminum alloy crankcase using modified aluminum silicon alloys with minor alloying additions. The crankcase has been fabricated via gravity die casting technique by using the modified aluminum silicon alloys which are supplied by CSIR-NIIST to WABCO India Limited, Chennai. The crankcase has been successfully tested by the user industry for 500 h and satisfied all the basic test parameters.

Aluminum alloy crankcase supplied by CSIR-NIIST to WABCO India Limited

Commercialization of the Virtual Casting Solver Technology

Virtual Casting is a software package for the simulation of solidification process of industrial castings which has been developed by CSIR-NIIST to predict shrinkage defects in a given casting design. In 2011, the Virtual Casting Solver Technology was transferred to 3D Foundry Tech Pvt. Ltd. (3DFT) a company incubated in the Indian Institute of Technology Bombay (IITB), Mumbai. The 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 fully integrated with their casting design software *AutoCAST*, giving birth to *FLOW+* module in *AutoCAST X1* software. During 2013-19, *AutoCAST X1 with FLOW+* has been showcased at various Indian Foundry Exhibitions. Till date, more than 185 licenses of *AutoCAST-X1* have been sold to various ferrous and non-ferrous foundries as well as Academic Institutes in India by 3D Foundry Tech Pvt. Ltd. CSIR-NIIST is a lead technical partner for this product.

AutoCAST X1 – functionalities

During this year, this software was updated with enhanced functionalities after benchmarking with industrial case studies. In AutoCAST-X1 Release 11.12.1, during May 2019, an improved part shrinkage porosity volume calculations were added in FLOW+ module. Also, the shrinkage porosity volume is displayed in quality tab and it is displayed for the voxels having porosity equal/greater than the set limit. The improved shrinkage volume calculations help the user to measure the shrinkage volume for the shrinkage in the part only.

In AutoCAST-X1 Release 11.12.2, during August 2019, modifications were made in FLOW+ module to take care of special situations where the shell temperatures are higher than the melt temperatures in the investment casting process. In AutoCAST-X1 Release 11.13.1, during October 2019, databases for new chill and sleeve materials were added. Also, gating optimization is introduced in this version. Some screenshots of the enhancements are shown below.

Part shrinkage porosity volume displayed for part shrinkage location

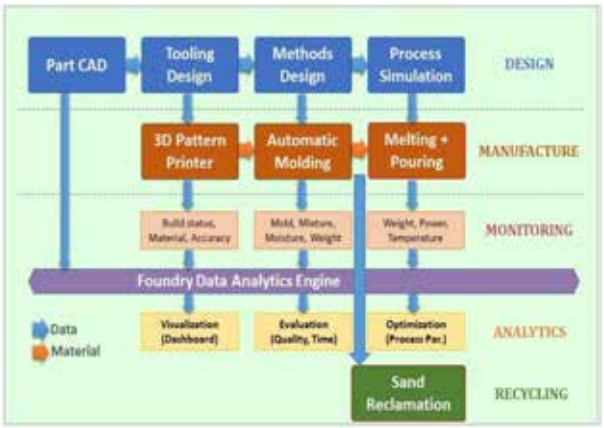
Temperature profile during Investment Casting process

AutoCAST X1-FLOW+ is available from Shri. Babaprasad Lanka, CEO, 3D Foundry Tech Pvt. Ltd. 507-C, Ecstasy Business Park City of Joy, JSD Road, Mulund (W) Mumbai – 400 080, India. Phone: +91 98921 00072 E-Mail: babaprasad@autocast.co.in

SMART FOUNDRY 2020

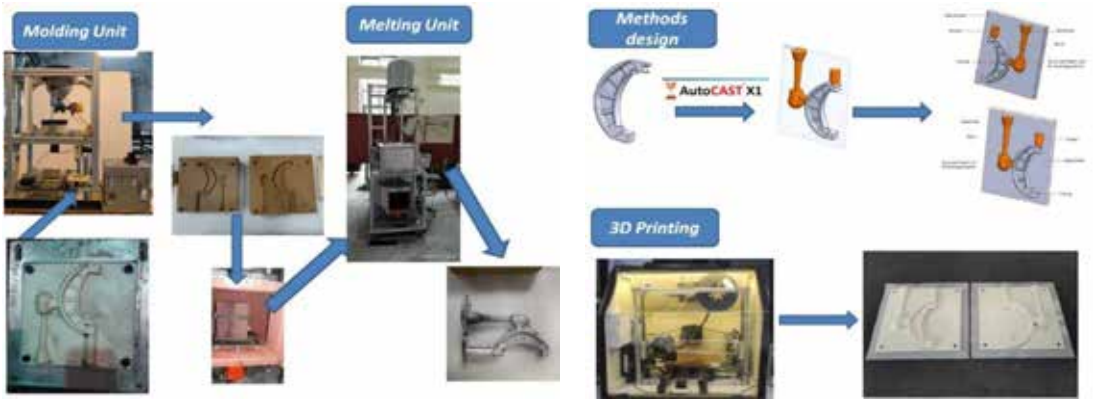
This project was sanctioned during August 2016 for Rs. 8.25 Crore from DST under Technology Systems Development Program and with a contribution of Rs. 1.25 Crore from five private industrial partners and CSIR-NIIST is the overall project coordinator for this project and the amount sanctioned for CSIR-NIIST is Rs. 3.32 Crore for a period of three years

The main goal is to develop a compact SMART Foundry for rapid manufacture of small parts (aluminium and magnesium alloys) required in tiny order quantities, which are not economical for conventional foundries. This is achieved by 3D modeling of the required part, plastic pattern printing, no-bake molding, direct melting and metal pouring. The acronym SMART stands for sustainable metalcasting by advanced research and technology. The project leverages five key technology drivers – virtual engineering, Cloud computing, smart sensors, Internet of Things, and big data analytics as shown in the figure below



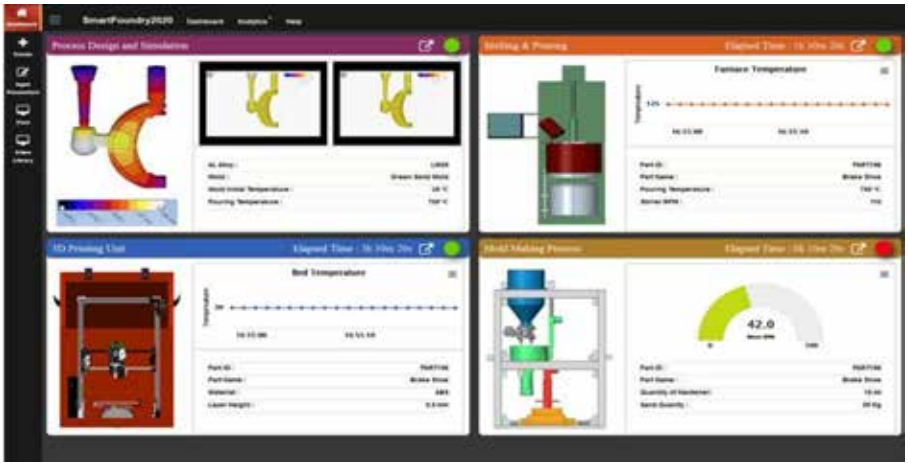
Overall architecture of SMART FOUNDRY

SMART Foundry comprises of four hardware units: 3D pattern printer, molding, casting and sand reclamation. The actual process flow diagram of SMART Foundry is demonstrated for a typical casting in the figures shown below



Process flow diagram of SMART FOUNDRY – VERSION 1

An IOT platform was developed in-house by the project team for data sensing and collecting from the hardware units of SMART Foundry. It has Cloud-based dashboards for data monitoring through display of live data streamed from sensors in various hardware units. Control buttons on the dashboard enable critical operations like emergency on/off for sub-systems and overall power shutdown on emergency.

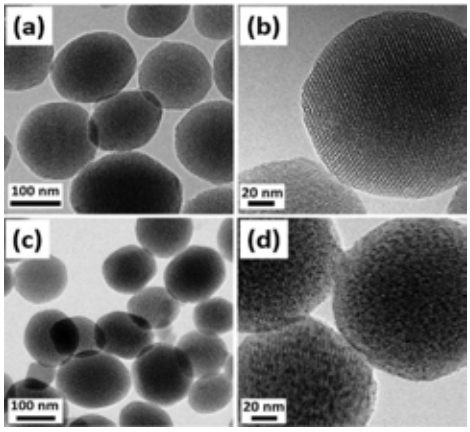


IOT platform for SMART FOUNDRY

Version 1 of SMART FOUNDRY was demonstrated at CMTI, Bengaluru during November-2019 and version 2 which will be an integrated industrial scale SMART FOUNDRY with an Industrial-IOT enabled control and monitoring platform is being built now.

Smart nanocontainer-based anticorrosive bio-coatings for corrosion protection of aluminium alloys

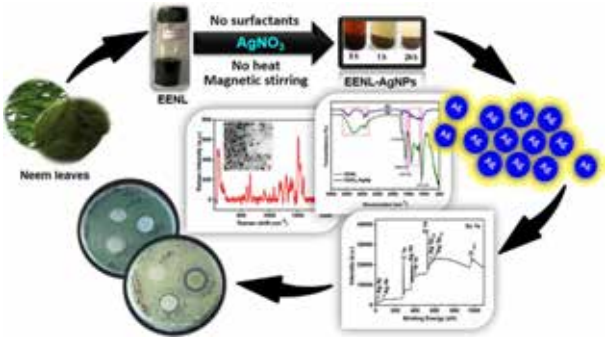
Active anticorrosive coatings were obtained by "phytochemical" Quercetin (QCT), a known secondary metabolite of plants, loaded in silica nanocontainers (MSN) as the natural organic inhibitor. With an artificial defect induced on the epoxy nanocomposite coating and subsequent corrosion reactions, active corrosion protection was triggered. The optimum performance was achieved from the 1.0 wt% loaded coatings. The unscratched nanocomposite coatings were also examined and revealed enhanced corrosion protection in comparison with the unmodified epoxy coating. The anticorrosive action of the bio-coatings was controlled by the release and reactions of the inhibiting component from the coating at pH 10. The corrosion protection offered by QCT was due to the chemical transformation experienced by QCT with pH influence involving possible autoxidation and polymerization processes. Both immersion and electrochemical corrosion tests were employed in the study to systematically evaluate the corrosion protection. Furthermore, a primary investigation was conducted to assess the antibacterial property of the bio-coatings which offered significant antibacterial protection to the aluminium alloy surfaces by inhibiting the growth of the biofilm-forming bacteria Pseudomonas nitroreducens. These findings encourage the exploration of bio-based coatings for enhanced anticorrosion protection of aluminium alloys.



EM micrographs of (a, b) empty MSN and (c, d) MSN-QCT at different magnifications.

Biogenic Ag nanoparticles from neem extract for antimicrobial applications

Silver nanocrystals have been successfully fabricated via bioreduction route by using the ethanolic extract of Azadirachta indica (neem) leaves as the reducing and capping agent without solvent interference. The silver nanocrystals were grown in a single-step method, without the influence of external energy or surfactants, at room temperature. The nanoparticles were prepared from different ratios of silver ions to reducing agent molecules. The nanoparticles were roughly spherical and polydispersed with diameters of less than 40 nm with excellent crystalline nature. The presence of participating functional groups was determined by using Fourier transform infrared (FTIR) spectroscope. The synthesized silver nanoparticles were analyzed as a potential surface-enhanced Raman spectroscope (SERS) substrate by incorporating rhodamine B as the Raman reporter molecule. The bioreduction process was monitored through SERS fingerprint, which was evaluated by the change in vibrational energies of metal–ligand bonds. It was possible to detect the



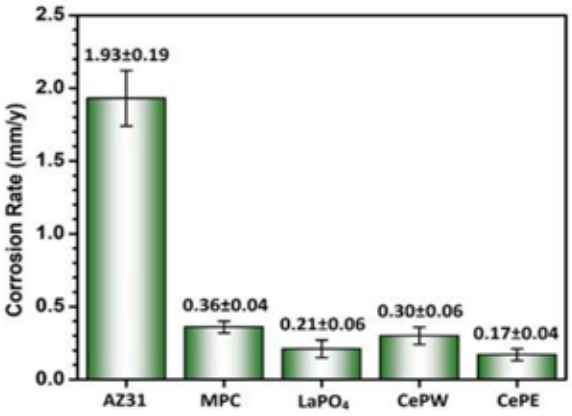
Antimicrobial behaviors biogenic silver nanoparticles

SERS spectral pattern of the probe molecules on the Ag nanoparticles without the use of any aggregating agent. Thus, the formation of probable intra- and inter-particle hotspots was attributed to evaporation-induced aggregation. Furthermore, stirring and precursor salt concentration influenced the kinetics involved in the fabrication process. The biomass-capped silver nanoparticles provided antimicrobial activity by inhibiting the growth of Pseudomonas nitroreducens, a

biofilm-forming bacterium, and the fungus, Aspergillus unguis (NII 08123).

Cerium phosphate chemical conversion coating on Mg alloys for biomedical applications

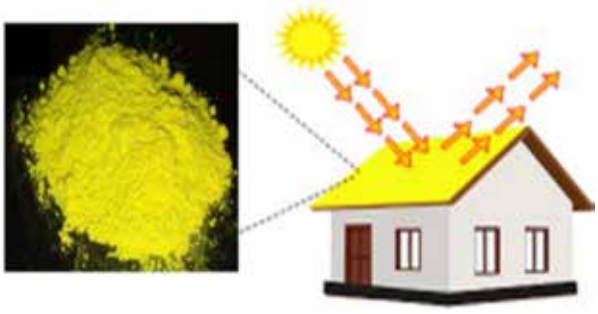
Magnesium and its alloys gained a lot of attention for temporary implant applications. However, the high reactivity of magnesium has always restricted its widespread usage. We recently developed corrosion resistant rare-earth phosphate coating based on lanthanum using a two-stage chemical conversion route. The reason for developing a two-stage process is the high reactivity generally exhibited by most rare-earth elements due to which it is observed that $LaPO_4$ gets precipitated during phosphate bath preparation rather than coating to the Mg substrate. In the present study, similar two-stage chemical conversion process was used for developing cerium based phosphate coating on AZ31 magnesium alloy. For coating, two separate baths were prepared: ammonium biphosphate [$NH_4H_2PO_4$ - 1 M] and cerium (III) nitrate hexahydrate [$Ce(NO_3)_3.6H_2O$ - 0.1 M]. In the first stage, AZ31-Mg alloy substrate was immersed in $NH_4H_2PO_4$ bath, maintained at pH 7.5 (adjusted using NH_3) for 20 min, followed by drying in the oven at 55°C. This stage results in the formation of a composite magnesium phosphate coating (termed as MPC) of struvite ($MgNH_4PO_4.6H_2O$) and newberyite ($MgHPO_4.3H_2O$). For the second stage, the pre-coated samples were dipped in $Ce(NO_3)_3.6H_2O$ solution prepared with two different solvents, water (CePW) and ethanol (CePE) to obtain CeP coatings. The degradation rate of the coated samples was carried in Kirkland body fluid (KBF) for 60 days. The test was carried out in a CO_2 regulated incubator kept at 37±1°C and the pH range was maintained around 7.3-7.4. The degradation properties of CeP coatings were compared with those of bare AZ31, and previously developed magnesium phosphate (MPC) and lanthanum phosphate ($LaPO_4$) coatings. The least corrosion rate (0.17 mm y^{-1}) obtained with CePE sample suggesting that the developed cerium based phosphate coating has great promise to be used in biodegradable implant applications. In-depth analysis on the cell viability and hemolysis has been currently undertaken.



Corrosion characteristics of cerium phosphate chemical conversion coating on Mg alloys

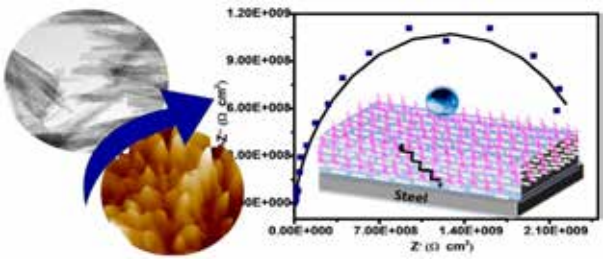
$BiVO_4$–ZnO complex inorganic pigment for energy efficient buildings

Bismuth vanadate ($BiVO_4$) is a yellow inorganic pigment which could replace the conventional chrome and cadmium yellow. However, its high cost over other yellow pigment restricted its usage. CSIR-NIIST has demonstrated an effective strategy to develop low-cost $BiVO_4$ complex pigments. Nanoparticles of $BiVO_4$ decoration (content ~ 75%) on white pigment was achieved by the citrate-gel method and reductions in the $BiVO_4$ have shown an impact on the economic viability of the new complex pigment and the developed complex inorganic pigment exhibited excellent greenish-yellow colour (a* = -6.28, b* = 76.45), like pure $BiVO_4$. An exceptional near infrared reflectance of 90% was observed which gives temperature shielding resulting in a temperature reduction of 8.4 °C in the interior of buildings.



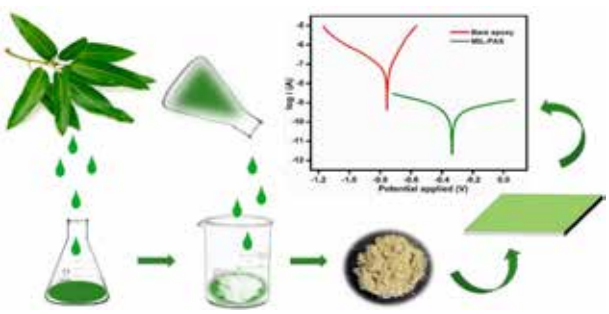
Durable hydrophobic coating for corrosion protection

A new eco-friendly cerium phosphate (CP) nanorod system can be used as an anti-corrosive pigment to protect steel from corrosive environment. CP nanorod (10 wt%) loaded epoxy exhibited the best corrosion resistance efficiency. The anti-corrosion property of the coating was further improved by the introduction of hydrophobicity through siliconization process. Average surface roughness (R_a = 0.4 to 11 nm) and contact angle of 121° were obtained for the coating which result in three-fold increase of the corrosion resistance of epoxy. The durability of the coating was two months. The enhanced corrosion inhibition efficiency and durability can be of significant importance for the industrial applications.



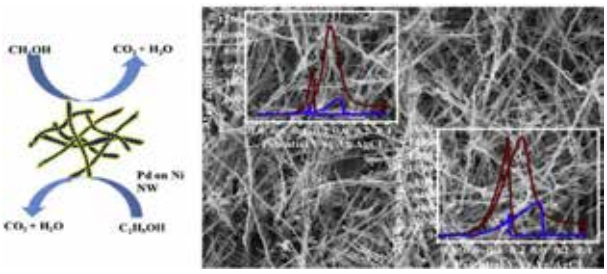
Plant extract based hybrid anticorrosive coating on steel

Ecological awareness brought adequate innovations in corrosion prevention as they are rich source of phytochemicals that can be explored as corrosion inhibitors in various electrolytic media. Herein, most ample tropical plant *Mangifera indica* L. leaf (MIL) extract was utilized for corrosion prevention of commercial steel (CS) in 3.5 wt% NaCl environment. This extract is a rich source of Polyphenol which gives excellent anticorrosive property. Corrosion prevention occurs by forming insoluble organometallic complex between metal ions and functional groups in the antioxidants at the metal-electrolyte interface. A new simple strategy is adopted here to make bio-extract containing epoxy coating on steel. MIL-precipitated amorphous silica (PAS) hybrid is incorporated in epoxy coating. Electrochemical measurement demonstrated that the developed coating have superlative corrosion inhibition efficiency of 99%.



Pd modified Ni nanowire as an efficient electro-catalyst for alcohol oxidation reaction

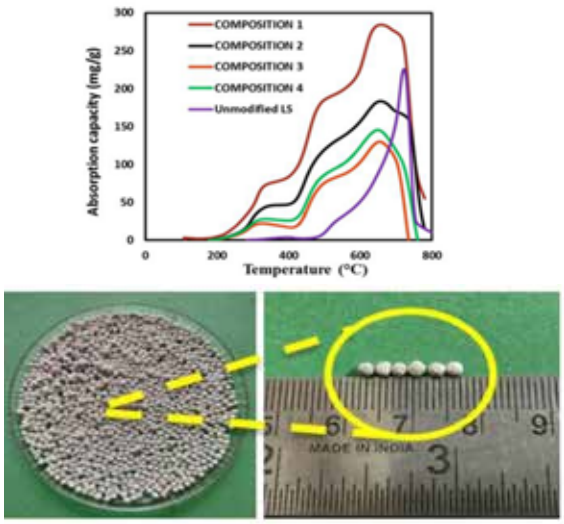
Developing highly efficient and economically viable electro-catalyst is very crucial research topic now-a-days for achieving affordable direct alcohol fuel cells. Nano-structural architecture plays a crucial role in the catalytic activity. Here, we report a cost effective one-dimensional (1D) nanostructured electro-catalyst for improved methanol oxidation reaction. Pd modified Ni nanowire catalyst towards methanol electro-oxidation were prepared by a simple galvanic replacement reaction. Exclusive nanowire morphology achieved through a wet chemical reduction method without employing any capping agents or surfactants. Pd modified Ni nanowires exhibited a supreme catalytic activity and durability towards methanol electro-oxidation. The distinctive 1D morphology and strong metal support interaction (SMSI) between Pd and NiO along with the bifunctional effects attributed to the enhanced catalytic activity. The amount of precious Pd metal was reduced by 90 wt% with enhanced catalytic efficiency. Ethanol electro-oxidation study showed an improved catalytic activity with mass activity of 1479.79 mA mg^{-1} Pd.



silicate based ceramics granules for high temperature CO_2 capture

It is of great significance to develop advanced functional materials satisfying the essential requirements of faster sorption kinetics, higher sorption capacity, selectivity, and durability in the quest for efficient CO_2 absorbing materials. High-temperature stability and selective CO_2

capture of the absorbent materials can aid CO_2 sorption in typical processes where CO_2 is a product (For Example hot flue gases, equilibrium shift reactions). Among the various CO_2 absorbents, lithium silicate based ceramic absorbents are known to work extremely well for CO_2 capture within the temperature range of 500-700°C. Moreover, lithium silicate (Li_4SiO_4) shows excellent chemisorption properties wherein up to 8.3 mmol of CO_2 per gram of sorbent can be absorbed. It also exhibits better thermal cyclability over a wide range of temperatures and is therefore a candidate material for the in situ removal of CO_2 from various CO_2 producing reaction environments. CSIR-NIIST in collaboration with Noritake Co. Ltd, Aichi, Japan has developed synthetic strategies for the realization of highly efficient alkali silicate based materials for CO_2 sorption. Near theoretical

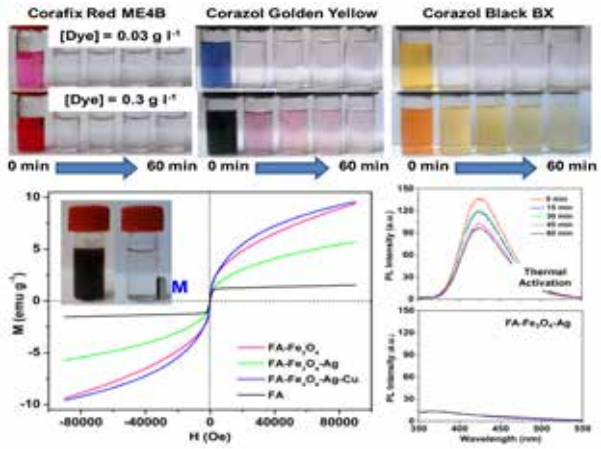


Dynamic thermograms demonstrating CO_2 capture in the temperature range of 200-650°C absorption capacity and exceptional rates for absorption-desorption kinetics were achieved by the compositional and morphological tuning of such materials. Alkali silicate nanorods with a eutectic mixture of carbonates helped to realize absorbents with extraordinary CO_2 absorption rates of 7.2 mg g^{-1} s^{-1} at 100% CO_2/923 K. Furthermore, the modified samples showed appreciable absorption performance at lower temperatures (~300°C) as well as lower CO_2 pressures (0.15 atm) demonstrating their potential in practical CO_2 separation applications such as in steel industry. The process is patented and scaled up the synthesis process to 2 kg levels maintaining the absorption capacity and kinetics. A process is also developed for the granulation of powders based on extrusion-spheriodization methodology.

Removal of azo reactive dyes from aqueous solutions using Flyash-Fe_3O_4-Ag and Flyash-Fe_3O_4-Ag-Cu magnetic composite particles via persulfate activation

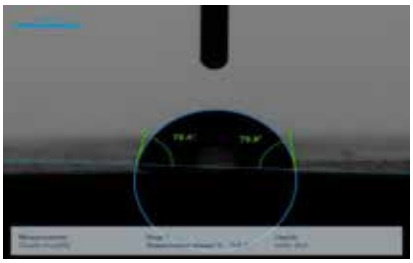
Magnetic Flyash (FA)-Fe_3O_4, FA-Fe_3O_4-Ag, and FA-Fe_3O_4-Ag-Cu composite particles have been synthesized via the combination of inverse co-precipitation, UV-reduction, and electroless coating techniques. The composite particles have been utilized as catalyst for the removal of industrial azo reactive dyes, such as Corafix Red ME4B, Corazol Golden Yellow, and Corazol Black BX from the aqueous solutions, via the activation of persulfate ($S_2O_8^{2-}$) anions at room temperature. The specific surface-area of as received FA particles is very low (1.21 m^2 g^{-1}). However, FA-Fe_3O_4, FA-Fe_3O_4-Ag, and FA-Fe_3O_4-Ag-Cu composite particles exhibit relatively higher specific surface-area of 92.5, 86.4, and 58.7 m^2 g^{-1} respectively which enhances the dye adsorption capacity of these particles relative to that of bare FA particles. The thermal and catalytic activation of $S_2O_8^{2-}$ anions results in the generation of hydroxyl ($^{\bullet}OH$) and sulfate ($SO_4^{\bullet-}$) radicals which are responsible for the attack and degradation of dye molecules. Within the initial dye concentration range of 0.03-0.3 g l^{-1}, all three azo reactive dyes have been decomposed via the advanced oxidation process in less than 60 min. All composite catalyst particles are superparamagnetic in nature with the saturation magnetization values of 9.43, 5.74, and 9.65 emu g^{-1} respectively which are larger than that (1.56 emu g^{-1}) of bare FA particles. Hence, all composite particles could be separated from the treated aqueous solutions using an external magnetic field. The $^{\bullet}OH$ trapping experiments conducted via the photoluminescence (PL) experiments using the terephthalic acid (TA) as a trapping agent show that the $^{\bullet}OH$ concentration is reduced significantly in the presence of composite particles which in turn suggests that $^{\bullet}OH$ also contribute to the regeneration of

composite catalyst particles. The deposition of Cu along with Ag has been noted to benefit not only in enhancing the saturation magnetization value but also in reducing the need for the post activation carbon (AC) treatment to reduce the final COD level of the treated dye solution.



Functional glaze coatings from rare earths ceramics

Glaze is a transparent, glassy protective coatings applied on ceramic bodies. Conventional glaze coatings produce only hydrophilic surface with the contact angle of less than 25° . Rare Earth ceramics exhibit hydrophobic surface properties at high processing temperatures. CSIR-NIIST developed high temperature stable hydrophobic glaze coatings out of Lanthana and Ceria compositions. Rare Earth Silicate compositions containing La_2O_3 produced greenish glaze coatings at 1200°C over porcelain insulator bodies. Here, the glazed body showed a hydrophobic contact angle of 90°. This value is three times higher than the conventional glaze. The glaze prepared with ceria offered contact angle above 60° on the surface of terracotta tiles. Hydrophobic ceramic glaze for sanitary wares is much needed because

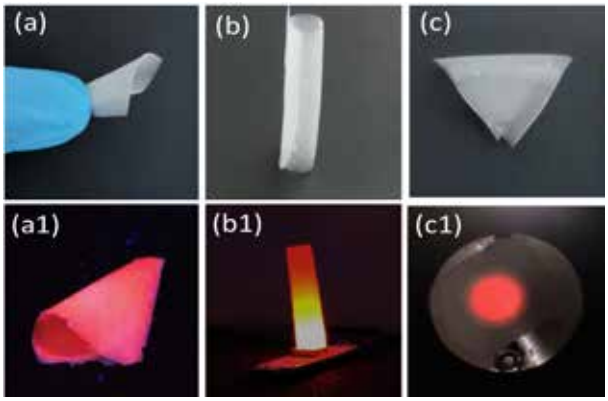


it offers less water for cleaning the sanitary ware bodies. Figure shows Rare Earth silicate glaze processed at 1200°C on porcelain ceramic insulator. Glaze shows contact angle value ~80°

Red-orange emitting phosphor-based composites for flexible lighting applications

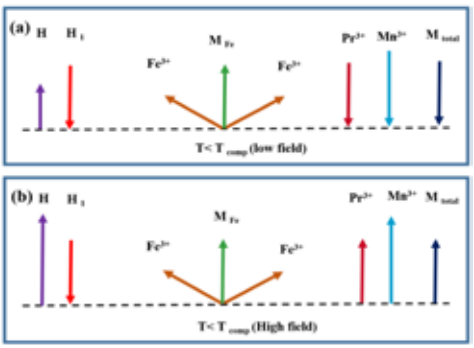
Flexible electroluminescent devices need light-emitting phosphor and CSIR-NIIST has fabricated some innovative polymer-phosphor composites, which could be suitable for several flexible lighting applications. $Sr_{2.9-3x/2}Ln_xAlO_4F$: $0.1Eu^{3+}$(Ln = Gd, Y) phosphors were developed which showed intense red-orange emission (Eu^{3+}: $^5D_0 \rightarrow {}^7F_{1,2}$) under UV light with high red color purity. Later on, flexible polydimethylsiloxane (PDMS) based films were also fabricated using optimized $Sr_{2.765}Gd_{0.09}AlO_4F$: $0.1Eu^{3+}$ phosphor from the above series. The flexibility of the $Sr_{2.765}Gd_{0.09}AlO_4F$: $0.1Eu^{3+}$ phosphor - PDMS composite film was tested under different bending conditions. Fig. (a, b & c) represents the composites at various bending or twisting conditions, while Fig. (a1, b1 & c1) are representing the corresponding images of the composites under the same conditions as those in Fig. (a, b & c), respectively with the UV illuminations. The photographs show that the composites are showing excellent red color display under the UV exposure in various bending modes without any color or intensity degradation. Furthermore, the good color uniformity

indicates the uniform distributions of the phosphor particles within the PDMS films.

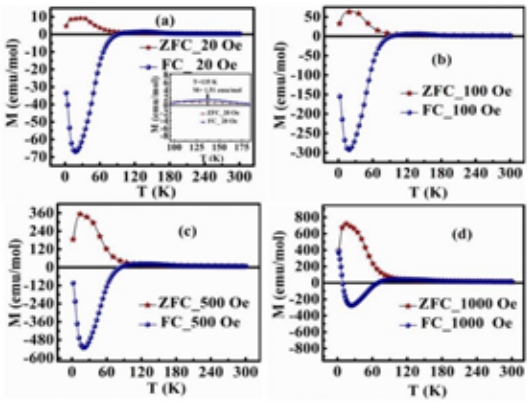


Sign reversal of magnetization in rare earth perovskites Pr_2FeMnO_6 and Sm_2CrMnO_6

Sign reversal of magnetization was observed in the polycrystalline Pr_2FeMnO_6 and Sm_2CrMnO_6 sample synthesized via citrate gel combustion method. $Pr_2FeMnO_{6\ is}$ crystallizes in orthorhombic structure with Pbnm space group; while, Sm_2CrMnO_6 has monoclinic structure with P21/n space group. Low-temperature magnetization reversal has been observed for both samples at low applied fields. When the applied field or temperature is increased, the negative magnetization got diminished. Such a sign reversal of magnetization is a result of the interaction between components of paramagnetic Pr^{3+}/$Sm^{3+}$and Mn^{3+} moments opposite to the component of the ferromagnetic Fe^{3+}/Cr^{3+} moment or the anti-aligned Fe/Cr–rich regions to that of Mn-rich regions containing with Pr^{3+}/Sm^{3+}. These materials are the promising candidates for magnetic switching application



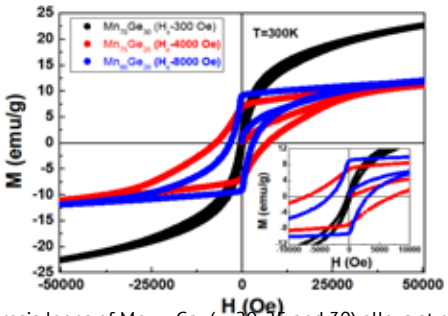
A schematic representation of Magnetization reversal mechanism



Temperature dependence of FC and ZFC magnetization at different magnetic field

Development of Mn based RE-free permanent magnets for automotive and energy generation

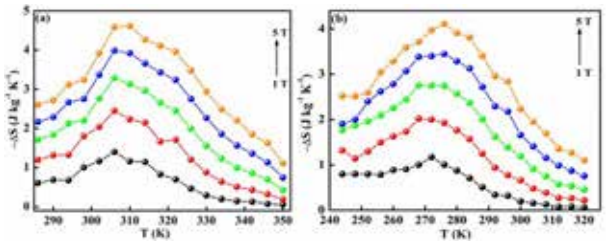
Permanent Magnets (PMs) are materials used to convert mechanical-to-electrical energy (and vice-versa) in many critical alternative energy, consumer electronics, and military applications due to their large maximum energy product $(BH)_{max}$ values, which describe their magnetic energy storage. For the last two decades, RE-element based materials have dominated PM applications. Recent crisis associated with global RE supplies, however, have made it necessary to explore routes for the development of more economically-viable RE-free alternative PMs with excellent properties. Materials having $(BH)_{max}$ between AlNiCo and $Nd_2Fe_{14}B$ in the range of 15 to 25 MGOe, would have important applications in energy conversion and generation technologies. Hence, developing Mn-based PMs are promising in the present scenario due to their ready availability and low cost. Most promising candidates in the Mn based family are Mn-Al, Mn-Bi and Mn-Ga alloys. We could successfully synthesised a hard magnet, $Mn_{80}Ge_{20}$ with a Coercivity around 8 KOe.



Hysteresis loops of $Mn_{100-x}Ge_x$ (x=20, 25 and 30) alloys at room temperature. Inset shows the enlarged view of the same

Development of magnetocaloric materials for room temperature magnetic refrigeration applications

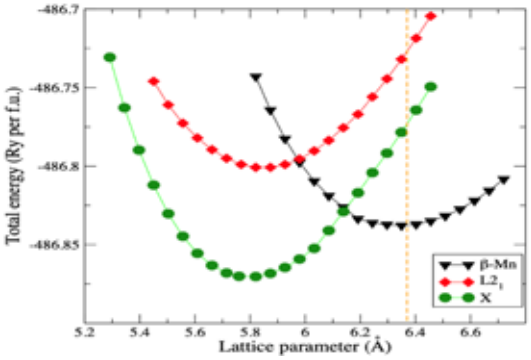
Green and sustainable energy is the prime motivation of present-day research. Conventional gas compression based refrigeration technology is a major consumer of energy and is an important cause of greenhouse gas emissions in modern society. Thus, it is important to conduct research on efficient and affordable cooling technologies that would result in reduction in energy consumption. Magnetic refrigeration based on magnetocaloric effect (MCE), has evolved as an environment-friendly and efficient alternative to conventional gas based compression refrigeration by eliminating the use of greenhouse gases and hazardous chemicals. MCE is a magneto-thermodynamic phenomenon that results from the warming and cooling response of a magnetic material to the applied magnetic field, characterized by the isothermal entropy change (ΔS_M) and the adiabatic temperature change (ΔT_{ad}), which is the working principle of magnetic refrigeration. Although numerous magnetic materials have been reported to show very high values of MCE but still the practical utilization of this effect has not been realized since very few materials exhibit this phenomenon at room temperature and ambient conditions. Manganites are cheap, non-toxic, resistant to corrosion, easy to manufacture, have a decent MCE and have easily tunable transition temperatures (T_C). Moreover, these materials are shapeable and can be processed in bulk quantities easily. In this attempt, we achieved a ΔS_M value of 4.61 J kg^{-1} K^{-1} at 310 K for a 50 kOe field for $La_{0.67}Sr_{0.15}MnO_{3-\delta}$ compound which could be a potential candidate for room temperature magnetic refrigeration applications.



Magnetic entropy change of La0.67Sr0.15MnO3-δ (a) and La0.67Sr0.06MnO3-δ (b)

Development of half-metallic ferromagnets for spintronics applications

Intermetallic compounds containing transition metals and metalloids often form a gap at the Fermi energy (E_F) due to the hybridization effects of d and sp elements. This gap can be exploited for applications such as thermoelectric and spintronics, making these compounds the subject of intense study to the researchers from the past three decades. In ferromagnetic (FM) materials, the gap is asymmetric with spin; however, if a gap occurs at E_F for one spin but not the other, is called a half-metal (HM), resulting in complete (100%) spin polarization of electrons at the Fermi level. The HM-FMs with such high spin polarization can be used to increase the performance of spintronic devices such as spin transistors, spin valve, spin diode and nonvolatile logic. Thus, we have developed a newer Heusler composition (such as Mn_2FeAl) stabilizing in a primitive cubic structure (X-type) which shows the half-metallic nature. Mn_2FeAl exhibits into 3 configurations and the electronic density of states reveal that Mn_2FeAl is metallic in β-Mn and $L2_1$ type structure whereas in the X type structure it is halfmetallic.

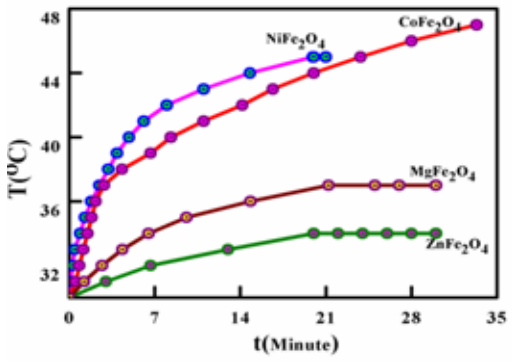


The total energy vs. lattice parameter curves for the β-Mn, $L2_1$ and X type structure of Mn_2FeAl. The dashed orange line corresponds to the experimental value 6.37 Å found for Mn_2FeAl in the β-Mn structure.

Development of biocompatible magnetic nanoparticles for hyperthermia therapy used in treating the cancerous cells

Hyperthermia therapy (HT) is a new and promising way of cancer treatment, in which body tissues are exposed to higher temperatures (42-46^{0}C) in order

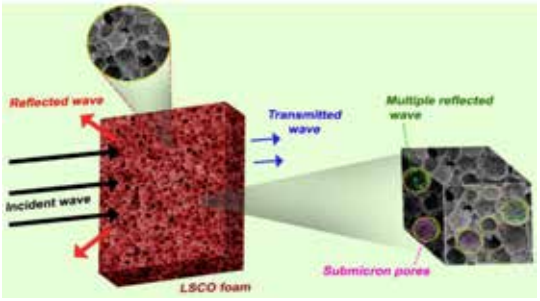
to kill the cancerous cells. Magnetic HT is a method to induce HT using magnetic nanoparticles (MNPs), which is because MNPs are capable of producing heat and the heat generated can be utilized to kill the tumour/cancerous cells. Tumour cells have lower heat resistance than that of the normal cells and could be selectively destroyed by delivering the heat to their exact tumour location. For this the MNPs should be injected into the blood stream and let they circulate in the dense blood vessels surrounding a tumour. By then subjecting the patient's tumour to a localized magnetic amplitude and frequency, the tumour cells can be heated up and destroyed. The MNPs must be delivered in a secure pathway specifically to the cancer spot and should be retained in the tumour in order to reach a sufficient concentration for effective HT. To succeed in delivering the MNPs into the tumour spot of the body, MNPs must have the characteristics of monodispersity, stability, and biocompatibility. The particle stability for the MNPs is to protect the magnetic core against air oxidation and prevent metal nanoparticles forming aggregates, hence ensure permanent biocompatibility. Moreover, the oxidized MNPs have detrimental effects in their magnetic properties. To date, the MNPs based on Iron Oxide Nanoparticles (IONPs) have been proven useful materials for HT; however, they do fail to achieve the effective heating. In this regard, we developed biocompatible $NiFe_2O_4$ / $CoFe_2O_4$ nanoparticles using a simple sol-gel technique with Egg-white as a medium satisfying the clinical temperatures in low concentrations within short duration of time.



Temperature vs. time curves at a field of 23 mT and a frequency of 263 kHz

Conducting $La_{0.5}Sr_{0.5}CoO_{3-\delta}$ foams for harsh condition microwave shielding

Mitigating or blocking the interfering EM signals is inevitable for many strategic communication systems for a healthy device management. Magnetic materials with metallic conductivity are the most suitable and well explored systems in EMI shielding. Metals are widely explored and applied materials in the EMI shielding applications..Conducting perovskite oxide $La_{0.5}Sr_{0.5}CoO_{3-\delta}$ (LSCO) possess moderately high electrical conductivity (>1000 S/cm), but their microwave absorbing abilities are unknown.

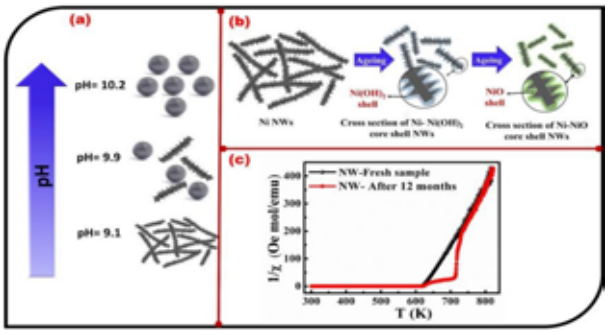


Schematic representation of the electromagnetic wave attenuation mechanism inside the macroporous LSCO

Hence, CSIR-NIIST has processed $La_{0.5}Sr_{0.5}CoO_{3-\delta}$ foams with broad range of porosities (76.9 to 90.3%) having near spherical cells through emulsion freeze gelcasting route. The LSCO foam bodies had compressive strength and Young's modulus in ranges of 1–7 MPa and 57 to 428 MPa, respectively. The increase in resistance of the foams with temperature shows their metallic conducting nature. Compared to the dense LSCO, the electrical conductivity values are inferior in foams, by an order. Impressive electromagnetic interference shielding effectiveness as high as 33 dB has been achieved for LSCO foams prepared at a porosity level of 80% with 10 vol% LSCO in the composition. The developed LSCO foams are lightweight and capable of withstanding harsh environmental conditions.

Printable hierarchical nickel nanowire based sensors

Ferromagnetic metals with controllable morphology and dimension are of considerable research interest due to their potential applications in optical, electronic, catalytic, magnetic resonance imaging, magnetic

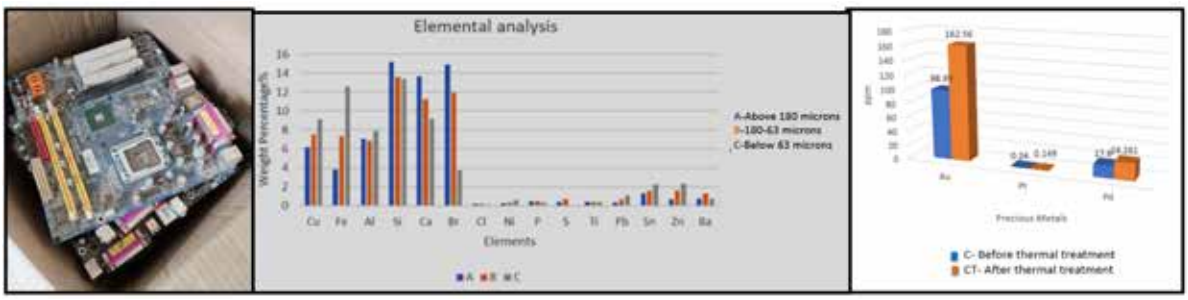


Schematic representation of (a) synthesis of Ni nanostructures by varying pH, (b) core-shell diffusion controlled mechanism in Ni NWs and (c) comparison between $1/\chi$ versus T of fresh and aged NW sample

data storage and biomedical fields. Among the soft ferromagnetic nanostructures, nickel (Ni) has fewer oxidation problems compared to other ferromagnetic materials. Hierarchical nickel nanostructures were synthesized through the wet chemical reduction process without the assistance of magnetic field and template. Effect of pH on the morphology of the Ni nanostructures was studied by changing the molar concentration of the base added. The nickel NW was formed by the subsequent self-assembly of sea-urchin-like nickel nanoparticles due to its dipolar interaction. As expected, the formation of different morphology and the consequent shape anisotropy largely control the magnetic properties of these nanostructures. Ageing study of the sample NW reveals the oxidizing tendency of Ni, which can diminish their magnetic properties since NiO is antiferromagnetic. It was further confirmed that annealing above 500 K could expedite the formation of NiO on the surface of nickel nanowires as well as nanoparticles, which in turn results in an asymmetry in hysteresis behavior, consequent to an exchange anisotropy operating at the interface of Ni and NiO. These results would provide critical informations on the factors controlling the shelf life of nickel-based magnetic memory devices.

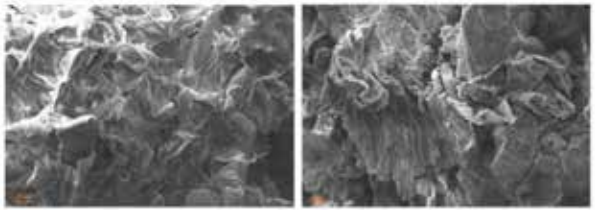
Enrichment of precious metals from urban mining wastes

Electronic waste (E-waste) recovery plays a vital role in a country's economy. Also, proper handling of E-waste shows the nations interest towards waste management and sustainability. The hazards of improper treatment of E-waste are very severe as it contains heavy metals and brominated flame retardant (BFR) which gives out harmful dioxins and furans during improper burning. The optimization and enrichment of E-waste for the recovery of valuable metals including precious metals like Au, Ag, Pd, Pt from waste Printed Circuit Board (PCB) from computers and mobile phones using a three step enrichment namely size reduction by using a hammer mill, size separation using ASTM sieves and thermal treatment using reduction furnace. The size reduction enhanced the surface area of the material and led to the easy liberation of metallic and non-metallic fraction; while, after size separation of E-waste into three different size fractions, XRF/ICPMS analysis showed that the metals are concentrated in all three but the amount of organic fraction is less in the least size fraction. XRD showed the presence of various metals including precious metals in E-waste. TGA analysis was done for the three samples at 900*C at a heating rate of 10°C/min showed that the thermal decomposition temperature is 390°-410°C where the organic fraction was degraded. Thermal treatment at 900°C was done using horizontal tubular furnace in air atmosphere showed a high metal enrichment due to the removal of organic fraction with no loss of metallic fraction. The weight loss of all three samples is in accordance with the results of TGA analysis. A temperature of 900°C is chosen as the harmful dioxin and furans are not stable under such conditions.

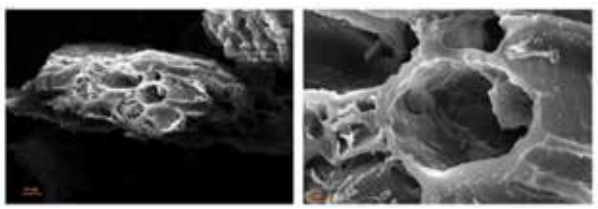


Conversion of waste coir pith into activated carbon for wastewater treatment

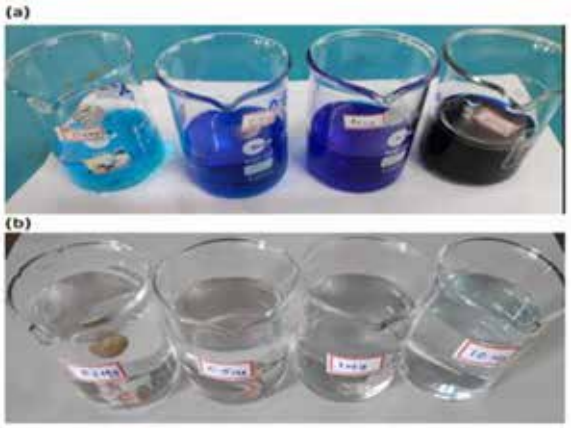
The coir pith is generated during the separation of fibres of coconut husk from coir processing industry. Due to its fluffy nature and lignin content, it easily affects the environment both soil and ground water and creates air pollution. Among the different pyrolysis temperatures



(400^0C, 500^0C, and 600^0C) for the waste coir pith, 400^0C has higher yield and high iodine value which indicates it has high adsorption property. The biochar is converted into activated carbon by activating agent KOH which diffuses into the internal structure of biochar and increases the existing pores there by creation of high pore volume in the activated carbon. The prepared activated carbon consists of large surface area and pore volume which is confirmed via SEM and iodine number analysis. The XRD and FTIR analysis shows the amorphous nature and oxygen containing functional group of the activated carbon, which help the adsorption of heavy metals. The COD analysis revealed that decrease of organic content after the treatment with activated carbon. The heavy metal removal efficiency of the activated carbon determined by ICPMS study. The result shows that the concentration of heavy metals such as Fe, Mn, Sb, Cr, Zn Cu, Cd, Ni, V, Mo, and Co significantly decreased after the treatment with activated carbon. UV-visible spectroscope analysis confirms 99.95% efficiency of methylene blue removal from water.



Coir pith Activated char



Methylene blue dye before (a) and after (b) treatment with activated char

Polymer/Coir composites : bio-degradable coir mulching mats and sheets for modern farming

Growing concern over global warming and to tackle climate change by 2030 as a part of the sustainable development goals (SDGs), scientists focus more on the development of sustainable and eco-friendly materials as an alternative material to petroleum-based single-use plastics. Mulches open up new horizons to biodegradable market which is generally used to cover the surface of soil to preserve soil moisture, to reduce weed growth, and thus, a healthy plant. Mulching is a covering, usually made of petroleum-based plastics, spread on the ground around plants to prevent excessive evaporation or erosion, inhibit weed growth, enrich the soil, and support drip-irrigation. Mostly, a mulch is organic in nature either synthetic (such as plastic sheeting or mats) or natural (such as bark chips or bricks). Plastic mulches or sheets, made of polypropylene or polyethylene provide many positive advantages, such as increased durability, enhanced insect management, and weed control. However, the removal and disposal of these plastic mulch is a serious environmental concern. Additionally, since it is not porous, plant roots may get deprived of oxygen and subsequently rot. Mulching mats produced from biodegradable materials like coir has several distinct advantages over conventional polymeric mulches. For example, they are eco-friendly due to their biodegradability, suppress weeds, prevent direct sunlight exposure protecting the plant from excess water loss due to evaporation, and hence, control

humidity. Currently, natural rubber latex is used as binder for coir mulching mats. However, the price of natural rubber latex is volatile depending on the season and also it has processing issues to achieve preferable thickness and proper bonding with fibers. Thus, there exists a huge demand for replacing the same with a bio-based bonding material for coir fibers.

The polymer group of Materials Science and Technology Division came up with a solution by developing bio-degradable binders for the production of coir-mulching mats and sheets in collaboration with National Coir Research and Management Institute (NCRMI). These mulching mats are biodegradable and are greener alternate to single-use plastic mulching films. A pilot-scale facility for the demonstration and fabrication of biodegradable coir-based mulching mats and sheets is established at CSIR-NIIST, Thiruvananthapuram.

(Top panel) Launching of the product: The developed biodegradable coir-based mulching mat was launched by the Honorable Finance Minister, Dr. T. M. Thomas Isaac in the presence of Shri. V. S. Sunil Kumar, Honourable Minister of Agriculture, Government of Kerala at Krishi Bhavan, Thiruvananthapuram on 18-June-2019; (Bottom panel) Custom-built Spray Booth unit: Pilot-scale demonstration and fabrication of biodegradable coir-based mulching mats and sheets using developed binder formulations.

Low density acoustic materials for building industry

The acoustic materials used in automotive and building interiors for noise cancellation are basically of glass wool, polyurethane and gypsum. The demand for ecofriendly, cost-effective and light-weight composites with better sound absorption coefficients is quite high in building industry. Coir fiber based acoustic composites with thermoset/thermoplastic polymers with tunable noise reduction coefficient of 0.7 – 0.9 as per ASTM C384-04, and flame resistance of V-0 under UL-94 test with a density of 90-180 Kg m^{-3} were developed.

Advantages include - a) room temperature processing, b) low density (0.10 – 0.14 g cm^{-3}), c) cost-effective (Rs. 30-50 $Sq.ft^{-1}$), d) non-toxic, e) self-extinguishing, f) no warping, g) good structural rigidity, h) aesthetic appearance.

Low density acoustic panels developed in collaboration with NCRMI, Government of Kerala

Rot-resistant coir bhoovastra for erosion control

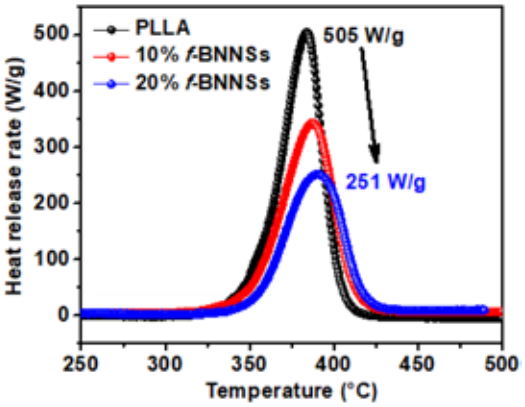
Coir, the golden natural fiber with high lignin content and unusual mechanical properties is extensively used in the preparation of geotextiles or bhoovastra. Geotextiles are used in road construction, prevention of soil erosion, and protection of river banks and sea shores as an environment friendly material in place of synthetic geotextiles; but, requires frequent replacement. A process is developed to make rot-resistant coir geotextiles with enhanced longevity, where an in situ chemical grafting was given with natural materials followed by curing for better properties and improved life time.

Highlights of the process	Advantages
• Process development for production of weather resistant coir geotextiles • Surface grafting leads to termite resistance • Nontoxic natural material based treatment • Resistant to microbial degradation • Increased UV resistance • Breaking force increased by 2.5% for treated GT on accelerated weathering • 100% retention of strength observed for 1 year on natural weathering • Expected durability for 5-7 years • Additional cost for treatment: 10%	• Weather resistant • Slow decaying • Durable • Flexible • Permeable • Light weight • Eco-friendly • Termite resistant • Cost-effective

Process for the development of surface treated geotextile

Polymer nanocomposites : sustainable multi-functional nanofiller for enhanced properties of poly(L-lactide)

A sustainable multifunctional nanofiller (f-BNNSs) based on the boron nitride nanosheets and biobasedphytic acid was prepared by using (γ-aminopropyl) triethoxysilane as a coupling agent. The structure of f-BNNSs was analyzed systematically using Fourier transform infrared spectroscope, X-ray photoelectron spectroscope and elemental mapping. The influence of f-BNNSs on the crystallinity, polymorphism, crystallization kinetics, thermal stability, thermal conductivity and flame retardant properties of poly(L-lactic acid) (PLLA) was systematically investigated. f-BNNSs show remarkable nucleating effects on the crystallization of PLLA and the crystallization rate increases with increasing f-BNNSs loadings. Upon the addition of 20 wt% of f-BNNSs, the crystallization half-time of PLLA/f-BNNSs nanocomposite decreases from 12.0 to 1.0 min at 130°C compared to PLLA. The presence of f-BNNSs in PLLA/f-BNNSs nanocomposites favors the formation of ordered form irrespective of the loadings of f-BNNSs. Thermal stability and thermal conductivity of PLLA increased significantly due to the strong interfacial interactions between hydroxyl groups of f-BNNSs and the carboxyl groups of PLLA. The presence of phosphorus, nitrogen, silicon and carbon elements in f-BNNSs improves the char forming capability of f-BNNSs leading to the enhancement of the flame retardancy of PLLA in PLLA/f-BNNSs nanocomposites. The limiting oxygen index (LOI) value of neat PLLA is 18.5 and it increases to 27.5 for PLLA nanocomposites containing 20 wt% of f-BNNSs. This work provides a new strategy towards the development of environmentally friendly multifunctional nanofiller for PLLA.

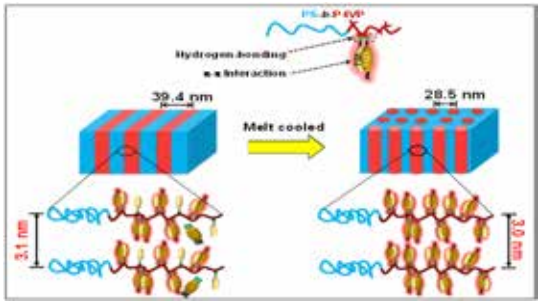


Heat release rate (W/g) vs. temperature curves for neat PLLA and its nanocomposites containing f-BNNSs

Co-assembly of functionalized donor-acceptor molecules within the block copolymer domains via supramolecular approach

Among the supramolecular designs, the functional groups on the π-systems exhibit several features, including the strong choice for π-π interactions, excellent charge-transfer (CT) complexation, semiconductivity and photophysical properties. We describe here the three-component self-assembly of functionalized small molecules (donor and acceptor) and

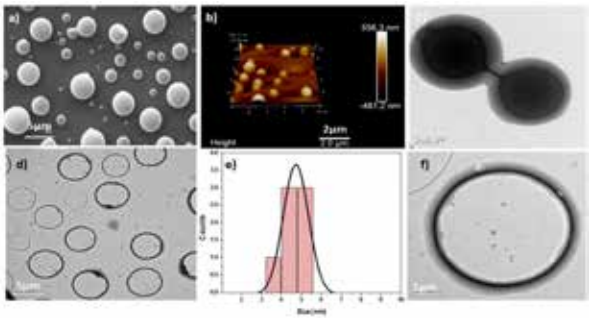
polystyrene-block-poly (4-vinylpyridine) (PS-b-P4VP) block copolymer. Herein, we depict the role of the functional groups on both donor (1-pyrenebutyric acid, PBA) and acceptor (functionalized naphthalene diimide, FNDI) molecules on the hierarchical assembly as well as the D-A stacking within the block copolymer domains. Both the molecules can form H-bonding with P4VP chains; and apart from this, π-π stacking between the PBA and FNDI molecules is also possible within the block copolymer domains. These noncovalent interactions lead to the formation of hierarchical structures and charge-transfer complexes between PBA and FNDI, where the bilayer D-A stacks formed within the block copolymer microdomains. It was also observed that the introduction of a functional group on FNDI molecules favors the formation of stable D-A stacks in the physical blend. Overall, the organization of both functionalized donor and acceptor molecules within the block copolymer domain exhibits enhanced charge carrier mobility, which is potentially useful in the field of electronic devices.



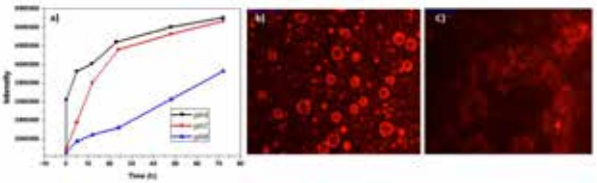
Schematic illustration of the hierarchical self-assembly of the functionalized donor and acceptor molecules within the block copolymer microdomains

Self-assembled giant vesicles of polystyrene / kaolinite in situ nanocomposites for pH-controlled delivery

A facile functionalization strategy for the fabrication of giant, inorganic-polymer hybrid vesicles by controlled aminosilyl / vinylsilyl (AS/VS) functionalization of the aluminol layer in kaolinite (Kaol) by intercalation and subsequent polymerization with styrene to *in situ* polystyrene clay nanocomposite (PCN) followed by self-assembly in solvents is reported. The synergistic effect of AS:VS ratio on functionalization assisted intercalation of Kaol was established in 1:3AS/VS-Kaol by the greater extent of formation of higher interlayer spacing observed corresponds to 1.12 nm compared to 1:1AS/VS-Kaol. With the increase in the values of AS:VS ratio, the PCN synthesised showed an increase in molecular weight attributed to higher vinyl functionalization of the Kaol. The PCN, 1:3AS/VS-Kaol/PS showed self-assembly in tetrahydrofuran (THF) at 2.5 mg mL^{-1}, into giant vesicular morphology having 2-6 μm diameter with a wall thickness of 300-400 nm. This result is attributed to functionalization induced molecular mass directed bilayer assembly of the delaminated, Janus type, modified-Kaol in polar aprotic solvent by end to end hydrogen bonding involving terminal -OH groups along the wall and laterally by $-NH_2$ groups, further stabilized by the π-π interactions of the phenyl moiety along the periphery. Rhodamine-loaded vesicles showed a controlled release in buffer solutions of pH, 7.0 and 9.0, attributed to the amino group assisted pore formation. In buffer solution of pH, 4.0, rapid release of the dye has been observed due to collapse of the vesicle directed by protonation of amino group. This study forms the first report on a novel method for the synthesis of rigid vesicles by functionalization induced self-assembly of Kaol based *in situ* PCN for possible applications in the cost-effective controlled delivery of drugs or cosmetics for topical applications.

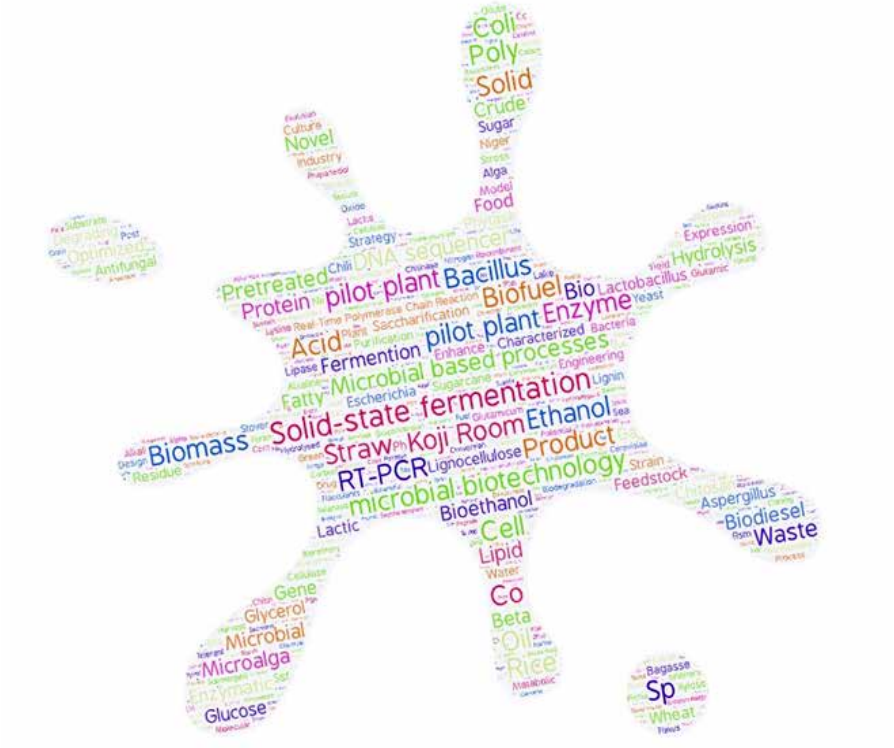


Self-assembly of PCN at 2.5 mg mL^{-1} in THF a) SEM micrograph of 1:3AS/VS-Kaol/PS, b) AFM height image of 1:3AS/VS-Kaol/PS, c) fusion of smaller vesicles in VS-Kaol, d) TEM image of 1:3AS/VS-Kaol/PS, e) distribution curve, and f) HRTEM image of the vesicle in 1:3AS/VS-Kaol/PS



pH controlled release of Rhm from PCN (a) fluorescence intensity observed at 556 nm with time in buffer solutions, (b) fluorescence microscope image of the dye loaded vesicles, and (c) fluorescence microscope image after 12 h in pH 4

Microbial Processes and Technology Division



DIVISIONAL DETAILS

Scientists: Nine	Technical staff: One	Students: Forty-Eight
Ongoing projects:	Twenty-Seven	Publications: Forty-One Ph. D. awarded: Three

Expertise: Microbial based processes and microbial biotechnology

Facilities: Biofuel pilot plant
Solid-state fermentation pilot plant (Koji Room)
DNA sequencer
Real-Time Polymerase Chain Reaction (RT-PCR)

सूक्ष्म प्रक्रियाओं और प्रौद्योगिकी प्रभाग

माइक्रोबियल प्रक्रियाओं और प्रौद्योगिकी प्रभाग (एमपीटीडी) प्रभाग का जनादेश जैव प्रौद्योगिकी के विशिष्ट सीमावर्ती क्षेत्रों में उच्च गुणवत्ता वाले आरएंडडी का संचालन करना है। पर्यावरणीय स्थिरता सुनिश्चित करते हुए क्षेत्रीय जैव स्रोतों के अन्वेषण और मूल्य संवर्धन में महत्वपूर्ण जोर दिया गया है। विभाजन सक्रिय रूप से माइक्रोबियल संसाधनों की खोज और दोहन करके बायोप्रोसेस और उत्पादों के विकास के लिए फोकस्ड क्षेत्रों में अनुसंधान में शामिल है। अनुसंधान का वर्तमान ध्यान i) औद्योगिक एंजाइमों और मूल्य वर्धित रसायनों के क्षेत्रों में है ii) जैव ईंधन और जैव ईंधन (iii) जैव सक्रिय अणु iv) स्वास्थ्य और जीनोमिक्स (v) संयंत्र माइक्रोब बातचीत और (vi) प्रोबायोटिक और अल्गल न्यूट्रास्यूटिकल्स। दूसरी पीढ़ी के बायोटेनॉल पर विशेष अनुसंधान एवं विकास के लिए डिवीजन के पास एक समर्पित "जैव ईंधन केंद्र" है। लिग्नोसेल्युलोसिक बायोएथेनॉल के उत्पादन के लिए पायलट प्लांट को अब साइट-सॉलिड-स्टेट किण्वन एंजाइम उत्पादन पायलट प्लांट द्वारा समर्थित किया गया है, जिससे बेहतर लागत-प्रभावी और हैंडलिंग के अवसर प्राप्त हुए हैं। डिवीजन विभिन्न माइक्रोबियल बायोप्रोसेस को विकसित करने के लिए अनुसंधान एवं विकास में शामिल है और इसमें किण्वन प्रौद्योगिकी, प्रोबायोटिक, जैव कीटनाशकों और जैव उर्वरक आदि के लिए माइक्रोबियल निर्माण पर काम करने के लिए मजबूत उद्योग संबंध हैं।

हाइलाइट

- चिकन पंख से अमीनो-एसिड का एंजाइमेटिक उत्पादन,: अवधारणा और प्रयोगशाला पैमाने प्रदर्शन का सबूत पूरा हुआ
- खर्च किए गए कॉफ़ी ग्राउंड या ऑलिव पोमेस क्रूड ऑयल से कम कैलोरी संरचित लिपिड का संश्लेषण, चुंबकीय नैनोकणों में स्थिर लिपिड द्वारा उत्प्रेरित
- 2,3-बुटानाडियोल के उत्पादन के लिए तेल ताड़ के मोर्चे का उपयोग करने के साथ-साथ संस्थानीकरण और किण्वन प्रक्रिया को अनुकूलित किया गया है।
- एसिनोबैक्टर ओलेइवोरन्स एस 27 द्वारा 5- हाइड्रोक्सीमेथाइल फ़्यूरफ़्यूरल से फ़्यूरन डेरिवेटिव के संश्लेषण के लिए एक बायोट्रांसफॉर्म विधि विकसित की है।
- दवा, और खाद्य उद्योगों में अनुप्रयोगों के लिए रासायनिक रूप से संशोधित ईपीएस का संश्लेषण।
- बुर्केपर्सिप Bmkn7 का उत्पादन करने वाला एक उपन्यास ऐंटिफंगल यौगिक अलग-थलग था और इसके जीनोम में कई अज्ञात द्वितीयक मेटाबोलाइट क्लस्टर होते हैं, जिन्हें अब तक वर्णित नहीं किया गया है।
- संभावित खारे चावल से जुड़े उपन्यास राइजोबैक्टीरिया के तीन ड्राफ्ट जीनोम पूरे हुए
- प्रत्यक्ष प्रमाण कि विब्रियो वास्तव में पौधे के साथ बातचीत करता है और इसके जीनोम में पहली बार प्रदान किए गए कई पौधे जुड़े लक्षण होते हैं।
- एक संभावित उपन्यास तनाव L1K23T जीनस सिसरिबैक्टेर के अंतर्गत आता है, परिवार राइजोबियासी की पहचान पोक्कली चावल से की गई थी।
- ओमेगा 3 फैटी एसिड का उत्पादन औद्योगिक सुविधा में बढ़ा
- कोरिनेबैक्टीरियम ग्लूटामिकम की क्रमागत ई ट्रांसपेप्टिडेज़ के जैव रासायनिक और कार्यात्मक लक्षण वर्णन को समझने में एक महत्वपूर्ण प्रगति की है
- पेनिसिलियमजनथिनेलम में सेल्यूलोज के जवाब में काज़िमेस की अधिक संख्या और बेहतर प्रेरण के लिए सबूत। बायोमास हाइड्रोलिसिस में इसकी श्रेष्ठता के लिए संभावित सबूत
- झिल्ली परिवहन और सिंथेटिक जीव विज्ञान में अनुप्रयोगों के लिए जैव-नकल कार्यात्मक विशाल पुटिकाओं की इंजीनियरिंग
- पैन सी एस आई आर 2 जी ई कार्यक्रम बहुत ही आशाजनक परिणाम और परिपक्व स्टैंडअलोन इकाई के संचालन के साथ पूरा हुआ। इथेनॉल की लागत 50% तक कम हो गई, जिससे वाणिज्यिक व्यवहार्यता प्राप्त करने के करीब पहुंच गया।
- इन-हाउसकोसेल्यूज़ और बीटा-ग्लूकोसाइडेज़ उत्पादन प्रक्रिया का पायलट पैमाने पर प्रदर्शन
- लिग्निन आधारित आसंजन-अवधारणा के आधार पर
- कोरिनेबैक्टीरियम ग्लूटामिकम में बायलोजेन के सोकोनोसे और बायोप्रोसेस के अनुकूलन के लिए जीन की विषम अभिव्यक्ति
- ग्लूटामिकम उपभेदों का उपयोग कर जैव-आधारित प्लास्टिक मोनोमर्स का किण्वन उत्पादन - α, अमीन्स -डि अमीन्स (प्यूटर्साइन और कैडेवराइन) और α, ω अमीनो अम्ल (5 अमीनोवालेरिक एसिड और गामा एमिनो-एरिक एसिड) लिग्नोसेलुलोसिक बायोमास से चयापचयी सी।

Microbial Processes and Technology Division

The mandate of the Microbial processes and Technology Division (MPTD) division is to conduct high quality R & D in specific frontier areas of Biotechnology. Significant emphasis is put in exploration and value addition of regional bioresources while ensuring environmental sustainability. The division is actively involved in research in the focussed areas for bioprocesses and products development by exploring and exploiting the microbial resources. The current focus of research are in the areas of i) Industrial enzymes and value added chemicals ii) Biofuels and biorefinary (iii) bioactive molecules iv) Health and genomics (v) plant microbe interactions and (vi) probiotic and algal nutraceuticals. The Division has a dedicated "Centre for Biofuels" for exclusive R&D on 2nd generation bioethanol. The pilot plant for the production of lignocellulosic bioethanol is now supported by on-site solid-state fermentation enzymes production pilot plant, bringing better cost-effective and handling opportunities. The Division is involved in R & D on developing different microbial bioprocess and has strong industry linkages to work on fermentation technology, microbial formulation for probiotic, biopesticides and biofertilizers etc.

Highlights

- Enzymatic production of amino-acids from chicken feather: Proof of concept and lab scale demonstration completed
- Synthesis of low-calorie structured lipids from spent coffee grounds or olive pomace crude oils catalyzed by immobilized lipase in magnetic nanoparticles
- Simultaneous saccharification and fermentation process using oil palm front for the production of 2,3-butanediol has been optimized.
- Developed a biotransformation method for the synthesis of furan derivatives from 5-hydroxymethyl furfural by *Acinetobacter oleivorans* S27.
- Synthesis of chemically modified EPS for applications in pharmaceutical, and food industries.
- A novel antifungal compound producing *Burkholderia* spp Bmkn7 was isolated and its genome contains many unknown secondary metabolite clusters, not described so far.
- Three draft genomes of potential brackish rice associated novel rhizobacteria were completed
- Direct evidence that Vibrio indeed interacts with the plant and its genome contains several plant associated traits provided for the first time.
- A potential novel strain L1K23T which belongs to the genus *Ciceribacter*, family Rhizobiaceae was identified from the Pokkali rice.
- Production of Omega 3 fatty acids scaled up at Industrial facility
- Made a significant progress in understanding the biochemical and functional characterization of sortase E transpeptidase of *Corynebacterium glutamicum*"
- Proof for higher number of CAZYmes and better induction in response to cellulose in *Penicillium janthinellum*. Probable evidence for its superiority in biomass hydrolysis
- Engineering of bio-mimicking functional giant vesicles for applications in membrane transport and synthetic biology
- PANCSIR 2GE program completed with very promising results and mature stand alone unit operations. Cost of ethanol reduced upto 50% making it closer to achieve commercial feasibility.
- Pilot scale demonstration of in-house cellulase and beta-glucosidase production process
- Lignin based adhesives -proof of concept
- Heterologous expression of genes for bioconversion of Xylose to Xylonic acid in *Corynebacterium glutamicum* and optimization of the bioprocess
- Fermentative production of the bio-based plastic monomers - $\alpha,\omega-$ diamines (Putrescine and Cadaverine) and α,ω aminoacids (5 aminovaleric acid and gamma amino butyric acid) from lignocellulosic biomass using metabolically engineered *C. glutamicum* strains

Brief report of the R &D activities

1. Bioprocesses and Products

1. Industrial Enzymes

1.1 Scale up of Keratinase enzyme production and its applications in amino acids production

Keratinase is an endo-peptidase that cleaves keratin, the key structural protein that makes up hair, feather, nails, horns, claws etc. The division works on process development for production of the enzyme using the microbial strain – *Streptomyces albidoflavus* TBGS13A5. The lab process for solid state fermentation (SSF) developed earlier was scaled to larger capacity in tray fermenter. The scale up experiment was conducted in 10 Nos of 50 g capacity trays. 5 L of crude enzyme, was collected and was concentrated using a tangential flow filtration system having 10 kDA cutoff. The 500 ml of crude enzyme obtained was again concentrated 2X by lyophilization. Concentrated enzyme was used for studies on chicken feather hydrolysis to generate amino-acids.

Fig 1: Growth and morphology of *S.albidoflavus* TBGS13A5 in 50 g SSF medium containing wheat bran as solid substrate along with 10% powdered chicken feathers A) Biological replicates of three trays. B) Magnified image single tray from the replicate. Image taken after 5 days of incubation.

Amino acids production from chicken feather

Concentrated Kertinase preparation was used for amino-acids production. Hydrolysis experiments were conducted in 150 ml flasks with 20 ml reaction volume. Multiple dilutions of enzyme (500, 750 or 1000 IU/ml) was tested for chicken feather hydrolysis to liberate amino-acids. The reaction mix was incubated at 55° C, in a shaking water bath at 200 rpm for 24h and the samples were collected different time points and analysed for amino acid content. Feather degradation efficiency of the enzyme was determined from the post hydrolysate (total) residual feather broth by measuring mass and also by electron microscopic observation.

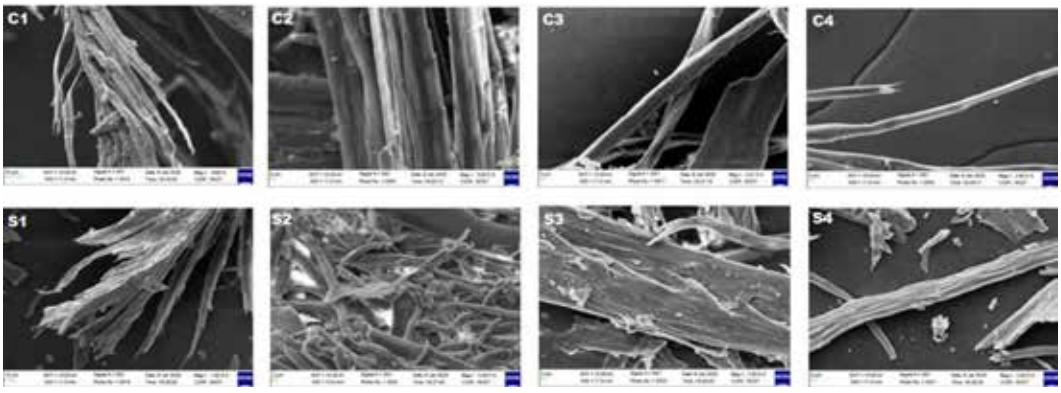


Fig 2: SEM Images of powdered chicken feathers taken after 6 hours of post hydrolysis treatment period. C1 to C4 controls (without enzymes). S1 to S4 treated with 1000 IU/ml of in-house keratinase. C1 & S1 in 1K magnification, and remaining others in 2.5K magnification

Presence of free amino acids in hydrolysate sample was qualitatively assayed with the ninhydrin staining method, (Sun et al. 2006) with the following 10 amino acids as a standard, Aspartic acid (ASP), Cystine (CYS), Glutamic acid (GLU), Glycine (GLY), Leucine (LEU), Methionine (MET), Phenylalanine (PHE), Serine (SER),

Tyrocine (TYR), and Valine (VAL). After spotting the TLC plates, the plates were kept in saturated TLC chamber with the mobile phase of n-Butanol (15): Acetic acid (1): Water (2) and run for 45 mins at room temperature, and the plates were dried under exhaust chamber for 15 mins, after drying the plates were stained with ninhydrin and heated by hot gun (50º C) and observed for spot development. The spot development (Fig 4) was compared between standards and test samples, which confirmed the presence of free amino acids in hydrolysates.

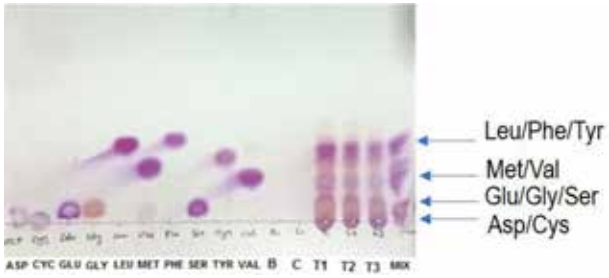
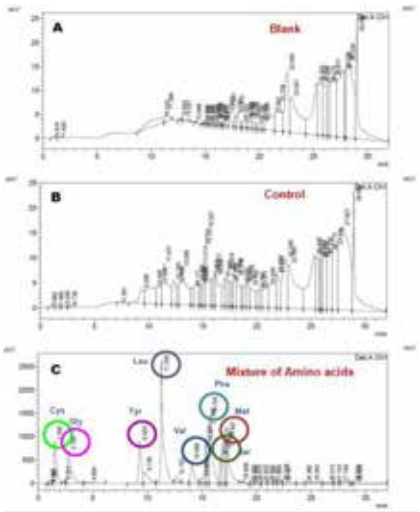


Fig 3: TLC of 10 Standard Amino Acids Aspartic acid (ASP), Cystine (CYS), Glutamic acid (GLU), Glycine (GLY), Leucine (LEU), Methionine (MET), Phenylalanine (PHE), Serine (SER), Tyrosine (TYR), and Valine (VAL) Enzyme Blank, Substrate blank and 3 test samples of 6 h post hydrolysis from T1) 1000IU/ml. T2) 750 IU/ml and T3) 500 IU/ml.

The profile of free amino acids in feather hydrolysates was further determined with HPLC analysis, For HPLC amino acid analysis, a hybrid mobile phase was used with two solvent systems, which contains solvent A (Sodium phosphate buffer pH 7.8) and solvent B (Acetonitrile (4.5): Methanol (4.5): MilliQ water (1)).



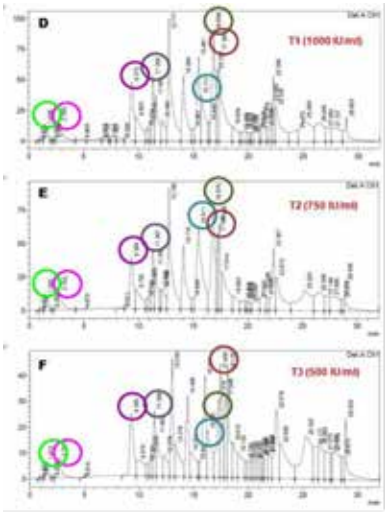


Fig 4: HPLC chromatogram profile of amino acids, compared with A) Blank, B) Control, C) mixture of amino acid standards. Liberated amino acid profile from hydrolysis samples treated with D) 1000IU/ml, E) 750IU/ml, and F) 500 IU/ml.

HPLC analysis detected liberation of 7 amino acids, namely, Cystine (CYS), Glutamic acid (GLU), Leucine (LEU), Methionine (MET), Serine (SER), Tyrocine (TYR), and Valine (VAL). *S. albidoflavious* keratinase shows promise for valorization of chicken feathers to generate amino acids.

1.2 Microbial Lipases

Lipase for making tailor made fats

Triacylglycerol (TAG) structure can be modified, namely by changing the original fatty acids (FA) by other FA with beneficial characteristics and/or by changing their original position in the glycerol skeleton. These modified fats, are known as "structured lipids" (SL) or "tailor-made fats,"

In our study, crude oils extracted from olive pomace (OP) was used as raw- material to synthesize low-calorie triacylglycerols, either by acidolysis with capric acid, or by inter-esterification with ethyl caprate, in solvent-free media, catalyzed by *sn*-1,3 regioselective lipases. The *Rhizopus oryzae* lipase (ROL) was immobilized in magnetite nanoparticles (MNP–ROL) and tested as novel biocatalyst. MNP-ROL performance was compared with that of the commercial immobilized *Thermomyces lanuginosus* lipase (Lipozyme TL IM). For both oils, Lipozyme TL IM preferred inter esterification over acidolysis. MNP-ROL catalyzed reactions were faster

and acidolysis was preferred, with yields of c.a. 50% new triacylglycerols after 3 h acidolysis of OP. MNP-ROL was very stable following the Sadana deactivation model with half-lives of 163 h and 220 h when reused in batch acidolysis and interesterification of OP oil, respectively (Fig.5). MNP-ROL showed to be an active and stable biocatalyst, alternative to the commercial immobilized preparation Lipozyme TL IM. This strategy opens a new market to added value products based on the oil from olive pomace. These are promising results towards the sustainability of MLM production.

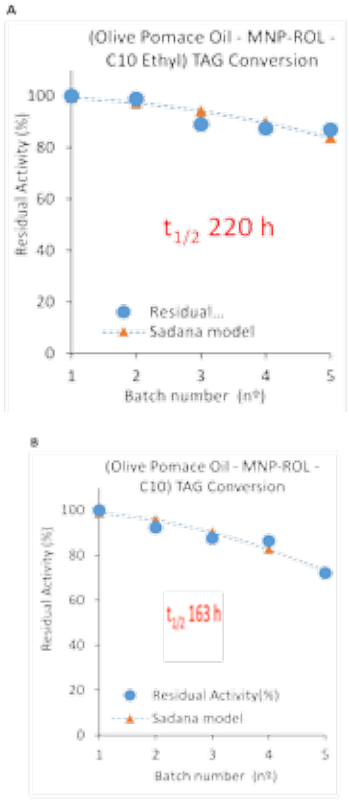


Fig.5. Residual activities of MNP-ROL at the end of each consecutive 24 h-batch of acidolysis or interesterification of olive pomace oil with A) capric acid (C10) B) ethyl caprate (C10 Ethyl) at 40 °C.

2. Biopolymers, Bio-surfactants and Microbial Metabolites

2.1. Simultaneous saccharification and fermentation of oil palm front for the production of 2,3-butanediol

2,3-Butanediol (BDO) is a valuable platform chemical with various industrial applications. This chemical is commercially synthesized from petrochemical feedstock. It is important and challenging to find an economical, safe and green route for the large scale production of such petroleum based chemicals. The present study aims to develop a process for the production of 2,3-butanediol by Simultaneous Saccharification and Fermentation (SSF). The study compared SSF with Separate Hydrolysis and Fermentation (SHF) and batch fermentation using glucose. The results showed that SSF is one of the most attractive techniques for the microbial production of 2,3-butanediol using lignocellulosic biomass. The enzymatic digestibility and fermentative efficiency of alkali pre-treated OPF biomass was checked and the role of various experimental parameters like enzyme loading and inoculum loading were optimized. SSF experiments

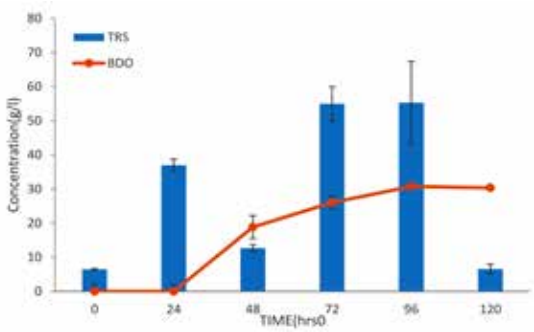


Fig 6: Total reducing sugar and 2,3-butanediol under SSF

gave 30.74g/l BDO in shake flask (Fig 6)

2.2. Biotransformation of 5-hydroxymethylfurfural by *Acinetobacter oleivorans* S27 for the synthesis of furan derivatives

5-Hydroxymethylfurfural (HMF) is the potent toxic furanic aldehyde produced during the chemical pretreatment of lignocellulosic biomass. In this study, a complete transformation of HMF was achieved using a novel isolate, *Acinetobacter oleivorans S27*. The conversion products were evaluated and found that it contained many useful and high-value intermediates like 5-hydroxymethyl-2-furancarboxylic acid (HMFCA) and 2,5-furan dicarboxylic acid. The biotransformation efficiency was found to be 100%, as there is complete conversion of HMF to other

chemicals. The biodegradation capability of this strain is quite remarkable. Within 12 hours of incubation, almost all substrate was utilized. Interestingly from the 24th hour of incubation HMFCA production has started. It was the indication that first oxidation of HMF had been started. Focusing on HMFCA production from the RSM based optimization experiments resulted in maximum yield of 85% when pH ranged between 6.5 and 8.2. The relation between inoculum age and pre-inoculum size was crucial for the HMFCA yield (27h and 3.5mL respectively).

The biocatalytic production of 2,5-furan dicarboxylic acid (FDCA) involves three subsequent oxidation steps. Our studies showed that the particular strain had no inhibition at given HMF concentration because it could degrade the toxic HMF to less toxic carboxylic acids and alcohols. The conversion of HMF to HMFCA was comparatively faster than HMFCA to FDCA. Availability of oxygen for the further oxidation may be the reason and also compared to HMF, the strain may be more tolerant towards HMFCA because it is less toxic than aldehyde. It should be noted that while pH is changing towards acidic (5.5-6.5) FDCA yield increased. At the same time initial pH was decreased and showed slightly alkaline as incubation time is increasing. Complete HMF degradation has occurred and approximately 65% yield of FDCA was obtained. *Acinetobacter oleivorans* S27strain has comparatively wide range of pH tolerance. Actual relation between pH tolerance and FDCA production is to be investigated further.

3. Probiotics and Nutraceuticals

3.1. Chemical modification of food grade exopolysaccharides for improved biological properties

Modification of native EPS for better biological properties was one of the objectives of the research work. Modified EPS usually finds applications in pharmaceutical, and food industries. Sulphonation, carboxymethylation, acetylation and phosphorylation are some of the reported chemical modifications that have a positive impact on the physiochemical nature of the EPS (Fig7). *L. plantarum* BR2 produces a glucomannan type of exopolysaccharide and has antioxidant activity which has already been reported. Modification of this EPS can be a better option to improve its biological property. Literature report proves that the antioxidant activity of exopolysaccharide derivatives might be related to their electron donating or hydrogen-donating ability. Though the functional groups such as –COOH, CH_3CO–, -SH and – H_2PO_3 were generally recognized as good electron or hydrogen donors, variations were observed for antioxidant activity of these derivatives. The studies on the assays and biological activity of the modified EPS are under progress.

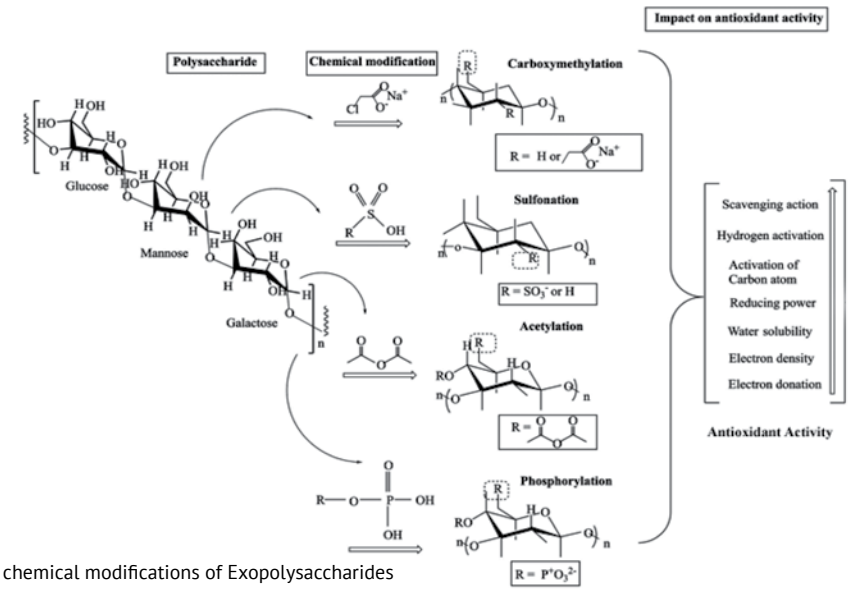


Fig 7. Possible chemical modifications of Exopolysaccharides

3.2. Essential omega-3 fatty acid - EPA production – Scale up study

Essential omega-3 fatty production and commercial scope: Ability of Plant growth regulators to promote growth, lipid production and Omega-3 fatty acid production may reduce the production cost and increase the nutraceutical value of *N. oceanica CASA CC201*. In order to validate the laboratory scale results, a scale up study (1500 L) also completed at commercial firm ABAN, Biotechnology Division (Fig 8).

Commercial scope: Currently the major source of omega 3 fatty acid is marine fish oil. However, fish do not synthesize DHA and EPA themselves; they obtain these essential fatty acids from PUFA rich microalgae in the aquatic food chain. Increasing demand for fish oil and its commercial production from wild fish stocks has led to economic, ethical and environmental concerns. As the global supply of fish oil in omega-3 fish oil market remains static or on the decline, the demand for these alternative sources of omega-3 is on the rise. As per WHO guidelines the dietary intake of DHA and EPA is 200 to 500 mg per day in global population. Due to the increased competition in global fish oil market, fish oil is being substituted with krill oil, algal oil and other vegetable oil. Thus, there is a great demand for new sources of omega-3 fatty acids and microalgae are currently regarded a promising alternative, as many species naturally produce high levels of EPA and DHA.

Major observations from scale up study at the commercial firm

i. The *areal biomass productivity* of *Nannochlorpsis sp.* in all the trials conducted ranged from a minimum of 1.83 g/m^2/day in scale-up trial 6 (without CO_2 supplementation) to a maximum of 6.85 g/m^2/day in scale-up trial 7 (with plant growth regulators and with CO_2).

ii. The *volumetric biomass productivity* ranged from a minimum of 0.012 g/L/day in scale-up trial 6 (without CO_2 supplementation) to a maximum of 0.046 g/L/day in scale-up trial 7 (with plant growth regulators and with CO_2).

iii. The *areal lipid productivity* of *Nannochlorpsis sp.* in all the trials conducted between Nov 2018-Jan 2019, ranged from a minimum of 0.788 g/m^2/day in scale-up trial 6 (without CO_2 supplementation) to a maximum of 3.544 g/m^2/day in scale-up trial 7 (with plant growth regulators and with CO_2).

iv. The *volumetric biomass productivity* ranged from a minimum of 0.005 g/L/day in scale-up trial 6 (without CO_2 supplementation) to a maximum of 0.024 g/L/day in scale-up trial 7 (with plant growth regulators and with CO_2).

v. EPA content in the total fatty acid profile ranged from a minimum of 2.79% in scale-up trial 7 (with chemical amendment and with CO_2) to a maximum of 14.56% in scale-up trial 6 (without CO_2).

Applied social and commercial value of activity:

i. Targeted Industries: Food and feed supplements in focused industry (i) poultry and (ii) Fish and aquaculture

ii. Poultry feed industry: The global poultry feed market was worth of USD 3,161.14 million in 2017. It is expected to have a CAGR of over 3.91% over the forecast period. The Indian poultry feed market is forecast to grow at CAGR of around 15% during 2015- 2020.

iii. Fish and Aquaculture: The global aqua feed market is expected to progress form US$ 57.7 billion in 2012 to US$122.6 billion by 2019, at a CAGR of 11.40%. The Indian aqua feed market is worth of USD 1.20 billion in 2017 and expected to have a CAGR of 10.4% during 2018-2023.

Fig. 8. Large-scale cultivation, harvesting downstream processing and dried biomass of *N. oceanica* CASA CC201.

4. Plant Microbe Interaction

4.1. PGPR tools for improving crop productivity in stressed agricultural systems:

4.1.1. A potent *Burkholderia* with novel broad spectrum antimicrobial metabolites from a landrace rice variety grown in saline affected area and its genome analysis

Plant growth-promoting rhizobacteria (PGPR) are naturally occurring soil bacteria that establish a positive relationship with the plants and benefit the hosts in different ways including preventing the deleterious effects of phytopathogenic microorganisms. These antagonistic interactions between rhizobacteria and plant pathogens, is certainly the most relevant for agriculture, to contribute more effective disease management. The plant probiotic studies of under explored ecosystem will definitely offer an opportunity to obtain biocontrol agents having novel biologically active metabolites that can be of agricultural benefits. A field in Kannur district of Kerala, where an inland landrace variety of rice 'Aiswarya' was grown in a salinity affected agriculture fields was selected as site for study. During a microbial screening for potential rhizobacteria producing antimicrobial agents from this rice variety, we had isolated a culture named as Bmkn7 that showed strong antifungal activity (zone of inhibition >20mm) against wide range of phytopathogens such as *Macrophomina phaseolina*, *Alternaria alternata* and *Fusarium oxysporum*. It also possessed antibacterial property against other bacteria such as *Escherichia coli*, *Staphylococcus aureus*, an environmental *Mycobacterium etc*. All these observations suggest that Bmkn7 produce a broad-spectrum antimicrobial agent. Notably, the antimicrobial property was observed only in agar but not in broth (Fig.9) made us to choose this culture for an in-depth study.

Fig. 9. (a) Boxplot representation (b) pictorial representaton – Confrontation of fungus (*Macrophomina phaseolina*) towards 2 days incubated Bmkn7 in agar, broth and control (without culture). Images were taken after 10th day post inoculation.

Bmkn7 was identified asa member of *Burkholderia cepacia* complex (Bcc) sharing highest similarity to *Burkholderia cepacia* (99.86 %) through 16S rRNA analysis. As majority of *Burkholderia* species has siderophores mediated antimicrobial activity mediated through depletion of iron, a vital nutrient required for all life forms, the strain was checked for siderophore production. Siderophore production was evident in Bmkn7 both in agar and in broth by Chrome Azurol S (CAS) assay. However, the siderophore inhibitory assay done by amending 100µM

iron to this media also showed similar antifungal activity as the control (without iron), thus, pointing out that there is a non-siderophore mediated antagonistic action of Bmkn7 (Fig.10). The result was further confirmed by checking the inhibitory effect using purified siderophore.

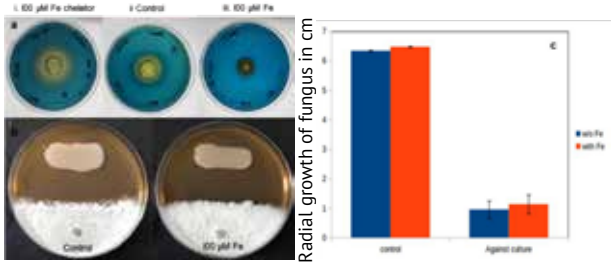


Fig.10 (a) CAS agar plate assay showing the release of siderophore by Bmkn7 - (i) iron limited condition by amending external iron chelator 2,2-dipyridyl, (ii) control plate and (iii) iron amended condition - siderophore production is higher in (i) compared to (ii) [(i)>(ii)] and no siderophore production in (iii) is observed. (b) Control and 100μM iron amended plates showing the same Inhibitory effect against *Macrophomina phaseolina*. (c) Graphical representation of the growth of the fungus in control and iron amended plate without and with Bmkn7.The two-tailed P value is 0.7322 (Not significant).

To be used as a biocontrol agent it is crucial for a bacterium to have a non-inhibitory effect on the plants. Through in-planta studies using VTL9 (saline tolerant variety) and Zordar (Inland variety) seeds with Bmkn7 we confirmed that this strain doesn't have any negative effect on rice seed germination and growth, indicating its non-phytotoxic nature.

The genome of Bmkn7 was sequenced for further investigation. The draft genome of Bmkn7 has a size of 8397732 bp with 8294 number of CDS (CoDing Sequence) genes and 63 number of rRNA genes. The average G+C content of the strain was 66.8%. Analysis using Antibiotics and Secondary Metabolite Analysis Shell (antiSMASH) showed that the genome of Bmkn7 strain has almost all Biosynthetic Gene Clusters (BGCs) such as polyketide synthase (PKS), non-ribosomal peptide synthase (NRPS), terpene, bacteriocins etc that are responsible for the biosynthesis of secondary metabolites. Besides, antiSMASH was unable to annotate the NRPS like cluster spanning 578250-622086 bp region of contig-1 (Fig.11), suggesting that the compounds produced from this cluster may be novel or under-studied. Thus, data obtained from antiSMASH provided a concrete insight that the strain can indeed produce novel antimicrobial compounds. Finally, we were able to extract the secondary metabolite of Bmkn7 from agar and the extract exhibited inhibitory effect (MIC- 7mg/ml) only towards fungus and *S.aureus* and with other tested bacteria indicating that more than one antimicrobial compound is being produced by this strain. The initial data obtained from HRMS and LC-MS analysis gives us a hint that the compound obtained from this culture is not corresponding to any of the already known compounds of *Burkholderia* till date. Altogether, the above findings summarise the possibility of a novel antimicrobial compound from a rice associated *Burkholderia*, for which further analytical based characterisation studies are underway.

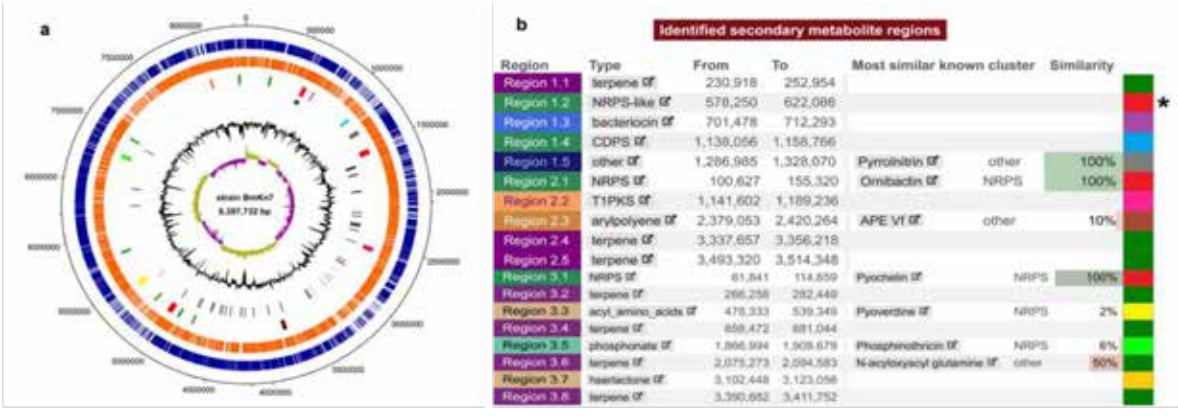


Fig.11- (a) Circular representation of Burkholderia strain BmKn7 genome. From inside to outside 1) GC skew 2) GC content 3) tRNA and rRNA genes 4) Secondary metabolite regions 5) Predicted CDS in the counter-clockwise and 6) Predicted CDS in clockwise direction. (b) List of secondary metabolite regions in strain BmKn7 identified using antiSMASH.

4.1.2. Host-association and genome characterization of a novel marine adapted *Ciceribacter* strain from brackish grown wild pokkali rice

Plant growth and productivity is directly and indirectly influenced by the activities of plant growth promoting rhizobacteria (PGPR) ranging from nutrient acquisition to defence against phytopathogens. Indeed, several of these PGPRs are widely used in sustainable farming for increased crop yields with reduced environmental impact. However, the PGPRs used till date comprise a very meagre percentage of the total rhizobacterial population which is very diverse as proved from the plant microbiome studies. Therefore, it is very essential to screen and isolate diverse and potential PGPRs, for which unexplored ecosystems are to be targeted. Hence, the site we selected in this study was brackish rice fields of Ernakulam district in Kerala which cultivates a saline-tolerant wild rice variety, Pokkali. During our screening for novel PGPRs, we had isolated two bacterial strains designated as L1K22 and L1K23T which showed very good growth in artificial marine media (ZoBell marine agar) and R2A broth media's prepared with 4% NaCl and in full strength natural seawater (NSW), which was the first indication on its brackish adaptive trait (Fig. 12). Additionally, 20% natural seawater enhanced the colonization of L1K23T

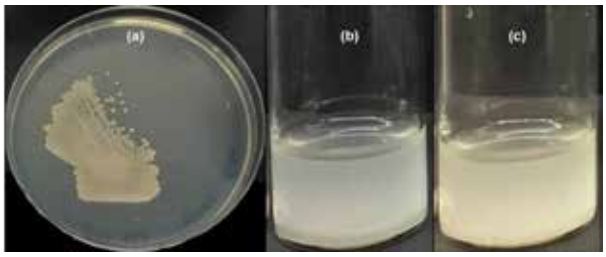


Fig. 12 Growth of L1K23T after 3 days of incubation in (a) Zobell marine agar, (b) R2A broth + 4% NaCl, and (c) R2A broth prepared in full strength natural seawater

cells by 3-log higher compared to non-seawater conditions as inferred from the binary association experiments performed in gnotobiotic hydroponic setup (Fig. 13). The recovery results thus confirmed the strong influence of a brackish condition in aiding the root colonization ability of L1K23^T.

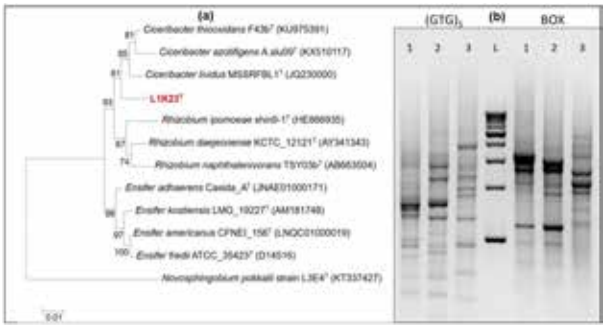


Fig. 14 16S rRNA gene based phylogenetic tree showing the phylogeny of L1K23^T strain, (b) Genomic DNA fingerprinting using $(GTG)_5$ and BOX primers. 1, L1K22; 2, L1K23^T; 3, *Ciceribacter lividus* MTCC 11352^T; L, 1 kb DNA ladder

Neighbour, *Ciceribacter lividus* (Fig. 14 (b)). Further, from the results of multi-locus sequence analysis (MLSA), we could provide final validation in claiming L1K23^T to be a novel species under *Ciceribacter* genus. All these leads made us to sequence the draft genome of L1K23^T. The genome size of L1K23^T was 4,808,689 bp with 4854 number of coding sequences, 1441 hypothetical genes and 9 rRNA genes (Fig. 15 (a)). The G+C content of L1K23^T was 61.3%. Basic analysis using RAST (Rapid annotation using Subsystem technology) server identified several important genes and gene clusters that complement the plant beneficial and colonization traits of L1K23^T. More importantly, L1K23^T genome coded for flagellar motility, chemotaxis (CheA, CheD, CheY, CheB, CheW, CheR) and tight adherence (tad) operon genes which are assumed to play a major role in binding followed by subsequent colonization in the host (Fig. 15 (b)). In addition to type I secretion system, L1K23^T genome also coded for type VI secretion system which is presumed to be very important in attributing rhizosphere competance against other dominant rhizobacterial populations (Fig. 15 (b)).

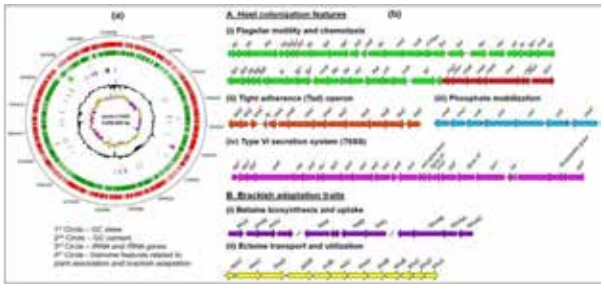


Fig. 15 (a) Circular map of L1K23^T draft genome, (b) Gene clusters related to host colonization features and brackish adaptation traits present in L1K23^T genome

Finally, supporting for their enhanced growth in seawater amended media and survival as planktonic cells in 20% NSW, we could identify gene clusters coding for ectoine degradation and transport and also for glycine betaine uptake which signifies the brackish adaptive traits coded in L1K23^T genome. All these findings led us to consider L1K23^T as a potential rhizobacteria native to pokkali and further studies are underway to provide strong validations in their host-interaction physiology and associated molecular factors.

4.1.3. Metagenomic abundance and genome analysis of a plant beneficial *Vibrio* strain MSSRF30 from rhizosphere of a mangrove associated wild rice

The advancement in sequencing technologies and allied bioinformatics pipelines have led us to know more about the hidden microbial richness in varied ecological niches. Similar approaches have been followed to understand the plant as a holobiont through several microbiome studies targeting different plant regions such as phyllosphere, rhizosphere, root etc. Similarly, in our study we made an attempt to understand the unexplored rhizosphere and root microbiomes of a unique brackish wild rice variety, Kagga cultivated along the coastal belts of Karnataka. Through QIIME (Quantitative Insights Into Microbial Ecology) analysis, we could observe very good enrichment of *Vibrio* genus specific OTUs in the roots of Kagga (Fig. 16). Interestingly, during OTU mapping, majority of OTUs showed highest similarity (100%) to 16S rRNA gene of *Vibrio porteresiae,* a strain isolated from the rhizosphere of mangrove associated wild rice a decade ago.

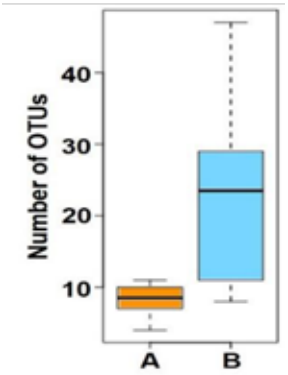


Fig. 16. Box plot representing the abundance of Vibrio OTUs from (A) rhizosphere and (B) root samples of Kagga.

This observation made us to investigate more on the plant growth promoting traits of *V. porteresiae* through *in-vitro* assays. *V. porteresiae* showed positive growth in minimal media containing 1-aminocyclopropane-1-carboxylic acid (ACC) as the sole nitrogen source **(Fig. 17 (a))**. Further, we quantified the ACC deaminase activity of *V. porteresiae* by determining the amount of alpha-ketobutyrate produced, which was calculated to be 0.24 µmol/mg/h of specific activity and L1E11^T (marine gammaproteobacteria strain reported for ACC deaminase activity) was used as the positive control as represented in **Fig. 17(b)**. Interestingly, no studies till date have reported the presence of active ACC deaminase gene in *Vibrio* genus. Moreover, previous literature has suggested that inoculations with PGPR containing ACC deaminase activity make the host plants more resistant to saline stress. *V. porteresiae* also showed preliminary evidences supporting the nitrogen fixation ability through positive growth observed in nitrogen-free broth and sub-surface pellicle formation in nitrogen-free semi-solid agar medium **(Fig. 17 (c))**. Similarly, we observed a clear halo zone around the *V. porteresiae* spotted area on Pikovskaya's medium containing 0.5% of calcium triphosphate **(Fig 17(d)).** In order to confirm if the bacterium produced organic acids to release inorganic phosphate (Pi) into the surrounding medium, the culture was inoculated in Pikovskaya's broth and a drastic drop in

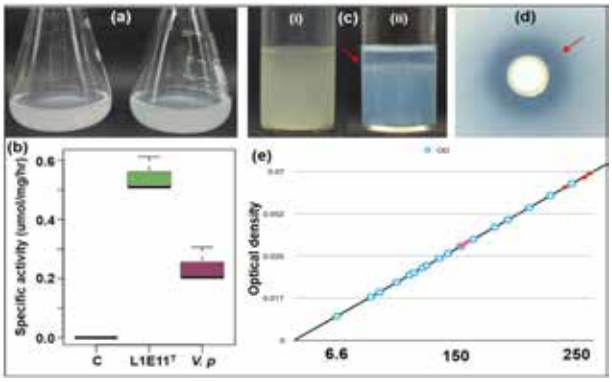


Fig. 17. *In-vitro* PGPR traits of *V. porteresiae* (a) Growth in minimal media containing ACC as the sole nitrogen source, (b) Box plot representing the ACC deaminase activity of *V. porteresiae (V. p)* and positive control strain L1E11T measured by determining the specific activity of alpha-ketobutyrate produced, (c) Growth in (i) nitrogen-free broth, and (ii) sub-surface pellicle formation (indicated by red arrow) in nitrogen-free semi-solid agar, (d) Phosphate solubilization (clear halo zone indicated by red arrow) in pikowskaya agar medium, (e) Graph representing the release of inorganic Pi mediated through gluconic acid metabolism

the pH was noted. The acid was confirmed to be gluconic acid, as confirmed through HPLC analysis and the release of inorganic Pi by *V.porteresiae* was estimated using the ammonium molybdate-ascorbic acid method **(Fig. 17 (e))** which confirmed that phosphate solubilisation and Pi release was mediated through gluconic acid metabolism.

Followed by, the *V. porteresiae* cells were tagged with green fluorescent protein (GFP) through conjugation to visualize whether *V. porteresiae* cells colonized brackish rice roots to attribute their PGP traits. Through epi-fluorescence microscopy imaging, we could locate the colonized *V. porteresiae* cells in the intercellular spaces (Fig. 18 (a)) and fine lateral root junctions (Fig. 18 (b)) throughout the primary root, which was taken for visualization after vigorous washing of pokkali rice seedling roots post 3 hours of attachment.

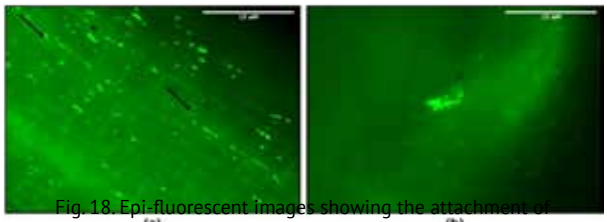


Fig. 18. Epi-fluorescent images showing the attachment of GFP labelled *V. poteresiae* cells in (a) intercellular spaces, and (b) fine lateral root junctions

From the above leads, we proceeded for a draft genome sequencing of *V. poteresiae*. The genome size of *V. poteresiae* was 5,432,918 bp harboring a total of 4964 genes of which 4027 genes were functionally predicted whereas remaining 937 genes coded for hypothetical proteins. The genome comprised of 11 rRNA genes and the average G+C content was 44.8% (Fig. 19). Using RAST (Rapid annotation using Subsystem technology) server for functional categorization, highest number of genes were assigned to carbohydrate (614 genes), amino acid and derivatives (473 genes) and Cofactors, vitamins, prosthetic groups and pigments (383 genes) categories. Higher proportion of carbohydrate metabolism indicated an efficient utilization of plant derived materials. *V. porteresiae* genome also had higher number of methyl accepting chemotaxis genes (62 genes) compared to *V. cholerae* (43 genes) complementing their ability to colonize the plant roots. Additionally, the genome harbored type IV pili, MSHA and tight adherence genes, which are known to be involved in attachment. Finally, the growth of *V. porteresiae* in nitrogen-free conditions were strongly supported by the presence of the nitrogen fixation gene cluster with a total size of 23.4 Kb size comprising 30 genes that were distributed in two different locus and the structural components of nitrogenase complex consisted of a MoFe type *nifHDK* genes. All these phenotypic evidences and genome features clearly confirmed *V. porteresiae* to be plant associated and hence their abundance was observed in the metagenomic analysis of kagga rice roots. Further molecular and transcriptomic studies are underway with the aim to establish a model system for *Vibrio*-plant interactions under brackish conditions using *V. porteresiae* as a potential rhizobacterial strain.

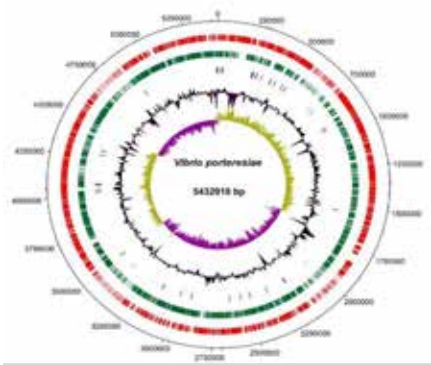


Fig. 19. Circular map of *V. porteresiae* genome. 1st circle, GC skew; 2nd circle, GC content; 3rd circle, tRNA and rRNA genes.

5. Understanding Biological processes and Molecular Biology of Industrial Microorganisms

5.1. Cloning, overexpression and functional characterization of NCgl 2838 as Sortase E (Cg-SrtE) of *Corynebacterium glutamicum* ATCC 13032

Most Gram-positive bacteria contain a membrane-bound transpeptidase known as sortase which covalently incorporates the surface proteins on to the cell wall. The sortase-displayed protein structures are involved in cell attachment, nutrient uptake and aerial hyphae formation. Among the six classes of sortase (A-F), sortase A of *S. aureus* is the well-characterized

housekeeping enzyme considered as an ideal drug target and a valuable biochemical reagent for protein engineering. Similar to SrtA, class E sortase in GC rich bacteria plays a housekeeping role which is not studied extensively. However, *C. glutamicum* ATCC13032, an industrially important organism known for amino acid production, carries a single putative sortase (*NCgl2838*) gene but neither *in vitro* peptide cleavage activity nor biochemical characterizations have been investigated. In this study, we focused on elucidating the specificity of peptide substrates for *C. glutamicum* sortase and its biochemical characterization by fluorescence resonance energy transfer (FRET)-based assay (Fig 20)

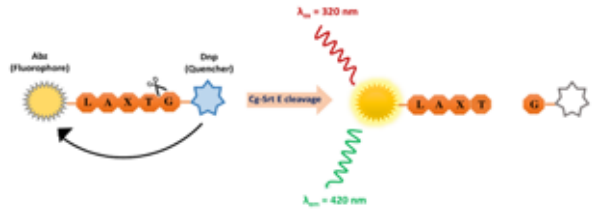


Fig.20: FRET-based cleavage assay.Schematic representation of Abz-LAXTG-Dap(Dnp) cleavage by Cg-SrtE. The fluorophore (Abz) and quencher (Dnp) is sandwiched between the peptide substrate. The fluorescence is measured when thesortase E-mediated reaction separates the fluorophore from the quencher.

Purified recombinant Cg-SrtE incubated with recognized substrate motifs Abz-LAHTG-Dap (Dnp), Abz-LAETG-Dap (Dnp) and Abz-LPETG-Dap (Dnp) to investigate the substrate specificity. The enzyme failed to cleave the LPETG motif recognized by *S. aureus* sortase A (Fig.21). Results shown here is an average of three independent enzyme assay each done in triplicates.

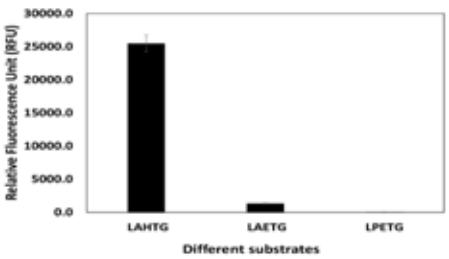


Figure 21. Enzyme activity and substrate specificity of Cg-SrtE by using a FRET-based cleavage assay

5.2. Transport across membrane:

Giant unilamellar vesicle (GUV) serve as an excellent scaffold to study biological processes occurring at the membrane interface. Giant vesicles are employed to probe specific membrane-biophysical properties with controlled lipid-composition under defined external conditions. In this report, we systematically construct Gram-negative and Gram-positive bacterial mimicking membrane models under controlled physiological conditions. We established the functionality of these models by quantifying the diffusion of small molecules across membranes of varying lipid composition. We propose such bio-mimetic model membrane systems can find applications in synthetic chemical biology. For example, we studied diffusion of antibiotics specifically fluoroquinolones using their intrinsic fluorescence as detection system inside single giant vesicle using imaging. Antibiotic transport properties are probed under different lipid compositions and effect of charge of antibiotic on its permeation is studied (Figure 1B). We quantified the diffusion of antibiotics by immobilizing giant vesicles in agarose for ease of imaging. Diffusion of antibiotic is measured as a change in fluorescence intensity inside vesicles in a time-dependent manner (Figure 22 A1 to A4). We studied lipid dependence, pH and ion dependence of antibiotic transport across membranes.

Importantly, we have quantified the diffusion rates by calculating the fluorescence intensity inside the vesicle which is a direct measure of antibiotic concentration using ImageJ-Fiji software. For Gram-negative (GN) mimicking vesicles, the scatter plot of normalized intensity ($\Delta I = (I_{out}-I_{in})/I_{out}$) of antibiotics, norfloxacin and ciprofloxacin at pH 5 and pH 7 at two-time points is plotted. The ΔI calculated at two different time points are used to determine the permeability coefficient individually for each vesicle (GN vesicles Figure 1A to 2D). The histograms of permeability coefficients are shown in Figure 2E, 2F for GN vesicles. The mean and standard errors of the mean are calculated from the statistics represented in the histograms. In GN vesicles, norfloxacin at pH 7 has a permeability of $0.6\pm0.08 \times 10^{-6}$ cm/s (mean ± S.E of mean calculated from 26 individual GUV's) and at pH 5 the value is $0.22\pm0.04 \times 10^{-6}$ cm/s (n=16). Similar results are obtained for Ciprofloxacin where at pH 7 it has a higher permeability coefficient of $0.65\pm0.07 \times 10^{-6}$ cm/s (n=21) as compared to pH 5 the coefficient is $0.39\pm0.04 \times 10^{-6}$ cm/s (n=17) (Figure 2B and 2C).

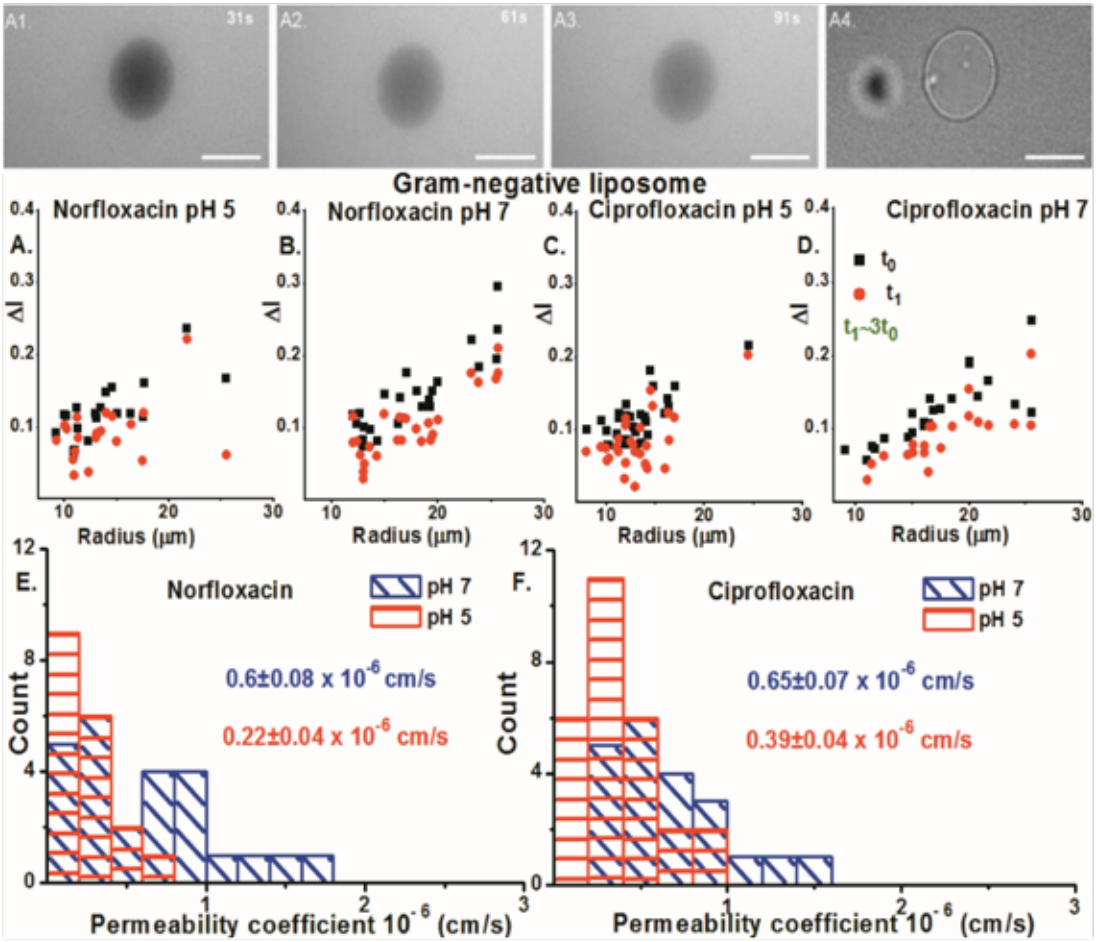


Figure 22: Gram-negative mimicking Giant vesicles, Diffusion of antibiotics in a time dependent manner: Norfloxacin A1 to A3: at pH 7; Scatter plots of $\Delta I=(I_{out}-I_{in})/I_{out}$ versus the radius at t_0 (black squares) and t_1 (red circles), where t_0= 26± 10 s A. Norfloxacin pH 5 (N=16), B. Norfloxacin pH 7 (N=26), C. Ciprofloxacin pH 5 (N=17), D. Ciprofloxacin pH 7 (N=21); Histograms of Permeability coefficients of E. Norfloxacin at pH7 and pH 5 and F. Ciprofloxacin pH 7 and pH 5.

5.3 Targeted metabolomic analysis towards understanding the fatty acid synthesis in *Nannochloropsis oeanica CASA CC201*

In order to elucidate the physiological role of key metabolic pathways that contribute to lipid synthesis, the targeted metabolites were selected from glycolysis, citric acid cycle and pentose phosphate pathway. Metabolomics analysis revealed that, there is significant increase in ATP, NADPH, NADP and NADH for cultures treated with high concentrations of selected PGRs and significant elevation of these metabolites are associated with increased lipid production (Fig. 23A). Further, free amino acids levels also positively correlated with lipid yield at higher PGR concentration (Fig. 23B).

(a) Targeted metabolites

To understand the regulation of energy metabolism which is associated with lipid synthesis upon plant growth regulators treatment, targeted metabolites were identified by LC-MS and analysed by heat-map. The result shown in Fig.23 (A) explains that glycolysis, pentose phosphate and TCA cycles were highly regulated in GA 10ppm treatment because the intermediate compounds of all those metabolic cycles were up-regulated such as F6P, UDP-glucose, FBP, AKG, SUC, OXA, PEP, R5P and CIT, compared to other treatments. This indicates that GA 10ppm treatment regulates the energy metabolism which results in active cell growth. Followed by GA 10ppm treatment on the effect of energy metabolism,

SA 10 and MA 10 ppm treatments were also shown significant up regulation of metabolites of glycolysis, TCA and pentose phosphate pathway. This clearly explains that the energy metabolism of plant growth regulators treatment with 10ppm was found to be increased, indicates the 10ppm was a sustainable concentration, wherein it regulates the energy metabolism resulted in efficient cell division, cell growth and obtained the significant biomass, whereas, these energy metabolisms were severely affected in 40ppm treatments of plant growth regulators. The result of SA 40ppm and GA 40ppm shown that significant down regulation of metabolites involved in Pentose phosphate pathway, also some metabolites involved in glycolysis and TCA cycles were not found to be upregulated compared to control and 10ppm treatments, but MA 40ppm treatment did not significantly affect the energy metabolism as compared to other 40ppm treatments, also found to be increased in NADPH and Acetyl-CoA, Indicates that SA 40ppm and GA 40ppm creates an oxidative stress to algae which resulted in down regulation of energy metabolisms, lead to reduction in cell number biomass and accumulation of lipids, mostly Saturated and monounsaturated fatty acids. Whereas, in 40ppm of MA was found to be less affected in energy metabolism, indicating that less oxidative stress and significant increase of precursors for fatty acid synthesis, leading to significant biomass and lipid, mostly saturated and mono-unsatured fatty acids.

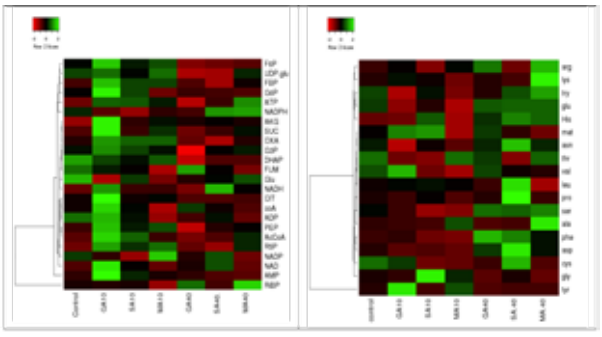


Fig.23. LC-MS based metabolomics analysis of targeted metabolites and aminoacids after 15 days of culture of *N.oceanica* with plant growth regulators treatments. The concentration of metabolites (A) and aminoacids (B) were calculated by normalizing with internal control and cell number. Control, no treatment; GA3 (Gibberlic acid), treatment with 10ppm and 40ppm; SA (Salicylic acid), treatment with 10ppm and 40ppm; MA (Malic acid), treatment with 10ppm and 40ppm in the initial culture.

(b) Aminoacids

We also studied the level of free amino acids upon plant growth regulators treatment, which was identified by LC-MS and analysed by Heat-map. The result shown in Fig.23 (B) suggests that the free amino acids were found to significantly increase in 40ppm treatments compared to control and 10ppm treatments. We speculated that the increase of free amino acids in 40ppm treatments is a result of protein degradation to gain energy under oxidative stress and these amino acids acts as the precursor for the synthesis of metabolites involved in energy metabolism. The metabolomic analysis of targeted metabolites and amino acids revealed that the 40ppm treatments of plant growth regulators affects the energy metabolism which in turn upregulate the lipid synthesis in the form of TAG to with stand un favourable condition and found to be obtained significant increase of amino acids which act as a precursor for metabolites involved in energy metabolism such a way cells gain energy and survive, whereas 10ppm treatments of plant growth regulators up regulate the energy metabolisms which resulted in significant increase of biomass and PUFA. The significant increase of PUFA and EPA obtained in MA 10ppm treatments, indicates that MA 10ppm causes no oxidative stress but improves cell growth, also involves in transhydrogenase cycle to produce precursor NADPH to lipid synthesis whereas 40ppm treatments causes oxidative stress, leading to reduction in cell number and PUFA, but enhances the Saturated fatty acids and MUFA to withstand in the unfavourable condition. When the concentration of plant growth regulators exceeds that of physiological concentration of an algae, it affects the energy metabolism via oxidative stress and due to that the production of PUFA also get altered in algae. So we conclude that under oxidative stress algae enhances lipid accumulation (TAG) to survive. But to obtain the significant increase of omega-3 fatty acids, supplementation of MA at minimal level would be feasible.

5.4 Decoding of Selenoprotein T from microalga

Selenoproteins are a class protein with an essential trace element Selenium (Selenocysteine) with

significant role in human health and relevance to several pathophysiological disease conditions. Selenoprotein T from *Scenedesmus quadricauda* was shown for the first time with experimental evidence (Fig. 24) and compared with selenoprotein T of marine microalgae *Nannochloropsis oceanica*. Along with selenoprotein T, all the associated machinery required to synthesis the selenoproteins were also identified. The evolutionary relatedness of Selenoprotein T of these two organisms with other known bacteria and eukaryotes were demonstrated (Fig. 24).

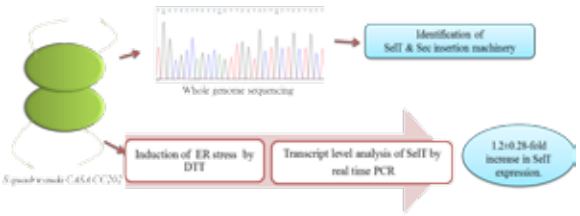


Fig.24: Selenoprotein T from microalga: Identification and characterization

5.5. Molecular reasons for the improved performance of *Penicillium janthinellum* cellulases

The extracellular enzyme preparation from *Penicillium janthinellum* was found to be more efficient than the *Trichoderma reesei* enzyme (currently used commercially for biomass hydrolysis cocktails) in the hydrolysis of pretreated rice straw. The cellulase system of the fungus is relatively unexplored. The enzyme from *P. janthinellum* hydrolyzed the pretreated biomass better, indicated by the higher glucose release. Interestingly, the glucose release from the pretreated biomass was ~70 % higher compared to *T. reesei*. The results are surprising for a "new" cellulase producer to outperform the established industrial producer. Hence the extracellular enzyme preparations from both fungi were analysed for their major component activities. These included endoglucanases (EGs), cellobiohydrolases (CBHs), and β-glucosidases (BGLs), which act in synergism to hydrolyze cellulose.

Proteomic approaches have been widely used in filamentous fungi for the identification of both intracellular and extracellular proteins. The genome of *T. reesei* QM6a, which is the parent strain of Rut-C30 was first sequenced in 2008 giving insight into its CAZyme system. *T. reesei* is known to encode at least 10 cellulases, 16 hemicellulases and a total of around 400 CAZymes in its genome. But the composition of secretome varies depending on the carbon source used, culture conditions or experimental parameters. The first proteome analysis of *T.reesei* RUT-C30 identified a total of 22 proteins using lactose as carbon source (Herpoel-Gimbert et al, 2008)]. Another study using different carbon sources identified 230 extracellular proteins and 90 CAZymes (Adav et al, 2012). In the present study using a minimal mineral salt medium under identical conditions, a total of 53 proteins were identified from *T. reesei* secretome, *P. janthinellum* secreted 85 different proteins. As expected, most of the proteins identified from both the fungi were related to biomass degradation. More number of CAZymes was identified from the *P. janthinellum* secretome. CAZymes from *T. reesei* included 2 cellobiohydrolases, 3 endoglucanases, 9 hemicellulases and the accessory activities - Swollenin and Lytic Polysaccharide monooxygenase (LPMO). CAZymes from *P. janthinellum* were grouped into 12 cellobiohydrolases, 3 endoglucanases, and 6 hemicellulases. No beta glucosidases were identified from both secretomes to support the extremely higher beta glucosidase activity shown by *P. janthinellum*. However, the number of cellobiohydrolases and their relative abundance was very high in *P. janthinellum*. The proteins identified from the secretome may not be a complete representation of all the CAZymes secreted by the organism, as the study used only a single time point and pure cellulose as sole carbon source. The highest differentially expressed protein from *T. reesei* was the GH7 family endoglucanase EG-1 which showed 184310-fold increase in expression upon cellulose induction. The normalized fold difference shown by the most highly expressed protein from *P. janthinellum* was almost 2 million, and this was a cellobiohydrolase from GH7 family. While *T. reesei* secreted a wider variety of

enzymes involved in lignocellulose hydrolysis, it was the *P. janthinellum* that secreted more glycosyl hydrolases and especially very high level of exoglucanases (Fig 25). The study provides preliminary information on the presence of all major cellulolytic and hemicelluloytic activities in the fungus and a very high induction in presence of cellulose, which could account for its enhanced hydrolytic performance.

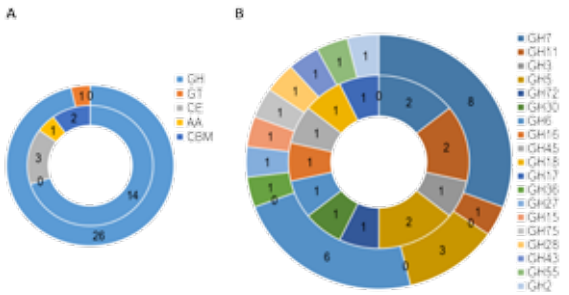


Fig 25: Distribution of secreted proteins of the fungi in different CAZyme families, and the glycosyl hydrolase family representation in the secretome A) secreted protein distribution in CAZyme families, B) distribution of glycosyl hydrolases in subfamilies.
Inner circle – *T. reesei,* Outer circle – *P. janthinellum*

II. Biofuels and Biorefineries

PANCSIR-2G Ethanol (PANCSIR-2GE) Program

CSIR's integrated 2G ethanol program with participation from 9 sister laboratories (CSIR-NIIST, CSIR-IIP, IICT, NCL, CFTRI, NEERI, CSMCRI and CGCRI) was operated as a PAN CSIR FTT project on where CSIR-NIIST was the coordinating lab. 8 other labs –are involved in the project. End to end process scheme for conversion of rice straw to ethanol was derived, and the process was successful in bringing down the estimated operation cost to 50 % lower than the starting point, achieving 85-135 Rs /L ethanol (with credits for energy savings and by-product value addition). The project outcomes are described below

1. Current estimate for the cost of production of is Rs 85-135 Rs/L, using an improved NIIST process for alkali pretreatment and in-house enzymes for hydrolysis
2. Enzyme production process has been tested successfully at pilot scale and with an improved membrane process for hydrolysis, that has significantly reduced the enzyme cost and hence the cost of hydrolysis step (the major cost contributor to 2G ethanol)
3. Hydrolytic is achieved in 12h and room available for further improvement of hydrolytic efficiency
4. Waste Water treatment is achieved at Rs 3.0/L of ethanol and does not draw energy from the ethanol production (self-sustaining)
5. Enzyme recycle (2-3 X only) and improvement in power consumption can bring the cost down to the targeted <Rs 100 mark
6. Electrical power efficiencies maybe improved at larger scale of operation (~20-30 %), through variable flow drive motors, intermittent mixing instead of continuous mixing wherever applicable.
7. Value addition of side streams can reduce the cost of 2GE.

The status of development in the project against the perceived necessity for commercial success is given in Fig 26

Fig 26: Status of development in different unit operations/ processes in the CSIR-Integrated 2GE program

Many of the unit operations have attained a fair amount of maturity and could be considered also as stand-alone for translation.

7. Lignin as a phenol source for phenol formaldehyde adhesives

7.1. Chemo-enzymatic study on the utilization of biomass lignin as phenolic adhesive.

Lignin is the one of the major component of lignocellulosic biomass and is the most underutilized fraction. Valorization of lignin has emerged as global research theme for the development of lignocellulose-based integrated bio refineries. Adhesives represent one of the most promising industrial applications of lignin and replacement of phenol in phenol formaldehyde (PF) resin with phenolic lignin is an attractive proposition for the preparation of adhesives. The study focused on evaluating the use of laccase assisted oxidized lignin in the preparation of PF resin as the oxidized lignin will promote higher cross linking with formaldehyde. Lignin isolated by alkaline hydrolysis and organosolv method was studied for oxidation. The aim of using Lacasse mediated oxidized lignin was to oxidize the phenolic OH and activate the available C3 and C5 positions. Lacasse mediated oxidation results suggested a significant decrease in the amount of C5 substituted lignin units for alkali lignin. In the case of organosolv lignin, the value became nil after oxidation using Lacasse.

The oxidized and unoxidized lignin-based resin (LF) was further characterized for its solid content, pH, alkalinity, and free formaldehyde content. The above properties are summarized in the below table. These are some of the critical parameters that influence the performance of the resin as adhesives. OOSL based LF resin exhibited desirable adhesive properties with higher pH and % alkalinity along with low formaldehyde content. OAL also showed better adhesive properties. Adhesive properties of LF resin were not in par with commercial PF resin but are comparable with commercial phenol resorcinol-formaldehyde resin (Kalami *et al*, 2017). The adhesive properties of 100% LF resin can be improved by further optimization and fine-tuning of the reaction conditions.

Lignin	Solid Content (%)	pH	Alkalinity (%)	Free formaldehyde content (%)
Std. kraft lignin (KL)	34.60 (1.11)	9.8	0.49 (0.30)	6.06 (1.64)
Alkali lignin (AL)	29.04 (2.82)	9.3	0.76 (0.58)	5.51(0.45)
Organosolv lignin (OSL)	24.93 (8.57)	9.1	0.86 (0.34)	4.38 (2.60)
Oxidized alkali lignin (OAL)	29.52 (6.23)	9.9	0.82 (0.49)	2.107 (2.15)
Oxidized organosolv lignin (OOSL)	26.07 (3.54)	10.7	2.016 (1.06)	2.806 (0.87)

Table-1 Adhesive properties of lignin-based formaldehyde (LF) resin (standard deviations are in parenthesis)

8. Use of metabolically engineered *Corynebacterium glutamicum* as the cell factory for the production of value added products from lignocellulosic derived sugars

8.1. Xylonic acid production from lignocellulose using engineered *Corynebacterium glutamicum*

In bacterial system, direct conversion of xylose to xylonic acid is mediated through NAD-dependent xylose dehydrogenase (*xylB*) and xylonolactonase (*xylC*) genes.

Heterologous expression of these genes from *Caulobacter crescentus* into recombinant *Corynebacterium glutamicum* ATCC 13032 and *C. glutamicum* ATCC 31831 (with an innate pentose transporter, *araE)* resulted in an efficient bioconversion process to produce xylonic acid from xylose (Fig 27).

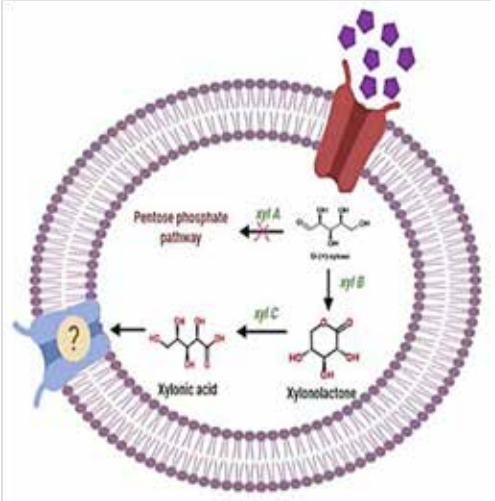


Fig.27. Metabolic pathway for the Bioconversion of Xylose to Xylonic Acid

Process parameters including the design of production medium was optimized using a statistical tool, Response Surface Methodology (RSM). Maximum xylonic acid of 56.32 g/L from 60 g/L xylose i.e. about 76.67 % of the maximum theoretical yield was obtained after 120 h fermentation from pure xylose with recombinant *C. glutamicum* ATCC 31831 containing the plasmid pVWEx1 *xylB* (Fig. 28). Under the same condition, the production with recombinant *C. glutamicum* ATCC 13032 (with pVWEx1 *xylB*) was 50.66g/L, i.e. 69 % of the theoretical yield. Finally, proof of concept experiment in utilizing biomass derived pentose sugar, xylose, for xylonic acid production was also carried out and obtained 42.94 g/L xylonic acid from 60 g/L xylose. These results promise a significant value addition for the future bio refinery programs.

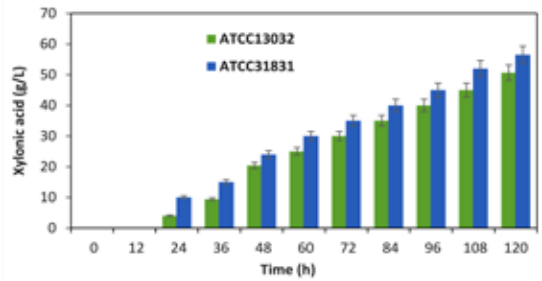


Fig.2. Xylonic acid production by *C. glutamicum* ATCC 13032 and *C. glutamicum* ATCC 31831 harboring plasmid pVWEx1-xylB.

8.2. Direct utilization of agro residual biomass for the production of α,ω–diamines as well as α, ω–amino acids: strain and process development using *Corynebacterium glutamicum*

The current interest is on the fermentative production of the bio-based plastic monomers - α,ω– diamines (Putrescine and Cadaverine) and α,ω aminoacids (5 aminovaleric acid and gamma amino butyric acid) from lignocellulosic biomass using metabolically engineered *C. glutamicum* strains named as C. *glutamicum (*ATCC 31831) AVAxyl, GABA xyl and Putxyl.All strains were capable of Xylose utilization available in biomass hydrolysates. The maximum production of AVA obtained by *C. glutamicum* AVAxyl was 18.232g/L after 48h of incubation, in CGXII medium with 6 % glucose with a productivity of 0.33g/L/h. 17.1 g/L of AVA was produced when CGXII medium was supplemented with alkali pretreated rice straw hydrolysate (RSH) and 12.78 g/L of AVA was obtained with acid pretreated RSH was supplemented in CGXII medium. The maximum productivity of GABA by *C. glutamicum* GABAxyl obtained was 0.18 $gL^{-1}h^{-1}$ 48h of incubation, in the flask culture with CGXII medium containing 4 % of glucose. 9.56 g/L of GABA was produced in when alkali pretreated RSH was used whereas 6.3 g/L of GABA was obtained with acid pretreated RSH. 0.18 g/L of Putrescine produced by *C. glutamicum* PUTxyl from 4% glucose after 72h of fermentation in CGXII synthetic medium. Further purification studies for the recovery of these platform chemicals in being carried out.

अनुसंधान योजना और व्यवसाय विकास प्रभाग

अनुसंधान योजना और व्यापार विकास प्रभाग (आर पी बी डी) साइंटिस्ट्स और एडमिनिस्ट्रेशन के अलग-अलग विंग्स के बीच लेन-देन करता है जिसमें सीएसआईआर, हेडक्वार्टर और अन्य प्रायोजन एजेंसियां भी शामिल हैं। आर पी बी डी कार्यक्रम समन्वय, परियोजना निगरानी और मूल्यांकन, समीक्षा और रिपोर्टिंग, सीएसआईआर और अन्य बाहरी स्रोतों से प्राप्त वित्तीय संसाधनों के प्रबंधन, प्रौद्योगिकी हस्तांतरण और व्यावसायीकरण में शामिल है। डिविजन आविष्कार और आईपी / पेटेंट संरक्षण से संबंधित एसएंडटी समर्थन गतिविधि में शामिल है।

विभाजन विशेष रूप से बुनियादी ढांचे और एसएंडटी प्रबंधन आवश्यकताओं के संदर्भ में समय पर कार्रवाई के लिए वार्षिक बजट तैयार करने में शामिल है। उपरोक्त के अलावा, सी एस आई आर के आर & डी कार्यक्रमों की भी निगरानी की जाती है और समीक्षा रिपोर्ट समय-समय पर सी एस आई आर को भेजी जाती हैं। समूह प्रयोगशाला में धन के आवंटन और उपयोग के संबंध में निगरानी अभ्यास भी करता है।

प्रभाग अनुसंधान परिषद और प्रबंधन परिषद दस्तावेजों को तैयार करने में मदद करता है, सी ए जी और सीएसआईआर ऑडिट टीम द्वारा उठाए गए परियोजनाओं से संबंधित ऑडिट पैरा यदि कोई हो तो परियोजना के नेताओं, परियोजना समन्वयकों और संबंधित वर्गों के प्रमुख के साथ समन्वय करके उत्तर प्रदान करता है।

आर पी बी डी ने 2019-20 में 131 बाह्य वित्त पोषित परियोजनाओं और सी एस आई आर से 21 परियोजनाओं के सफल निष्पादन की सुविधा प्रदान की। आरपीबीडी ने छह प्रौद्योगिकी हस्तांतरण और कई निजी उद्योगों के साथ अनुसंधान एवं विकास सहयोग किया। समूह वार्षिक रिपोर्ट 2018-19 और संस्थान के द्विभाषी समाचार पत्र एन आई आई एस टी समाचार और ब्रोशर के प्रकाशन के साथ-साथ प्रयोगशाला को पेश करने के हिस्से के रूप में विभिन्न प्रदर्शनियों का आयोजन करने में शामिल था। इस समूह ने सहयोगी अनुसंधान और विकास के लिए विभिन्न उद्योगों के साथ गठबंधन करने के लिए एक आर एंड डी उद्योग बैठक का आयोजन किया है।

Research Planning And Business Development

The Research Planning and Business Development Group (RPBD) liaises between the Scientists and different wings of administration including accounts and also with the CSIR Headquarters and other sponsoring agencies. RPBD is involved in the programme coordination, project monitoring and evaluation, reviewing and reporting, management of financial resources received from CSIR and other external sources, technology transfer and commercialization. The division is involved in S&T support activity relating to inventions and IP/Patent Protection.

The division is involved in the preparation of annual budget for timely action particularly with reference to infrastructure and S&T Management requirements. In addition to the above, R&D programmes of CSIR are also monitored and the review reports are periodically sent to CSIR. The group also does the monitoring exercise with respect to allocation and utilization of funds in the laboratory.

The division helps in the preparation of Research Council and Management Council documents, providing reply to Audit para raised by CAG and CSIR Audit team if any, related to projects in consultation with project leaders, project coordinators and Head of the respective sections.

RPBD facilitated the successful execution of 131 externally funded projects and 21 projects from CSIR 2019-20. RPBD catalyzed six technology transfers and R & D collaboration with a good number of private industries. The group was involved in bringing out the Annual Report 2018-19 and Publication of Institute's Bilingual Newsletter NIIST SAMACHAR and brochures as well as conducting various exhibitions as part of projecting the laboratory. The group has organized a R&D Industry Meet, to forge alliance with various industries for collaborative Research and Development.

Research Planning and Business Development
Contract Research Projects

CONTRACT RESEARCH PROGRAMMES 2019-20		
PROJECT TITLE	**CLIENT**	**PROJECT LEADER**
AGRO PROCESSING & TECHNOLOGY DIVISION		
Bio processing of two coded anti-diabetic medicinal plants based on ethnomedical leads- A molecular pharmacological approach	Dept.of Biotechnology (DBT)	Dr P Jayamurthy
Development of analytical protocols for detection of vegetable oil adulteration	M/s. KLF Nirmal Industries Pvt. Ltd., Thrissur	Mr V V Venugopal
Development of biflavonoid based lead molecule (NIIST -OBT-2) from *Garcinia travancorica* for non-alcoholic fatty liver disease	Dept. of Health Research (DHR), New Delhi	Dr G Sindhu
Development of guar gum nano particle based mitochondrial antioxidants for cardiac hyper trophy	Dept. of Health Research (DHR), New Delhi	Dr R S Soumya
Development of novel leads for anti-obesity from North East traditional system through chemistry biology interphase	Dept. of Biotechnology (DBT)	Dr K G Raghu
Enhancement of the stability & acceptability for newly developed products	M/s. Pankajakasturi Herbals India Ltd, Thiruvananthapuram	Mr V V Venugopal
Evaluating the medicinal properties (weight reducing, immunomodulation and lipid lowering property) of KLFs virgin coconut oil	M/s. KLF Nirmal Industries Pvt. Ltd., Thrissur	Dr K G Raghu
Evaluation of beneficial effect of Boeravinone-B from *Boerhaavia diffusa* against diabetic cardiomyopathy through mitochondria mediated pathway in H9c2 cardiomyoblast and heart for development of nutraceuticals	Dept. of Health Research (DHR), New Delhi	Mr Salin Raj
Identification of proprotein convertase subtilisin kexin-9 (PCSK-9) inhibitors from *Garcinia cambogia*	Dept. of Health Research (DHR), New Delhi	Dr G L Shyni
Investigation of resveratrol based compounds from Dipterocarpaceae family for their anti-diabetic potential	Kerala State Council for Science, Technology and Environment (KSCSTE)	Dr P Jayamurthy

Novel antibacterial compounds from marine Streptomyces strains associated with four mangrove species from selected regions of Kerala coast for curbing resistant acquired pathogens with special reference to methicillin resistant *Staphylococcus aureus*	Ministry of Earth Sciences (MoES)	Dr B S Dileepkumar
Post-harvest operations for value addition of indigenous fruits and vegetables	Dept. of Agriculture , Government of Kerala	Dr P Nisha
Process development for oil/fat to powder by encapsulation for food and nutritional application	Dept. of Science & Technology (DST)	Dr P Nisha
Product development and stability for milk based herbal extract formulation	M/s. Arya Vaidya Pharmacy, Palakkad	Mr V V Venugopal
Setting up processing unit for dehydrated fruits and vegetables	Horticorp, Thiruvananthapuram	Dr P Nisha
Significance of mitochondria associated ER membrane (MAM) in the genesis of diabetic cardiomyopathy	Dept. of Health Research (DHR), New Delhi	Ms Anupama Nair
Technological solutions to normalize the quality parameters during refining and to fractionate the fatty acids	M/s. KSE Ltd, Thrissur	Mr V V Venugopal
Technology development for value addition/ preservation of coconut water	Coconut Development Board, Kochi	Mr V V Venugopal
Valorization of spent turmeric/amla: Process development for antioxidant dietary fibre enriched products as metabolic enhancers	Biotechnology Industry Research Assistance Council (BIRAC)	Dr P Nisha
Value addition of coconut syrup and its studies	Coconut Development Board, Kochi	Dr M V Reshma
CHEMICAL SCIENCES & TECHNOLOGY DIVISION		
Activity guided screening of phospho diestrease inhibitors from Indian medicinal plants to treat erectile dye function	Indian Council of Medical Research (ICMR)	Dr A Kumaran
Biocompatible combined polymer polysaccharide core-shell VEGF-Targeted Nano-Carrier for sustained Intraocular pharmacotherapy towards diabetic retinopathy	Dept.of Biotechnology (DBT)	Dr Kaustabh Kumar Maiti
Design and development of efficient , stable and cost effective organic dyes for application in dye-sensitized solar cells	Science and Engineering Research Board (SERB)	Dr A Ajayaghosh

Design and processing of nano structured hybrid composite materials for electro chemical energy storage	Dept. of Science & Technology (DST)	Dr Narayanan Unni
Design and synthesis of novel NIR absorbing squarine dyes & star shaped Donor acceptor molecules for optoelectric applications	Dept. of Science & Technology (DST)	Dr Suresh Das
Development of advanced thermoelectric modules with superior performance in TEG and TEC modes	GAIL (India) Ltd, Noida	Dr Biswapriya Deb
Development of multiplexing detection platform of breast cancer biomakers by non-invasive Surface Enhanced Raman Scattering (SERS)- Nanoprobe	Dept. of Science & Technology(DST)	Dr Kaustabh Kumar Maiti
Development of novel NIR absorbing sensitizers and their nano-conjugates for the multi model cancer imaging and therapy	Dept.of Biotechnology (DBT)	Dr Joshy Joseph
Development of synthetic strategies for diverse compound collection of privileged structural motifs for medicinal chemistry	Kerala State Council for Science, Technology and Environment (KSCSTE)	Dr L Ravi Shankar
Dynamic molecular, supramolecular and surface chemistry for spatiotemporal modulation of smart advanced functional materials	Dept. of Science & Technology (DST)	Dr Sreejith Shankar Pooppannal
Dynamic molecular, supramolecular and surface chemistry for spatiotemporal modulation of smart advanced functional materials	Science and Engineering Research Board (SERB)	Dr Sreejith Shankar Pooppannal
Engineering intelligent theranostic nano carrier for targeted therapy and diagnosis of Cancer	Science and Engineering Research Board (SERB)	Dr Kaustabh Kumar Maiti
Engineering Nanostructured surfaces for Developing SERS Sensing Platform	Dept.of Biotechnology (DBT)	Dr Yoosaf Karuvath
Exploration of the structures and bioactivities of semi-synthetic and glycoside derivatives of abundant natural products from the Western Ghats of India and East Java, Indonesia	Science and Engineering Research Board (SERB)	Dr L Ravi Shankar
Fabrication of portable (Handheld) SERS system for explosive chemicals detection and unique identification	Defence Research and Development Organisation (DRDO)	Dr Yoosaf Karuvath
Fluorescent molecules and assemblies for sensing and imaging	Dept. of Science & Technology (DST)	Dr A Ajayaghosh
Gold nanorod based targeted nanoprobe for cancer theranostics: Diagnosis by Surface Enhanced Raman Scattering (SERS) and fluorescence imaging and therapy by PDT and PTT	Dept.of Biotechnology (DBT)	Dr Kaustabh Kumar Maiti

Indigenous development of Semi-automatic equipments for large area dye-sensitized solar module fabrication	Dept. of Science & Technology (DST)	Dr Narayanan Unni
Large area opto-electronics for Australia and India : From materials to advanced devices	Dept. of Science & Technology (DST)	Dr A Ajayaghosh
Mechanical stimulation induced microscopic crystalline structure changes in molecular materials: Implications on drug formulation and mechanochromic behaviour	Science and Engineering Research Board (SERB)	Dr Sunil Varughese
Nature Inspired chemical entities for healthcare applications	Science and Engineering Research Board (SERB)	Dr B S Sasidhar
Novel strategies for the generation of long lived photo induced charge separated states in donor-acceptor systems	Science and Engineering Research Board (SERB)	Dr K R Gopidas/ Dr Karunakaran Venugopal
Quantum chemical modelling of CC and CN metathesis reactions and functional molecules containing unusual carbon-metal bonds	Science and Engineering Research Board (SERB)	Dr C H Suresh
Revealing the interaction mechanism of the protein with lipids in the apoptosis process: electronic, vibrational and confirmational relaxation dynamics of the heme in the liposomes	Dept. of Biotechnology (DBT)	Dr Karunakaran Venugopal
Screening and characterization of some selected phytomedicines in Homeopathy	Government Homeopathic Medical Collage, Thiruvanathapuram	Dr K V Radhakrishnan
Solar Hydrogen: An alternative avenue	Dept. of Science & Technology (DST)	Dr Suraj Soman
Sustainable utilization of abundant natural resources: Synthetic transformations of zerumbone and germacrone towards chemically diverse sesquiterpenoid architectures	Science and Engineering Research Board (SERB)	Dr K V Radhakrishnan
ENVIRONMENTAL TECHNOLOGY DIVISION		
Common research and technology development-Hub for environmental intervention in the MSME Sector	Department of Scientific and Industrial Research (DSIR)	Dr K P Prathish
Development and demonstration of a 500kg/ day food waste biomethanation plant at Thiruvananthapuram International Airport	Airport Authority of India, Thiruvananthapuram	Dr B Krishnakumar
Development and field demonstration of waste management systems for a medium scale industry	M/s. Jai Hari Food Products, Pathanamthitta	Dr B Krishnakumar
Development of chloride free saleable iron oxide from by-products of Titanium pigment production via chloride route	Dept. of Science & Technology (DST)	Dr K P Prathish

Installation of 50kg/D biogas plant at RBI campus in Thiruvananthapuram	Reserve Bank of India, Thiruvananthapuram	Dr B Krishnakumar
Novel hybrid nanostructured surface modified electrodes for sensors and biosensors	Dept. of Science & Technology (DST)	Dr K P Prathish
STP secondary treatment, a feasibility study	Kerala Water Authority, Thiruvananthapuram	Dr B Krishnakumar
Water characterization for pond renovation	Government Engineering College, Thiruvananthapuram	Mr B Abdul Haleem
MATERIALS SCIENCE & TECHNOLOGY DIVISION		
Adsorbents for gas and vapour molecules. Rational design of materials, porous nano structures and surface chemistry	Noritake, Japan	Dr U S Hareesh
Chemical functionalization of Si with 2D structures: Anode materials for lithium ion battery with significantly improved volumetric capacity	Dept. of Science & Technology (DST)	Dr Saju Pillai
Dark-catalytic and planar solar-concentrator based reactors for removal of organic pollutants from textile effluents	Dept. of Science & Technology (DST)	Dr Satyajit Shukla
Design and development of bio-based novel liquid crystalline conductive electrodes and electrolytes for high performing flexi-energy storage devices	Dept. of Science & Technology(DST)	Dr Saju Pillai
Design and development of near net shape manufacturing process for light weight high strength aluminium composite and engineering components by squeeze infiltration technique for automotive and aerospace applications	Indo German Science And Technology Centre (IGSTC)	Dr T P D Rajan
Designing green, self-healing coatings for metal protection	Science and Engineering Research Board (SERB)	Dr K G Nishanth
Development and in-vitro characterization of magnesium alloys for biocompatible and biodegradable implant applications	Science and Engineering Research Board (SERB)-DST	Dr A Srinivasan
Development and invitro characterization of rare earth phosphate coatings for biodegradable and biocompatible magnesium based temporary implants	Indian Council of Medical Research (ICMR)	Dr A Srinivasan
Development of a miniaturized and portable laser induced breakdown spectroscopy LIBS set up for fast identification and sorting of different plastic classes	Dept. of Science & Technology (DST)	Dr E Bhoje Gowd

Development of Biodegradable mulching mats using coir-polymer systems	National Coir Research & Management Institute (NCRMI)	Dr Saju Pillai
Development of building materials from steel foundry slag/sand waste	M/s. Peekay Steel Castings Pvt Ltd, Calicut	Dr S Ananthakumar
Development of ceramic membranes and setting up of a pre-pilot plant manufacturing facility	Dept. of Science & Technology (DST)	Dr U S Hareesh
Development of environmentally benign inorganic pigments for energy saving cool roof and anti-corrosive applications	Science and Engineering Research Board (SERB)	Dr K G Nishanth
Development of graphene based membranes from graphite ore for desalination	Ministry of Mines	Dr S S Sreejakumari
Development of Iridium coating over carbon-carbon composites for space applications	Indian Space Research Organisation (ISRO), Thiruvananthapuram	Dr S S Sreejakumari
Development of iron aluminide coated high performance steels	Dept. of Science & Technology (DST)	Dr K Jayasankar
Development of light weight functionally graded metal- ceramic composite armour materials for defence applications	ARMREB, New Delhi	Dr T P D Rajan
Development of Light weight near net shape aluminium composite substrates for thermal management in electronic and avionic packaging systems	Dept. of Science & Technology (DST)	Dr T P D Rajan
Development of Lightweight Aluminum based Crankcase for Automotive Air Compressor Brake Systems	M/s. WABCO India Ltd., Chennai	Dr T P D Rajan
Development of magnetically modulated therapeutically active layered double hydroxide(LDH) as a nanomedicine with hyperthermia potential for cancer theranostics	Science and Engineering Research Board (SERB)	Dr Manoj Raama Varma
Development of novel magneto dielectric materials for miniaturized micro strip patch antennas	Indian Space Research Organisation (ISRO),Thiruvananthapuram	Dr Manoj Raama Varma
Development of sustainable pressure sensitive adhesives from bio-sourced pre-polymers: A green alternative for semi-structural applications	Science and Engineering Research Board (SERB)	Dr Sushanta Kumar Sahoo
Green Synthesis of Warm White Light Emitting Single Phase Oxyfluoride Phosphors for Thermally Stable, Energy Efficient, and Elevated color Rendering LED Lamps.	Science and Engineering Research Board (SERB)	Dr Subrata Das

Improvement of Flux Pinning in Bi-based superconductor Tapes	Science and Engineering Research Board (SERB)	Dr Manoj Raama Varma
Investigation of structural, optical, magnetic properties and electronic structure of binary inter-metallic alloys for the spintronic applications	Dept. of Science & Technology (DST)	Dr M Vasundhara
Investigation of Zintl phases as efficient thermoelectric materials for energy conversion	Science and Engineering Research Board (SERB)	Dr Manoj Raama Varma
Large-Scale Production of Coir/Polymer Composites for Acoustic Applications	National Coir Research & Management Institute (NCRMI)	Dr V S Prasad
Nanowire white LEDs based on innovative nano phosphors	Dept. of Science & Technology (DST)	Dr Subrata Das
Pilot scale manufacturing of innovative building materials from industrial solid wastes	M/s. Star Clays, Thrissur	Dr S Ananthakumar
Pilot scale processing of high Strength Al-Si-Cu-Mg-Sr alloy and prototype flange, suspension arm and knuckle component manufacturing by squeeze casting	M/s. Sri Kaliswari Metal Powders Pvt Ltd, Sivakasi	Dr M Ravi
Process development for precision planar optics patterning in the float glass surface via hot forming	M/s. Asahi India Glass Ltd., Mumbai	Dr Adersh Asok
Processing of CeO_2 Nanoparticles for energy saving glaze coatings and cool textiles	Indian Rare Earths Limited, Kollam	Dr S Ananthakumar
Processing of TiO_2 coated hydrous Kaolin for enhanced brightness and thermal stability	M/s. Surya Mine Chem, Ahmedabad	Dr S Ananthakumar
Production of polymer/coir composites for furniture Application	National Coir Research & Management Institute (NCRMI)	Mr M Brahmakumar
Quantitative assessment of hot tearing characteristics of aerospace magnesium alloys using instrumented constrained rod casting (CRC) technique	Aeronautical Research and Development Board	Dr A Srinivasan
Recovery of scandium metal from acid leach liquor from titanium mineral industries	Ministry of Mines	Dr M Sundararajan
Self-powered electro-optical memory devices for next generation display and data storage application	Science and Engineering Research Board (SERB)	Dr Achu Chandran
SMART FOUNDARY (SMART= Sustainable Metal casting using Advanced Research and Technology)	Dept. of Science & Technology (DST)	Dr S Savithri

Study for establishing microstructure mechanical properties of high strength Al-Si-Cu-Mg-Sr alloy processed by gravity die casting and squeeze casting	M/s. Sri Kaliswari Metal Powders Pvt. Ltd., Sivakasi	Dr M Ravi
Synthesis and characterization of broad spectrum ultraviolet filter with visible light emission and antioxidant activity: A potential multifunctional active ingredient with multitude of applications	Dept. of Science & Technology (DST)	Dr Adersh Asok
Technical support to flow + solver code of Autocast XI	M/s. 3D Foundry Tech. Pvt. Ltd., Mumbai	Dr S Savithri
X-ray photoelectron spectrocopy (XPS) of metallic powder samples	Vikram Sarabhai Space Center (VSSC), Thiruvananthapuram	Dr Saju Pillai
X-ray photoelectron spectroscopy (XPS) of metallic powder samples	Vikram Sarabhai Space Centre (VSSC), Thiruvananthapuram	Dr Saju Pillai
MICROBIAL PROCESSES AND TECHNOLOGY DIVISION		
Characterization of major agro-residues biomass in India	Technology Information, Forecasting and Assessment Council (TIFAC)	Dr Rajeev K Sukumaran
Characterization, recombinant expression, process scale up validation of selected hydrolases from native action bacteria for commercial exploitation	Dept. of Biotechnology (DBT)	Dr Rajeev K Sukumaran
Deciphering interacting partners of PAMPs / Effectors of C*olletotrichum falcatum* that trigger innate immunity in sugarcane	Dept. of Biotechnology (DBT)	Dr Rajeev K Sukumaran
Development of a bioprocess for the commercial production of Gibberallic acid	M/s. Margosa Biogrow India Pvt. Ltd. , Gujarat	Dr Madhavan Nampoothiri
Development of a bioprocess for the commercial production of the plant growth stimulant Gibberellic acid GA3	Biotechnology Industry Research Assistance Council (BIRAC)	Dr Madhavan Nampoothiri
Development of a gene expression platform for heterologous protein production in the filamentous fungus *Aspergillus unguis*	Dept. of Biotechnology (DBT)	Dr Rajeev K Sukumaran
Development of a sustainable process for the production of poly-3-hydroxybutyrate using kitchen and food waste	Dept. of Science & Technology (DST)	Dr R Sindhu
Direct utilization of agroresidual biomass for the production of α,ω-diamines as well as α,ω-amino acids: strain and process development using *Corynebacterium glutamicum*	Dept. of Biotechnology (DBT)	Dr Madhavan Nampoothiri

Exploration and exploitation of microflora from Marcha and soil samples from high altitude soils for the production of 2,5-furan dicarboxylic acid and selected industrially important enzymes	Institute of Bio resources and Sustainable Development, Manipur	Dr P Binod
Holistic processes and practices for clean energy in strengthening bio economic strategies	Dept. of Science & Technology (DST)	Dr P Binod
Integrated bio refinery for converting paper mill waste into chemical wealth	Dept. of Biotechnology (DBT)	Dr P Binod
Investigation of the dynamics & mechanism of flocculation by polymers and biopolymers for separation of solid particles of high rate thickeners in mineral processing industries	Ministry of Mines	Dr Rakesh Kumar Yasarla
Isolation and Development of starter cultures for Dairy Products	M/s. Accelerated Freeze Drying Co. Ltd., Kochi	Dr Madhavan Nampoothiri
Loktak lake biomass (para- grass) based bio refinery for fuels and chemicals: Value addition through biotechnological and thermochemical platform	Institute of Bio resources and Sustainable Development, Manipur	Dr Rajeev K Sukumaran
Microbiome analysis of saline tolerant Pokkali rice varieties of coastal agri saline fields(Pokkali and Kaippad tract) of Kerala and evaluating their core endophyte beneficial rhizobacteria for enhancing rice growth under saline conditions	Dept. of Biotechnology (DBT)	Dr N Ramesh Kumar
Molecular and functional characterization of active saline adapted nitrogen fixing plant growth promoting bacteria of native grown coastal saline tolerant rice varieties (Pokkali) of Kerala	Science and Engineering Research Board (SERB)	Dr N Ramesh Kumar
Quantification of substrate across membrane proteins	Dept. of Biotechnology (DBT)	Dr Harsha Bajaj
Quantifying molecular transport in membrane proteins using novel optofluidic assay	Dept. of Biotechnology (DBT)	Dr Harsha Bajaj
Study on chemo-enzymatic transformation of lignin derived from lignocellulosic biomass for potential application as adhesives	Dept. of Science & Technology (DST)	Dr Leena Perumal
Technical Consultancy	M/s. Greenisle Solutions Pvt. Ltd., Malappuram	Dr Madhavan Nampoothiri

Consultancy Programmes

PROJECT TITLE	CLIENT	PROJECT LEADER
Analysis and interpretation of Arsenic, Lead, Cadmium and Mercury in ayurvedic formulation	M/s Pankajakasthuri Herbals India Pvt. Ltd., Thiruvananthapuram	Dr K P Prathish
Characterization and confirmation of drug intermediates	M/s Apicore Pharmaceuticals Pvt. Ltd., Gujarat	Dr L Ravi Shankar
Characterization and interpretation of chemical intermediates (Cis) and active pharmaceutical ingredients (APIs)	M/s Omgene Life Sciences Pvt. Ltd., Gujarat	Dr L Ravi Shankar
Characterization of PVC Sheets	M/s Terumo Penpol Pvt. Ltd., Thiruvananthapuram	Dr E Bhoje Gowd
Characterization of silicone and silicone derivatives	M/s Momentive Performance Materials (India) Pvt. Ltd. Bengaluru	Dr E Bhoje Gowd
EIA and EMP study for IREL NK Block-II & NK Block-II EE	Indian Rare Earths Ltd., Kollam	Dr J Ansari
EIA study for KMML I V VII Phase II	Kerala Minerals and Metals Ltd. (KMML), Kollam	Dr J Ansari
Sampling and quality analysis of water from Kanjirapuzha and Pothundi rivers	Kerala State Remote Sensing and Environment Centre (KSREC)	Mr B Abdul Haleem
Studies on synthetic rutile and Ferrous chloride at elevated temperature & pressure with Teflon reactor	Cochin Minerals & Rutile Limited, Aluva	Mr T Dhani Babu
Study on dioxins, furan and dioxin-like PCB levels in sediment samples	MG University, Kottayam	Dr K P Prathish
Study on dioxins, furan and dioxin-like PCBs in fish samples	Marine Products Exports Development Authority, Kochi	Dr K P Prathish
Study on dioxins, furan emission levels from Sanchar Unit	CSIR-NEERI, Nagpur	Dr K P Prathish
Wheat Bran Waste Processing	M/s Aura Exim, Ernakulam	Dr Anjineyulu Kothakota

Technology transfer agreements during the period 2019-20

Sl No	Title	Name of the firm/firms with whom the MoU /Agreement is entered into	Project leader
1	Know-how transfer for making white pepper	M/s Synthite Industries (P) Ltd, Corporate House, Kadayiruppu P O, Kolenchery, Ernakulam	Dr Rajeev K Sukumaran
2	Know-how for making dye-sensitized solar module fabrication (IP Sharing)	M/s Elixir Technologies, No. 300/2, Chamundeshwari Layout, Doddabommasandra Main Road, Vidyaranyapura, Bengaluru	Dr Suraj Soman
3	Knowhow for making of invisible fluorescent dyes and pigments	M/s Huebright Colors Private Limited No.223 AB, Classic Orchards, 4th Main 7th Cross, behind Meenakshi Temple, Bannerghatta Road, Bangalore	Dr C Vijayakumar
4	A device for the biological treatment of wastewater containing biodegradable solids(Patent Licensing)	M/s Victoria Innovative LLP, Opposite Family Health Centre, Viruuthamkandathil Building, Kodanad P O, Ernakulam-683544	Dr Partha Kundu
5	Technology transfer for " Wheat bran based cutleries"	M/s Aura Exim 11/916-B, Gokulam, Thuthiyoor Road, Rajeev Gandhi Junction, Behind Special Economic Zone, Ernakulum	Dr Anjineyulu Kothakota
6	Process for converting grey water to clear water	M/s Sathyam Enviro, Kottayam	Dr B Krishnakumar

Other MoUs/ Agreements Signed

Sl No	Title	Nature of the MoU	Name of the firm/firms with whom the MoU/Agreement is entered into	Project leader
1	Technology Solutions for normalizing the quality standards & developing fractionation techniques for refined coconut oil	Agreement for sponsored research	M/s KSE Ltd, Koratty	Dr V V Venugopal
2	Evaluating additive manufacturing technology applications, developing additive design prototype and exploring research opportunities and engaging in future research	NDA	GE India Industrial Pvt Ltd USA	Dr Adersh Asok
3	Development of building materials from steel foundry slag/sand waste	Agreement for sponsored research	M/s Peekay Steel castings Pvt Ltd, Calicut	Dr S Ananthakumar
4	Revealing the interaction mechanism of the protein with Lipids in the Apoptosis Process: Electronic, vibrational and conformational relaxation dynamics of the heme in the liposomes	MoU	Department of Biotechnology	Dr Karunakaran Venugopal
5	MoU for Collaborative research	MoU	C-DAC (T). MeitY, Thiruvananthapuram	Dr Yoosaf Karuvath
6	WAXS/SAXS testing	Agreement	M/s. SRF Limited, New Delhi	Dr E Bhoje Gowd
7	Analysis and interpretation of Arsenic lead , cadmium and Mercury in ayurvedic formulation	Agreement	M/s Pankajakasthuri Herbals India Pvt Ltd, Poovachal, Thiruvananthapuram	Dr K P Prathish
8	Feasibility study for the purpose of developing Coir based products	MoU	Neyyattinkara Coir Cluster Development Society(NCCDS), Neyyattinkara, Thiruvananthapuram	Dr Saju Pillai
9	To develop academic and educational Cooperation	MoU	University of Kerala, Thiruvananthapuram	Dr K G Raghu
10	Development of analytical protocol for detection of vegetable oil Adulteration	Agreement for Sponsored Research	KLF Nirmal Industries Pvt Ltd, Trichur	Mr V V Venugopal

11	Evaluating the medicinal properties (weight reducing, immunomodulation and lipid lowering property) of KLFs virgin coconut oil	Agreement for Sponsored Research	KLF Nirmal Industries Pvt Ltd, Trichur	Dr K G Raghu
12	Characterization of PVC Sheets	Agreement for Material testing	Terumo Penpol Private Limited, Thiruvananthapuram	Dr E Bhoje Gowd
13	Product development and stability for milk based herbal extract formulation	Agreement for Sponsored Research	THE ARYA VAIDYA PHARMACY(Coimbatore) LIMITED Factory,Palakkad	Mr V V Venugopal
14	MoU for Collaborative research	MoU	EEPC India, Kolkata	Dr S Savithri
15	Sampling and quality analysis of water from Kanjirapuzha and Pothundi rivers	Agreement for Consultancy Project	Kerala State Remote Sensing and Environment Centre,Thiruvananthapuram	Mr B Abdul Haleem
16	Academic Collaboration and creation of skill based training and practical exposure for the students	MoU	LMIHMCT, Lourdes Matha Catholic Educational Society	Dr P Nishy
17	Develop an alternative Aluminium composition for compressor components	NDA	ATLAS COPCO AIRPOWER NV, Airtech Division, 2610 wilrijk (Antwerp), Boomsesteenweg-957,	Dr M Ravi
18	Pilot scale manufacturing of innovative building materials from industrial solid wastes	Agreement for sponsored research	M/s Star Clays Vadama P O, Mala, Thrissur	Dr S Ananthakumar
19	Anaerobic Digester	Agreement for executing Technical Service Project	RBI, TVM	Dr B Krishnakumar
20	Setting up a processing unit for dehydrated vegetables	Agreement for Engineering consultancy	Horticorp Poojappura, Thiruvananthapuram	Dr P Nisha
21	Bio resources and secondary Agriculture	MoA	Department of Biotechnology	Dr N Ramesh Kumar
22	Analysis and interpretation of Arsenic lead , cadmium and Mercury in ayurvedic formulation	Deed of Variation	M/s Pankajakasthuri Herbals India Pvt Ltd, Poovachal, Thiruvananthapuram	Dr K P Prathish
23	Development of Aluminium alloys and products	Mutual Non-Disclosure Agreement	Log 9 Materials Scientific Private Limited, Bengaluru	Dr S Savithri

Patents

Granted in India

Patent No	Title	Grant Date	Inventors
311161	Blue colored inorganic pigments, having near infrared reflectance, based on mixtures of Lanthanum, Strontium, Copper And Lithium Silicate and process thereof	12-Apr-19	Mundlapudi Lakshmipathi Reddy, Sheethu Jose
318696	Improved anaerobic digester for household organic wastes	22-Aug-19	Vattackatt Balakrishnan Manilal
334999	A squaraine based fluorescent probe for selective labeling and sensing of serum albumin proteins, ph monitoring and thiol imaging in cells and a process for the preparation thereof	17-Mar-20	Ayyappanpillai Ajayaghosh, Palappuravan Anees

Granted Abroad

Patent No	Title	Grant Date	Inventors
3197956	New Inorganic Blue pigments from Cobalt doped Magnesium having Transition Element Oxides and a Process for the preparing the same	03-Apr-19	Padala Prabhakar Rao, Saraswathy Divya

Filed in India

Title	Inventors	File No	Filing Date
A process for making weather-resistant and slow-decaying geotextiles	Vadakkethonippuathu, Sivankuttynair PRASAD, Padinjareveetil ANJU, Methalayil Brahmakumar, Das Anitha Ravindranath, Sebastian Sumy	201911033776	22-Aug-19
Thermo-responsive molecules for controlled heat and light transmission windows and applications thereof	Ayyappanpillai Ajayaghosh, Das Satyajit, Soman Suraj, Asok Adersh, Shankar Pooppanal Sreejith	201911052506	18-Dec-19
A transparent gel electrolyte system and fast switching electrochromic devices thereof	Deb Biswapriya, Ayyappanpillai Ajayaghosh, Venugopal Ranjana, Prabhu Tulichal Ganesh Prabhu Gayathri, Shankar Pooppanal Sreejith	202011006474	14-Feb-20

Filed Abroad

Title	Inventors	File No	Filing Date
Screening kit for detection of precancerous lesions of cervix and process for the preparation thereof	Kaustabh Kumar Maiti, Varsha Karunakaran, Kunjuraman Sujathan	PCT/IN2019/050540	24-Jul-19
Thermoelectric materials and a process for the preparation thereof	Deb Biswapriya, Chakkooth Vijayakumar, Ignatious Vijitha, Meshram Manoj Ramakrishna, Singh Jaivinder, Tanjore Puli Yuvaraj	PCT/IN2019/050675	16-Sep-19

परीक्षण और विश्लेषण सेवाएँ सेल

सीएसआईआर-एनआईआईएसटी के पास कुछ बेहतरीन उपकरणों के आवास के लिए एक उत्कृष्ट परीक्षण और विश्लेषणात्मक सहायता सुविधा है जो न केवल अपने बहुआयामी अनुसंधान कार्यक्रमों में एक महत्वपूर्ण भूमिका निभाता है, बल्कि बाहरी आरएंडडी गतिविधियों, शिक्षाविदों और देश के उद्योगों की आवश्यकता को भी पूरा करता है। यह सुविधा देश के दक्षिणी हिस्से में अपनी तरह का सबसे अच्छा है और लैब के लिए राजस्व का एक स्थिर प्रवाह उत्पन्न करके बड़े पैमाने पर उपयोग किया जा रहा है। बाहरी नमूना विश्लेषण भुगतान के आधार पर किया जाता है।

रिपोर्ट की अवधि के दौरान विभिन्न शैक्षणिक संस्थानों और विश्वविद्यालयों के लगभग 169 छात्रों, आर एंड डी संस्थानों और 14 उद्योगों ने इस सुविधा का उपयोग करते हुए 14.85 लाख रुपये का राजस्व प्राप्त किया। उपकरणों के बीच, एक्स-रे इलेक्ट्रॉन माइक्रोस्कोपी (एक्सपीएस) ने 5.78 लाख एकत्र किए, और एनएमआर / एचआरएमएस सुविधाओं ने रु। 3.44 लाख की राशि अर्जित की।

पैन सीएसआईआर की विश्लेषणात्मक प्रगति को अब "एनेलिसिससीआईआर" पोर्टल के माध्यम से दुनिया भर में पहुँचा जा सकता है। यह पोर्टल सीएसआईआर के उपयोगकर्ताओं और बाहरी ग्राहकों के बीच बहुत आवश्यक प्लेटफ़ॉर्म इंटरफेस प्रदान करता है जिसमें उद्योग और अकादमिया शामिल हैं। इस पोर्टल के माध्यम से, पूरे सीएसआईआर प्रयोगशालाओं की परिष्कृत विश्लेषणात्मक इंस्ट्रूमेंटेशन सुविधा को पंजीकृत अधिकृत उपयोगकर्ताओं द्वारा बुक किया जा सकता है। वर्तमान में पूर्ण-विकसित चल रही सुविधा और सी एस आई आर - एन आई आई एस टी ने सफलतापूर्वक अपने प्रमुख उपकरणों को इस पोर्टल पर स्थानांतरित कर दिया है। इस पोर्टल ने बुकिंग की प्रक्रिया को आसान बना दिया था और यह प्रक्रिया उपयोगकर्ता के पारदर्शी होने के साथ ही उसकी विश्लेषणात्मक आवश्यकता की स्थिति की निगरानी करने में सक्षम हो गई है।

Testing And Analytical Services Cell

CSIR-NIIST has an excellent testing and analytical support facility in place housing some of the finest instruments which not only plays a pivotal role in its multidisciplinary research programs but also caters to the need of external R &D activities, academia and industries of the Country. This facility is one of the best of its kind in the southern part of the country and is being extensively utilized generating a steady flow of revenue for the Lab. The external sample analysis is carried out on payment basis.

During the period of the report approximately 169 students from various educational institutes and universities, R&D institutions and 14 Industries had utilized this facility generating a revenue of Rs.14.85 lakhs. Among the instruments, the X-ray Electron Microscopy (XPS) collected 5.78lakhs, and NMR/HRMS facilities generated Rs.3.44 lakhs.

The Analytical Prowess of PAN CSIR can now be accessed worldwide through the portal "AnalytiCSIR". This portal provides the much needed platform interfacing between users of CSIR and external clients comprising of Industries and Academia. Through this portal, the sophisticated analytical instrumentation facility of entire CSIR Laboratories can be booked by registered authorized users. The facility currently running full-fledged and CSIR-NIIST has successfully migrated its major instruments to this portal. This portal had eased the procedure for booking and the process has become transparent with the user able to monitor the status of his/her analytical requirement as it progress.

Knowledge Resource Centre

The Knowledge Resource Centre carried out a wide range of services to support the R&D activities in the institute related to information resources and information technology infrastructure.

Information resources & services

KRC enhanced its online as well as print resources, including books, journals, technical reports, standards, patents, theses, and other materials according to the information requirement of the scientific community. During the period 2019-20, KRC purchased 82 new books, including 17 Hindi books, 26 books were received as gratis. Apart from the directly subscribed e-journals, KRC provided access to more than 1000 scholarly electronic journals through CSIR-DST e-journal consortium known as the National Knowledge Resource Consortium (NKRC), this includes journals from American Chemical Society, Royal Society of Chemistry, Springer Nature, American Institute of Physics, Institute of Physics, etc. KRC continued the subscription of specialized databases viz SciFinder, Derwent Innovation Index, Qpat, and ASTM standards. Additional information requirement by the users was catered through resource sharing from other CSIR and DST institutes using J-Gate Plus. KRC procured the software iThenticate, which is the premier tool for researchers and professional writers to check their original works for potential plagiarism. Grammarly premium is made available to the scientific community for supporting research writing. KRC is automated using the integrated library management software 'Koha.'

KRC also maintains and updates the institute website, Social media pages, VIDWAN database and Institutional repository. The IR presently consists of 2586 journal articles, 344 Ph.D. Theses, and 235 News items. KRC is regularly providing training on reference management software, literature search, prior art search, open access, research evaluation, social media for researchers, preventing plagiarism, and effective communication, etc.

Information Technology Infrastructure & Services

KRC maintains two internet leased lines to fulfill the Internet and intranet requirements of the lab. At present, the laboratory is linked with 100 mbps leased line from NKN and also 28 mbps leased line from BSNL. These links are regularly managed and monitored using sophisticated UTM device & tools that enables to gain a real-time, end-to-end view with respect to system and network performance. All the buildings in the campus are interconnected through gigabit fiber optic backbone. Around 50+ internet ports were added / upgraded to the existing network. Separate VLANs have been created to connect a large no of High end personal computers to the campus network making the total internet connection to 1100+ through wired and wireless network. Secured VPN connectivity is provided to scientists to connect to office computers from home. Wi-Fi facilities are implemented covering all areas with a secured wireless network. Server grade antivirus software is deployed for virus-free network environment.

KRC manages the smooth functioning of AADHAR enabled Biometric Attendance System installed at eight different locations.KRC manages issue of institutional identity cards for the staff members, research scholars and pensioners and also maintains secured access to doors and gates . Printing and scanning facility is provided through a wide variety Heavy Duty Color Multi-Function Laser Printers and A3/A4 Scanners. Digital Display System was also maintained in seven different locations inside the laboratory for exhibiting research outcomes, notices, circulars, laurels etc.

The revamping and modification of the institute website is in progress in line with meeting the Government of India guidelines. Websites were developed for national and international conferences organized by the laboratory. AMC for more than 500 desktops, laptops, other computer peripherals, issues related to software installations, reinstallations, repairs, software updates, network related issues are managed. Softwares for Stores and Purchase, D-Space, Koha, Libsuite, Chemdraw, Sigmaplot, Origin etc are deployed and maintained.

CSIR Skill Initiative at CSIR NIIST

As a part of the CSIR Skill Initiative, CSIR-NIIST conducts courses since year 2017. We conducted nine skill development courses on Analytical Chemistry and Instrumentation Techniques, Operation and Maintenance of Fermenters, Techniques of Phytochemical Profiling and Characterization, Nutraceuticals and Functional Foods, Advanced Training in Sampling and Analysis of Dioxin and PCBs, Metal Casting and Characterization, Remote Sensing and GIS application in EIA and Management, Materials Characterization Techniques and Immunology Techniques during the year 2019-2020.

The programmes were given wider publicity through electronic and print media. During 2019-2020, 50 candidates were given intensive training in the execution of hands-on experimental activities and case studies. Many of the candidates got placements and few turned to be entrepreneurs. During the reporting period, a web portal for online submission of applications for the courses was designed and developed.

A one-day workshop on "Standardization of Ayurvedic Formulations for MSME Industries in Ayurveda Sector" was conducted on 24th January 2020. Around 80 participants from different fields of Ayurvedic sector attended the workshop.

Director, CSIR NIIST inaugurating the workshop on Ayurveda on 24th January 2020

List of Publications

1. ABRAHAM (A), PHILIP (S), NARAYANAN (S P), JACOB (K C), SINDHU (R), PANDEY (A), SANG (B), JAYACHANDRAN (K). Induction of Systemic Acquired Resistance in Hevea Brasiliensis by an Endophytic Bacterium Antagonistic to Phytophthora Meadii. Indian Journal of Experimental Biology, 2019, 57:796-805

2. ADARSH (N), SANEESH BABU (P S), AVIRAH (R R), VIJI (M), NAIR (S A), RAMAIAH (D). Aza-BODIPY Nanomicelles as Versatile Agents For The In Vitro and In Vivo Singlet Oxygen-Triggered Apoptosis of Human Breast Cancer Cells. Journal of Materials Chemistry B, 2019, 7(14):2372-2377

3. ADINARAYANA (B), DAS (M), SURESH (C H), SRINIVASAN (A). Homocarbaporphyrinoids: The m-o-m and p-o-p Terphenyl Embedded Expanded Porphyrin Analogues and Their Rh-I Complexes. Chemistry - A European Journal, 2019, 25(18):4683-4687

4. AKHIL (M G), PREENU (S), HARI (S), RAVI (M). Effect of Heat Treatment on the Mechanical Properties of Squeeze-Cast Al-5Si-3Cu Alloy for Automotive Applications. Transactions of the Indian Institute of Metals, 2019, 72(5):1129–1132

5. AKSHAY (V R), ARUN (B), MANDAL (G), CHANDA (A), VASUNDHARA (M). Significant Reduction in the Optical Band-gap and Defect Assisted Magnetic Response in Fe-doped Anatase Tio2 Nanocrystals as Dilute Magnetic Semiconductors. New Journal of Chemistry, 2019, 43(15):6048-6062

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10. ANEESH (P K), GOVIND (C), NAMBIAR (S R). Design and Fabrication of Surface Capped Palladium Nano clusters for the Subnanomolar Sensing of Glutathione. Analytical Methods, 2019, 11(15):2089-2096

11. ANGEL MARY JOSEPH, NAGENDRA (B), SURENDRAN (K P), BHOJE GOWD (E). Sustainable in Situ Approach to Covalently Functionalize Graphene Oxide with POSS Molecules Possessing Extremely Low Dielectric Behavior. Langmuir, 2019, 35(13):4672–4681

12. ANILA (S), SURESH (C H) Formation of large clusters of CO2 around anions: DFT study reveals cooperative CO2 adsorption. Physical Chemistry Chemical Physics, 2019, 21(41):23143-23153

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14. ANJANA (P M), BINDHU (M R), RAKHI (R B). Green Synthesized Gold Nanoparticle Dispersed Porous Carbon Composites for Electrochemical Energy Storage. Materials Science for Energy Technologies, 2019, 2(3): 389-395

15. ANJANA (P M), BINDHU (M R), UMADEVI (M), RAKHI (R B). Antibacterial and Electrochemical Activities of Silver, Gold, and Palladium Nanoparticles Dispersed Amorphous Carbon Composites. Applied Surface Science, 2019, 479:96-104

16. ANJU (V); PRIYA (S); BABY (S); RAMESHKUMAR (K B). Chemical Constituents and Cytotoxicity of Euphorbia vajravelui. Letters In Organic Chemistry, 2019, 16(8):643-646

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18. ARINDAM MAL, VIJAYAKUMAR (S), MISHRA (R K), JACOB (J), PILLAI (R S), DILEEP KUMAR (B S), AJAYAGHOSH (A). Supramolecular Surface Charge Regulation in Ionic Covalent Organic Nanosheets: Reversible Exfoliation and Controlled Bacterial Growth. Angewandte Chemie-International Edition, 2019, 58:2-9

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Observation of Enhanced Magnetic Entropy Change Near Room Temperature in Sr-site Deficient La0.67sr0.33mno3 Manganite. RSC Advances, 2019, 9(41):23598-2360

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Exploring Mitochondria-Mediated Intrinsic Apoptosis by New Phytochemical Entities: An Explicit Observation of Cytochrome c Dynamics on Lung and Melanoma Cancer Cells. Journal of Medicinal Chemistry, 2019, 62(17):8311-8329

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Rapid Degradation of the Organophosphate Pesticide – Chlorpyrifos by a Novel Strain of Pseudomonas Nitroreducens Ar-3. Bioresource Technology, 2019, 292:122025

25. ASWATHI (A), PANDEY (A), SUKUMARAN (R K).
Rapid Degradation of the Organophosphate Pesticide – Chlorpyrifos by a Novel Strain of Pseudomonas Nitroreducens Ar-3. Bioresource Technology, 2019, 292: 122025

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Sign Reversal of Magnetization in Sm2CrMnO6 Perovskites. Journal of Magnetism and Magnetic Materials, 2019, 483:89-94

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Excited State Electronic Interconversion and Structural Transformation of Engineered Red-Emitting Green Fluorescent Protein Mutant. Journal of Physical Chemistry B, 2019, 123(10):2316-2324

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एनआईआईएसटी वैज्ञानिकों द्वारा विदेश दौरा

नाम	यात्रा की जगह और अवधि	यात्रा का उद्देश्य
डॉ। बिनोद परमेस्वरन	यू के (28/07/2019 – 06/08/2019)	मैनचेस्टर विश्वविद्यालय का दौरा (भारत-ब्रिटेन परियोजना)
डॉ राकेश यासरला	यू के (28/07/2019 – 06/08/2019)	मैनचेस्टर विश्वविद्यालय का दौरा (भारत-ब्रिटेन परियोजना)
डॉ। के माधवन नामपुथिरी	यू के (28/07/2019 – 06/08/2019)	मैनचेस्टर विश्वविद्यालय का दौरा (भारत-ब्रिटेन परियोजना)
डॉ। के जयशंकर	ईटली (01/09/2019 – 31/01/2020)	दो मास्टर्स छात्रों के लिए प्रोजेक्ट इंटर्नशिप
डॉ। वसुंधरा मुत्ता	रशिया (07/09/2019 – 15/09/2019)	द्विपक्षीय परियोजना की बैठक
डॉ। सी विजयकुमार	रशिया (09/09/2019 – 13/09/2019)	जनरल और एप्लाइड केमिस्ट्री पर 21 वें मेंडेलीव कांग्रेस
डॉ। ए अजयघोष	ताइवान (17/09/2019 – 20/09/2019)	9 वीं ईएएस
डॉ। के माधवन नामपुथिरी	जर्मनी (18/09/2019 – 07/10/2019)	डीबीटी-बी एम बी एफ इंडो-जर्मन रिसर्च प्रोग्राम
डॉ। राजीव के सुकुमारन	चाइना (20/09/2019 – 23/09/2019)	गैर-बिंदु स्रोत प्रदूषण नियंत्रण पर अंतर्राष्ट्रीय सम्मेलन
डॉ। राजीव के सुकुमारन	स्विट्जरलैंड (01/10/2019 – 31/10/2019)	स्विस फेडरल इंस्टीट्यूट ऑफ टेक्नोलॉजी, लॉज़ेन (ई पी एफ एल) की यात्रा
डॉ। के जी रघु	फ्रांस (17/10/2019 – 18/10/2019)	ज्ञान शिखर सम्मेलन
डॉ। बिनोद परमेस्वरन	चाइना (02/11/2019 – 04/11/2019)	आईबीए- ए बी यू डी -2019
डॉ। ए अजयघोष	जर्मनी (17/11/2019 – 23/11/2019)	जर्मन शैक्षणिक विनिमय सेवा डीएएडी के हिस्से के रूप में प्रतिनिधिमंडल
डॉ। टी पी डी राजन	जर्मनी (24/11/2019 – 30/11/2019)	इंडो-जर्मन द्विपक्षीय कार्यक्रम
डॉ। बिनोद परमेस्वरन	फिनलैंड (16/12/2019 – 11/01/2020)	एसईआरबी ओवरसीज डॉक्टरल फेलोशिप

Foreign Visits by NIIST Scientists

NAME	PLACE OF VISIT & PERIOD	PURPOSE OF VISIT
Dr Binod P	UK (28/07/2019 – 06/08/2019)	Visit to Univ. of Manchester (INDO-UK project)
Dr Rakesh Yasarala	UK (28/07/2019 – 06/08/2019)	Visit to Univ. of Manchester (INDO-UK project)
Dr K Madhavan Nampoothiri	UK (28/07/2019 – 06/08/2019)	Visit to Univ. of Manchester (INDO-UK project)
Dr K Jayasankar	Italy (01/09/2019 – 31/01/2020)	Project internship for two Master students
Dr Vasundhara Mutta	Russia (07/09/2019 – 15/09/2019)	Bilateral project meeting
Dr C Vijayakumar	Russia (09/09/2019 – 13/09/2019)	21st Mendeleev Congress on General and Applied Chemistry
Dr A Ajayaghosh	Taiwan (17/09/2019 – 20/09/2019)	9th EAS
Dr K Madhavan Nampoothiri	Germany (18/09/2019 – 07/10/2019)	DBT-BMBF Indo-German Research programme
Dr Rajeev K Sukumaran	China (20/09/2019 – 23/09/2019)	International Conference on Non-Point Source Pollution Control
Dr Rajeev K Sukumaran	Switzerland (01/10/2019 – 31/10/2019)	Visit to Swiss Federal Institute of Technology, Lausanne (EPFL)
Dr K G Raghu	France (17/10/2019 – 18/10/2019)	Knowledge Summit
Dr Binod Parameswaran	China (02/11/2019 – 04/11/2019)	IBA-ABUD-2019
Dr A Ajayaghosh	Germany (17/11/2019 – 23/11/2019)	Delegation as part of German Academic Exchange Service DAAD
Dr T P D Rajan	Germany (24/11/2019 – 30/11/2019)	Indo-German bilateral program
Dr Binod Parameswaran	Finland (16/12/2019 – 11/01/2020)	SERB Overseas doctoral fellowship

विदेशी वैज्ञानिकों / प्रतिष्ठित व्यक्तियों के एनआईआईएसटी का दौरा

नाम	देश से	दिनांक	यात्रा का उद्देश्य
श्री चंदर एस जीना	सचिव, एंटी-जालसाजी समाधान प्रदाता एसोसिएशन (एएसपीए), नई दिल्ली	11-04-2019	विरोधी जालसाजी प्रौद्योगिकियों का अवलोकन - रुझान और विकास
डॉ। वी वडिवलान	निदेशक, इग्नेट्रा होलोग्रैफिक्स, कोयंबटूर	11-04-2019	होलोग्राफिक ऑप्टिकल तत्वों और इसके अनुप्रयोगों का परिचय
डॉ। सी वी रमना	वरिष्ठ प्रधान वैज्ञानिक, सीएसआईआर-एनसीएल, पुणे	31-05-2019	कुल संश्लेषण प्रेरित तरीके
प्रो हिदेहिरो सकुराई	एप्लाइड केमिस्ट्री विभाग, स्कूल ऑफ इंजीनियरिंग, ओसाका विश्वविद्यालय, जापान	20-06-2019	सुमेने रसायन विज्ञान में हालिया प्रगति
सुश्री श्रीजा वर्मा सी आर	वैज्ञानिक / अभियंता एसएफ, केंद्र सुरक्षा प्रभाग, केंद्र सुरक्षा प्रबंधन समूह, वीएसएससी	22-07-2019	रासायनिक प्रयोगशाला सुरक्षा अभ्यास
डॉ के वी आदर्श	एसोसिएट प्रोफेसर, भौतिकी विभाग, आईआईएसईआर भोपाल	26-07-2019	एक्सोविटॉन के नए दृष्टिकोण पेर्कोसाइट लीड हलाइड नैनोकिस्टल्स में कई-बॉडी इंटरैक्शन हैं
डॉ। मंदार बोडस	समाधान सलाहकार, एल्सेवियर	30- 07-2019	एक प्रस्तुति और रिएक्सिस और रिएक्सिस औषधीय रसायन विज्ञान का डेमो
प्रो एन सत्यमूर्ति /	मानद प्रोफेसर, जेएनसीएएसआर, बेंगलुरु और पूर्व निदेशक, आईआईएसईआर, मोहाली	02-08-2019	आचार्य प्रफुल्ल चंद्र रे मेमोरियल प्रतिष्ठित व्याख्यान 2019
डॉ। चंद्रशेखर वी कुलकर्णी	वरिष्ठ व्याख्याता, लिपिड नेनोस्ट्रक्चर प्रयोगशाला, केंद्रीय लंकाशायर विश्वविद्यालय	30-08-2019	कृषि-प्रसंस्करण और जैव-प्रौद्योगिकीय उद्योगों के लिए विकासशील सामग्रियों में लिपिड सेल्फ-असेंबली के उभरते अनुप्रयोग
प्रो बर्न कोहलर	ओहियो प्रख्यात विद्वान, रसायन विज्ञान और जैव रसायन विभाग, ओहियो स्टेट यूनिवर्सिटी, यूएसए	26-11-2019	डीएनए स्ट्रैंड्स और डीएनए-मेटल नैनो-असेंबलियों में अल्ट्राफास्ट एक्साइटेड-स्टेट डायनेमिक्स
प्रो एंडर्स हैगफेल्ट	ईपीएफएल स्विट्जरलैंड एडिटर-इन-चीफ, जर्नल ऑफ़ मैटेरियल्स केमिस्ट्री ए	29-11-2019	मेसोस्कोपिक सौर कोशिकाओं की बहुमुखी प्रतिभा
प्रोफेसर गौतम डे	आईएनएसटी मोहाली एसोसिएट एडिटर, जर्नल ऑफ़ मैटेरियल्स केमिस्ट्री ए	29-11-2019	कार्यात्मक अनुप्रयोगों के लिए गीला-रसायन विज्ञान के माध्यम से नैनोस्ट्रक्चर का डिजाइन
श्री इरशाद अबूबकर	रॉयल सोसाइटी ऑफ केमिस्ट्री, भारत	29-11-2019	अधिकतम प्रभाव के लिए अपनी पांडुलिपि कैसे लिखें
डॉ। वी राघवेंद्र रेड्डी	वैज्ञानिक जी, यूजीसी-डीएई कंसोर्टियम फॉर साइंटिफिक रिसर्च, खंडवा रोड, यूनिवर्सिटी कैंपस, इंदौर	02-12-2019	मैग्नेटो-ऑप्टिकल केर प्रभाव (MOKE) माइक्रोस्कोपी - पतली फिल्मों के चुंबकत्व का अध्ययन करने की तकनीक
प्रोफेसर तुषार जान	प्रोफ़ेसर रसायन विज्ञान के स्कूल हैदराबाद विश्वविद्यालय हैदराबाद	03-12-2019	पॉलिमर-आधारित नैनोमटेरियल्स: संरचनात्मक विविधता और अनुप्रयोग
प्रो शिगयुकि यागी	डिपार्टमेंट ऑफ एप्लाइड केमिस्ट्री, ग्रेजुएट स्कूल ऑफ इंजीनियरिंग ओसाका प्रान्त विश्वविद्यालय, जापान	05-12-2019	फॉस्फोरसेंट ऑर्गेनोप्लाटिनम (II) कॉम्प्लेक्स का अनोखा फोटोलुमिनेसेंस बिहेवियर
डॉ। चेतना सचिदानथन	इंस्टीट्यूट ऑफ जीनोमिक्स एंड इंटीग्रेटिव बायोलॉजी, दिल्ली	24-01-2020	जेब्राफिश में मानव रोगों की मॉडलिंग

Visits of Foreign Scientists/Eminent Personalities to Niist

Name	Country from	Date	Purpose of visits
Mr Chander S Jeena	Secretary, Anti-counterfeiting Solution Providers' Association (ASPA), New Delhi	11-Apr-2019	Overview of Anti-Counterfeiting Technologies – Trends and Developments
Dr V Vadivelan	Director, Ignetta Holographics, Coimbatore	11-Apr-2019	Introduction of Holographic Optical Elements and its Applications
Dr C V Ramana	Senior Principal Scientist, CSIR-NCL, Pune	31-May-2019	Total Synthesis Driven Methodologies
Prof Hidehiro Sakurai	Division of Applied Chemistry, School of Engineering, Osaka University, Japan	20-Jun-2019	Recent progress in Sumanene Chemistry
Ms Sreeja Varma C R	Sci/Engineer SF, Centre Safety Division, Centre Safety Management Group, VSSC	22-July-2019	Chemical Laboratory Safety Practices
Dr K V Adarsh	Associate Professor, Department of Physics, IISER Bhopal	26-Jul-2019	New perspectives of exciton many-body interactions in perovskite lead halide nanocrystals
Dr Mandar Bodas	Solution Consultant, Elsevier	30- Jul-2019	A presentation and demo of Reaxys and Reaxys medicinal chemistry
Prof N Sathyamurthy	Honorary Professor, JNCASR, Bengaluru & Former Director, IISER, Mohali	2-Aug-2019	Acharya Prafulla Chandra Ray Memorial Distinguished Lecture 2019
Dr Chandrashekhar V Kulkarni	Senior Lecturer ,Lipid Nanostructures Laboratory, University of Central Lancashire	30-Aug-2019	Emerging Applications of Lipid Self-Assembly in Developing Materials for Agro-processing and Biotechnological Industries
Prof Bern Kohler	Ohio Eminent Scholar, Department of Chemistry & Biochemistry, Ohio State University, USA	26-Nov-2019	Ultrafast Excited-State Dynamics in DNA Strands and DNA-Metal Nano-assemblies
Prof Anders Hagfeldt	EPFL Switzerland Editor-In-Chief, Journal of Materials Chemistry A	29-Nov-2019	The Versatility of Mesoscopic Solar Cells
Professor Goutam De	INST Mohali Associate Editor, Journal of Materials Chemistry A	29-Nov-2019	Design of nanostructures through wet-chemistry for functional applications
Mr Ershad Abubacker	Royal Society of Chemistry, India	29-Nov-2019	How to write your manuscript for maximum impact
Dr V Raghavendra Reddy	Scientist G, UGC-DAE Consortium for Scientific Research, Khandwa Road, University Campus, Indore	2-Dec-2019	Magneto-optical Kerr effect (MOKE) microscopy – Technique to study magnetism of thin films"
Prof Tushar Jana	Professor, School of Chemistry University of Hyderabad Hyderabad	3-Dec-2019	Polymer-Based Nanomaterials: Structural Diversity and Applications
Prof Shigeyuki Yagi	Department of Applied Chemistry, Graduate School of Engineering Osaka Prefecture University, Japan	5-Dec-2019	Unique Photoluminescence Behavior of Phosphorescent Organoplatinum(II) Complexes
Dr Chetana Sachidanandan	Institute of Genomics & Integrative Biology, Delhi	24-Jan-2020	Modelling human diseases in Zebrafish

पीएचडी पुरस्कृत

नाम	शोध का शीर्षक	सुपरवाइजगि गाइड	अवार्ड की तथि
	एसीएसआईआर		
शल्पिा जी	मानव गर्भाशय ग्रीवा और स्तन कैंसर की कोशकिाओं में बायोरल के संयुग्मक डडिोललिमेटेन (डीआईएम) के इन वट्रिो एंटीकैंसर गतविधि अध्ययन	डॉ। प्रयिा एस	30.04.2019
अथरि कृष्णा	डजिाइन, संश्लेषण, फोटोफजिकिल और इलेक्ट्रोल्यूमनिसेंस ट्राइफेनलिमाइन और कार्बेज़ोल डेरविटवि अध्ययन	डॉ आर लक्ष्मी वर्मा	13.05.2019
मोलजी सी	स्व-इकट्ठे संयुग्मति बहुलक नैनोकंपोजट्सि की तैयारी और डवािइस अनुप्रयोगों पर अध्ययन	डॉ। नारायणन उन्नी	22.05.2019
फातमिा सलीफ़ेना सी टी	लुईस एसडि ने च्लोकोन्स के परविर्तन को उत्प्रेरति कयिा: जैवकि और औद्योगकि रूप से संश्लेषण	डॉ बी एस शशधिर	11.06.2019
तनवषिता घोष	फोटोवोल्टकि अनुप्रयोगों के लएि थयिोफीन ऑलगिोमर्स: संश्लेषण, स्व-संयोजन और ऑप्टोइलेक्ट्रोनकि गुण	डॉ सी वजियकुमार	11.06.2019
मनगिंडा एस	लक्षति कैंसर चकित्सिा के लएि सथिंटकि और नैनोकैरयिर वतिरण प्रणाली का डजिाइन, संश्लेषण और जैवकि मूल्यांकन	डॉ कौस्तुभ कुमार मैती	11.06.2019
नरसिट्टी ववािक	बायोडीजल व्युत्पन्न क्रूड ग्लसिरॉल से 1,3-प्रपेंडीओल के माइक्रोबयिल उत्पादन के लएि एक बायोप्रोसेस का वकिास	डॉ बनिोद परमेश्वरन	26.06.2019
अंजू अल्फोंसा जोस	माइक्रोबयिल पॉली गामा ग्लूटामकि एसडि और इसके अनुप्रयोगों के उत्पादन के लएि प्रक्रयिा वकिास	डॉ बनिोद परमेश्वरन	26.06.2019
सीतारा थॉमस	कोलोरेक्टल कैंसर के खलिाफ चयनति फाइटोकेमकिल्स के एंटीकैंसर गुण	डॉ पी नशिा	16.07.2019
ए आशीष	हाइब्रडि प्रवाहकीय नैनोस्ट्रक्टर्ड इलेक्ट्रोड का डजिाइन और वकिास: स्मार्ट लचीले इलेक्ट्रॉनक्सि के लएि एक नया प्रतमिान	डॉ यू एस हरीश	16.07.2019
दजिति के एस	हाइब्रडि कार्यात्मक संरचनाओं के लएि उपन्यास ईएमई परररिक्षण रणनीतयिाँ	डॉ के पी सुरेंद्रन	31.07.2019
अंजलि सोमन	फ्लोरोसेंट कार्बनकि प्रकाश उत्सर्जक डायोड के ऑप्टोइलेक्ट्रोनकि गुण: डवािइस इंजीनयिरगि की भूमकिा	डॉ के एन नारायणन उन्नी	11.09.2019
जमशीना वी	1,2 डाइहाइड्रोपाइरडिाइन्स, डबिंजोक्साजेपाइन्स और डडिोललिेटेनेस के डजिाइन, संश्लेषण और अनुप्रयोग	डॉ एल रवशिंकर	21.10.2019
जेरनि के पंक्रेसयिस	संश्लेषण और बहुआयामी धातु और प्रकाश मश्रि पर बहुलक मश्रिति कोटगि्स के लक्षण वर्णन	डॉ टी पी डी राजन	29.10.2019
ऐश्वर्या आर	मुद्रति इलेक्ट्रॉनक्सि के लएि कार्यात्मक सामग्री स्याही	डॉ के पी सुरेंद्रन	26.11.2019

उलेटो सारा बलि	बायोमास अर्क से स्मार्ट एंटीकोर्सोशन कोटग्सि का वकिास	डॉ टी पी डी राजन	10.12.2019
अक्षय वी आर	थर्मोइलेक्ट्रक्सि और स्पनिट्रॉनक्सि अनुप्रयोगों के लिए कुछ कार्यात्मक अर्धचालक सामग्री के बॉटम-अप नैनो-इंजीनयिरगि	डॉ एम वसुंधरा	18.12.2019
सुदक्षणिा बी	एनडी-आधारति मैग्नेटोरसस्टिवि मशि्रति वेलेंटाइन मैंगनीज के संरचनात्मक, चुंबकीय और वद्युित परविहन व्यवहार पर अध्ययन	डॉ एम वसुंधरा	18.12.2019
जयंती एस पणक्किर	फोटोवोल्टकि अनुप्रयोग के लिए छोटे अणुओं का संश्लेषण और थयिोफीन आधारति अर्धचालक का अध्ययन	डॉ सी वजियकुमार	05.02.2020
स्वेथा एस	डाई-संवेदी सौर कोशकिाओं में वर्धति फोटोवोल्टकि प्रदर्शन के लिए ZnO आधारति कार्यात्मक परतों पर जांच	डॉ यू एस हरीश	05.02.2020
सत्यजीत दास	स्व-इकट्ठे प्रणालयिों के भौतकि रूप से और थर्मल नयिंत्रति भौतकि गुणों की फोटोकैमकिली	डॉ ए अजयघोष	11.02.2020
सजीथा एम जे	जैव-फोटोनकि अनुप्रयोगों के लिए बेहतर वशिषताओं के साथ प्लास्मोनकि नैनोमेट्रक्सि के सुस्पष्ट संश्लेषण	डॉ। योसाफ़ करुवथ	20.02.2020
सुमीना एन बी	कार्यात्मक अनुप्रयोगों के लिए व्यापक स्पेक्ट्रम सक्रयि TiO2 का नमि्न तापमान संश्लेषण	डॉ साजू पलि्लै	20.02.2020
अरुण बी	चुंबकीय चरण संक्रमणों और चुंबकीय प्रशीतन अनुप्रयोगों के लिए दुर्लभ-पृथ्वी मैंगनीज के चुंबकीय गुणों की ट्यूनगि	डॉ एम वसुंधरा	20.02.2020
रेम्या आर	ऑप्ओइलेक्ट्रोनकि अनुप्रयोगों के लिए समाधान संसाधति संक्रमण धातु ऑक्साइड	डॉ बस्विप्रयिा देब	05.03.2020
दीप्तकिृष्णन	पदानुक्रमति सुपरमॉलक्यिूलर ब्लॉक कॉपोलमिर की नर्दिेशति असेम्बली	डॉ ई भोजे गौड़	28.03.2020
सजिला रोसली सी वी	पाली (एल-लैक्टाइड) / बोरान नाइट्राइड नैनोकम्पोजट्सि की संरचना और गुण	डॉ ई भोजे गौड़	16.03.2020 (मौखकि परक्षिा ख़त्म)

Ph D Awarded

Name	Thesis Title	Supervising Guide	Date of Award
AcSIR			
Shilpa G	*In vitro* anticancer activity studies of diindolylmethane (DIM) conjugate of biaryls in human cervical and breast cancer cells	Dr P Priya	30.04.2019
Athira Krishna	Design, synthesis, photophysical and electroluminescence studies of triphenylamine and carbazole derivatives	Dr R Luxmi Varma	13.05.2019
Molji C	Studies on the preparation and device applications of self-assembled conjugated polymer nanocomposites	Dr Narayanan Unni	22.05.2019
Fathima Salfeena C T	Lewis acid catalyzed transformations of chalcones: Synthesis of biologically and industrially relevant heterocyclic compounds	Dr B S Sasidhar	11.06.2019
Tanwishta Ghosh	Thiophene oligomers for photovoltaic applications: Synthesis, self-assembly and optoelectronic properties	Dr C Vijayakumar	11.06.2019
Maniganda S	Design, Synthesis and biological evaluation of synthetic and nanocarrier delivery system for targeted cancer therapy	Dr Kaustabh Kumar Maiti	11.06.2019
Narisetty Vivek	Development of a bioprocess for microbial production of 1,3-propanediol from biodiesel derived crude glycerol	Dr Binod Parameswaran	26.06.2019
Anju Alphonsa Jose	Process development for the production of microbial poly gamma glutamic acid and its applications	Dr Binod Parameswaran	26.06.2019
Sithara Thomas	Anticancer properties of selected phytochemicals against colorectal cancer	Dr P Nisha	16.07.2019
Aashish A	Design and development of hybrid conductive nanostructured electrodes: A new paradigm for smart flexible electronics	Dr U S Hareesh	16.07.2019
Dijith K S	Novel EME shielding strategies for hybrid functional structures	Dr K P Surendran	31.07.2019
Anjaly Soman	Optoelectronic properties of fluorescent organic light emitting diodes: Role of device engineering	Dr K N Narayanan Unni	11.09.2019

Jamsheena V	Design, synthesis and application of 1,2 dihydropyridines, dibenzoxazepines and diindolylmethanes	Dr L Ravishankar	21.10.2019
Jerin K Pancrecious	Synthesis and characterization of multifunctional metallic and polymer composite coatings on light alloys	Dr T P D Rajan	29.10.2019
Aiswarya R	Functional material inks for printed electronics	Dr K P Surendran	26.11.2019
Ulaeto Sara Bill	Development of smart anticorrosion coatings from biomass extracts	Dr T P D Rajan	10.12.2019
Akshay V R	Bottom-up nano-engineering of some functional semiconducting materials for thermoelectrics and spintronics applications	Dr M Vasundhara	18.12.2019
Sudakshina B	Studies on structural, magnetic and electrical transport behavior of Nd-based magnetoresistive mixed valent manganites	Dr M Vasundhara	18.12.2019
Jayanthy S Panicker	Synthesis and study of thiophene based semiconducting small molecules for photovoltaic application	Dr C Vijayakumar	05.02.2020
Swetha S	Investigations on ZnO based functional layers for enhanced photovoltaic performances in dye-sensitised solar cells	Dr U S Hareesh	05.02.2020
Satyajit Das	Photochemically and thermally controlled physical properties of self-assembled π-systems	Dr A Ajayaghosh	11.02.2020
Sajitha M J	Facile synthesis of plasmonic nanomaterials with improved characteristics for bio-photonic applications	Dr Yoosaf Karuvath	20.02.2020
Sumina N B	Low temperature synthesis of wide spectrum active TiO_2 for functional applications	Dr Saju Pillai	20.02.2020
Arun B	Tuning the magnetic phase transitions and the magnetocaloric properties of rare-earth manganites for magnetic refrigeration applications	Dr M Vasundhara	20.02.2020
Remya R	Solution processed transition metal oxides for optoelectronic applications	Dr Biswapriya Deb	05.03.2020
Deepthi Krishnan	Directed assembly of hierarchical supramolecular block copolymers	Dr E Bhoje Gowd	28.03.2020
Sijla Rosely C V	Structure and properties of poly (L-lactide)/ boron nitride nanocomposites	Dr E Bhoje Gowd	16.03.2020 (Viva over)

प्रबंधन परिषद्

01/01/2018 से 31/12/2019 की अवधि केलिए

अध्यक्ष

निदेशक, सीएसआईआर- एनआईआईएसटी

सदस्य

डॉ अश्विनी कुमार नांगिया
निदेशक, सीएसआईआर-एनसीएल, पुना

डॉ एस सावित्री
मुख्य वैज्ञानिक

डॉ पी निशि
प्रमुख, आरपीबीडी

श्री सी के चंद्रकांत
प्रधान वैज्ञानिक

डॉ यू एस हरीश
वरिष्ठ वैज्ञानिक

डॉ पी जयमूर्ति
वैज्ञानिक

श्री एम ब्रह्मकुमार
प्रधान तकनीकी अधिकारी
/एफएओ सीओएफ,
एनआईआईएसटी

सदस्य सचिव

प्रशासन नियंत्रक/प्रशासन अधिकारी,
एनआईआईएसटी

प्रबंधन परिषद्

01/01/2020 से 31/12/2021 की अवधि केलिए

अध्यक्ष

निदेशक, सीएसआईआर- एनआईआईएसटी

सदस्य

डॉ एन कलैसेलवी
निदेशक, सीएसआईआर-सीईसीआरआई, कराईकुडी

डॉ पी निशि
मुख्य वैज्ञानिक & प्रमुख, आरपीबीडी और के.आर.सि

डॉ एस अनंतकुमार
वरिष्ठ प्रधान वैज्ञानिक

डॉ ए कुमारन
प्रधान वैज्ञानिक

डॉ के पी सुरेंद्रन
वरिष्ठ वैज्ञानिक

डॉ सूरज सुमन
वैज्ञानिक

डॉ बीना जॉय
प्रधान तकनीकी अधिकारी
/एफएओ सीओएफए ,
एनआईआईएसटी

सदस्य सचिव

प्रशासन नियंत्रक/प्रशासन अधिकारी,
एनआईआईएसटी

MANAGEMENT COUNCIL
Period 01/01/2018 to 31/12/2019

CHAIRMAN

Director, CSIR-NIIST

MEMBERS

Dr Ashwini Kumar Nangia
Director, CSIR-NCL, Pune

Dr S Savithri
Chief Scientist

Dr P Nishy
Head, RPBD

Shri C K Chandrakanth
Principal Scientist

Dr U S Hareesh
Senior Scientist

Dr P Jayamurthy
Scientist

Shri M Brahmakumar
Principal Technical Officer

CoFA/FAO Member
MEMBER SECRETARY
CoA / AO, NIIST

MANAGEMENT COUNCIL
Period 01/01/2020 to 31/12/2021

CHAIRMAN

Director, CSIR-NIIST

MEMBERS

Dr N Kalaiselvi
Director, CSIR-CECRI, Karaikudi

Dr P Nishy
Chief Scientist & Head, RPBD and KRC

Dr S Ananthakumar
Senior Principal Scientist

Dr A Kumaran
Principal Scientist

Dr K P Surendran
Senior Scientist

Dr Suraj Soman
Scientist

Dr Beena Joy
Principal Technical Officer

CoFA/FAO Member
MEMBER SECRETARY
CoA / AO, NIIST

पदोन्नतियॉ / Promotions

डॉ के जी रघु
Dr K G Raghu
वरिष्ठ प्रिंसिपल वैज्ञानिक
Senior Principal Scientist

डॉ के वी राधाकृष्णन
Dr K V Radhakrishnan
वरिष्ठ प्रिंसिपल वैज्ञानिक
Senior Principal Scientist

डॉ सी एच सुरेश
Dr C H Suresh
वरिष्ठ प्रिंसिपल वैज्ञानिक
Senior Principal Scientist

श्री वी वी वेणुगोपाल
Mr V V Venugopal
वरिष्ठ प्रिंसिपल वैज्ञानिक
Senior Principal Scientist

श्री सी के चंद्रकांत
Mr C K Chandrakanth
वरिष्ठ प्रिंसिपल वैज्ञानिक
Senior Principal Scientist

श्री आर एस प्रवीण राज
Mr R S Praveen Raj
प्रिंसिपल वैज्ञानिक
Principal Scientist

डॉ ए श्रीनिवासन
Dr A Srinivasan
प्रिंसिपल वैज्ञानिक
Principal Scientist

डॉ कौस्तुभ कुमार मैती
Dr Kaustabh Kumar Maiti
प्रिंसिपल वैज्ञानिक
Principal Scientist

डॉ एम सुंदरराजन
Dr M Sundararajan
प्रिंसिपल वैज्ञानिक
Principal Scientist

डॉ बिस्वप्रिया देब
Dr Biswapriya deb
प्रिंसिपल वैज्ञानिक
Principal Scientist

डॉ के पी सुरेंद्रन
Dr K P Surendran
वरिष्ठ वैज्ञानिक
Senior Scientist

डॉ जोशी जोसेफ
Dr Joshy Joseph
वरिष्ठ वैज्ञानिक
Senior Scientist

पदोन्नतियाँ / Promotions

डॉ बी कृष्णकुमार
Dr B Krishnakumar
प्रिंसिपल वैज्ञानिक
Principal Scientist

डॉ ई भोजे गौड़
Dr E Bhoje Gowd
प्रिंसिपल वैज्ञानिक
Principal Scientist

डॉ के जयशंकर
Dr K Jayasankar
प्रिंसिपल वैज्ञानिक
Principal Scientist

डॉ एम वी रेशमा
Dr M V Reshma
प्रिंसिपल वैज्ञानिक
Principal Scientist

डॉ करुणाकरण वेणुगोपाल
Dr Karunakaran Venugopal
प्रिंसिपल वैज्ञानिक
Principal Scientist

डॉ यू एस हरीश
Dr U S Hareesh
प्रिंसिपल वैज्ञानिक
Principal Scientist

डॉ एस प्रिया
Dr S Priya
वरिष्ठ वैज्ञानिक
Senior Scientist

डॉ मुत्तु अरुमुखम
Dr Muthu Arumugham
वरिष्ठ वैज्ञानिक
Senior Scientist

डॉ एम किरण कुमार
Mr M Kiran Kumar
वरिष्ठ वैज्ञानिक
Senior Scientist

डॉ एस के श्रीजाकुमारी
Dr S S Sreejakumari
वरिष्ठ वैज्ञानिक
Senior Scientist

डॉ एल रविशंकर
Dr L Ravi Shankar
वरिष्ठ वैज्ञानिक
Senior Scientist

डॉ युसफ़ करुवथ
Dr Yoosaf Karuvath
वरिष्ठ वैज्ञानिक
Senior Scientist

पदोन्नतियॉ / Promotions

डॉ पी बिनोद
Dr P Binod
वरिष्ठ वैज्ञानिक
Senior Scientist

श्री एस बी रिबिन जोन्स
Mr S B Ribin Jones
वरिष्ठ वैज्ञानिक
Senior Scientist

डॉ एन रमेश कुमार
Dr N Ramesh Kumar
वरिष्ठ वैज्ञानिक
Senior Scientist

डॉ सी विजयकुमार
Dr C Vijayakumar
वरिष्ठ वैज्ञानिक
Senior Scientist

डॉ बी एस ससिधर
Dr B S Sasidhar
वरिष्ठ वैज्ञानिक
Senior Scientist

डॉ सजू पिल्लई
Dr Saju Pillai
वरिष्ठ वैज्ञानिक
Senior Scientist

श्री एस पुश्किन
Mr S Pushkin
वरिष्ठ तकनीकी अधिकारी (1)
Senior Technical Officer (1)

श्री किरण मोहन
Mr Kiran Mohan
वरिष्ठ तकनीकी अधिकारी (1)
Senior Technical Officer (1)

श्री जे एस किरण
Mr J S Kiran
तकनीकी अधिकारी
Technical Officer

श्री बी सतीश कुमार
Mr B Satheesh Kumar
वरिष्ठ सचिवालय सहायक (सा)
Senior Secretariat Assistant (G)

श्रीमती ए एल सजीता
Mrs A L Sajitha
वरिष्ठ सचिवालय सहायक (सा)
Senior Secretariat Assistant (G)

श्रीमती शीबा सैतू
Mrs Sheeba Saithu
वरिष्ठ सचिवालय सहायक (एस&पी)
Senior Secretariat Assistant (S&P)

हाल ही में भर्ती हुए वैज्ञानिक 2019-20
Recently Recruited Scientists 2019-20

डॉ आर वेंकटेश
Dr R Venkatesh

डॉ जुबी जॉन
Dr Jubi John

डॉ आदर्श अशोक
Dr Adersh Asok

श्री अक्षय शेंडे
Mr Akshay Shende

श्री जे वेंकटेशन
Mr J Venkatesan

डॉ पी ए बालकुमारन
Dr P A Balakumaran

सीएसआईआर-एनआईआईएसटीमें स्थानांतरण
Transfer to CSIR-NIIST

डॉ सोमू रॉय/ Dr Somu Roy
वित्त और खाता अधिकारी
Finance & Accounts Officer

श्री जी पद्मकुमार/ Mr G Padmakumar
अनुभाग अधिकारी (सा)
Section Officer (G)

डॉ के आई सुरेश /Dr K I Suresh
वरिष्ठ प्रधान वैज्ञानिक
Senior Principal Scientist

डॉ अचू चन्द्रन
Dr Achu Chandran
वैज्ञानिक Scientist

सीएसआईआर-एनआईआईएसटीसे स्थानांतरण
Transfer from CSIR-NIIST
डॉ। एम वसुंधरा
Dr M Vasundhara
वैज्ञानिक ,Scientist
सीएसआईआर-आईआईसीटी, हैदराबाद
CSIR-IICT, Hydrabad

सेवानिवृत्ति/ Retirement

डॉ हरिकृष्ण भट्ट
Dr Harikrishna Bhat
मुख्य वैज्ञानिक
Chief Scientist
Retired on 30/04/2019

डॉ प्रभाकर राव
Dr Prabhakar Rao
मुख्य वैज्ञानिक
Chief Scientist
Retired on 30/04/2019

श्री बी राधाकृष्णन
Mr B Radhakrishnan
तकनीशियन (2)
Technician (2)
Retired on 30/04/2019

श्री टी पी पौलोस
Mr T P Paulose
वरिष्ठ तकनीशियन (3)
Senior Technician (3)
Retired on 30/04/2019

श्रीमती रमणी देवराज
Mrs Remani Devaraj
अनुभाग अधिकारी (एफ & ए)
Section Officer (F&A)
Retired on 31/05/2019

श्री हरिदासन पिल्लई
Mr Haridasan Pillai
वरिष्ठ तकनीशियन (1)
Senior Technician (1)
Retired on 31/05/2019

डॉ जे डी सुधा
Dr J D Sudha
प्रधान तकनीकी अधिकारीक
Principal Technical Officer
Retired on 31/05/2019

श्रीमती के एस लती देवी
Mrs K S Lathi Devi
हिंदी अधिकारी
Hindi Officer
Retired on 31/05/2019

श्री एम रामस्वामी पिल्लई
Mr M Ramaswamy Pillai
प्रधान तकनीकी अधिकारीक
Principal Technical Officer
Retired on 31/07/2019

श्री बी वेणुगोपाल
Mr B Venugopal
वरिष्ठ तकनीशियन (2)
Senior Technician (2)
Retired on 31/08/2019

श्रीमती पी वी विजी
Mrs P V Viji
अनुभाग अधिकारी (एफ & ए)
Section Officer (F&A)
Retired on 30/11/2019

श्री के शिवदासन
Mr K Sivadasan
अनुभाग अधिकारी (सा)
Section Officer (G)
Retired on 31/01/2020

पुरस्कार तथा सम्मान / AWARDS AND HONOURS

सीएसआईआर यंग साइंटिस्ट अवार्ड्स/ CSIR Young Scientist Awards

सीएसआईआर ने 1987 में विज्ञान और प्रौद्योगिकी के विभिन्न क्षेत्रों में उत्कृष्टता को बढ़ावा देने और उनके द्वारा किए गए उत्कृष्ट योगदान को मान्यता देने के लिए "सीएसआईआर यंग साइंटिस्ट अवार्ड्स" की शुरुआत की है। प्रत्येक पुरस्कार में एक प्रशस्ति पत्र (महानिदेशक, सीएसआईआर और उपाध्यक्ष, सीएसआईआर द्वारा हस्ताक्षरित), पट्टिका, रु। 50000 का नकद पुरस्कार और 25 लाख रुपये का अनुसंधान अनुदान शामिल होता है।

रासायनिक विज्ञान में विशेष रूप से फार्मास्यूटिकल्स, एग्रोकेमिकल्स और विशेष रसायनों के क्षेत्र में उनके महत्वपूर्ण योगदान के लिए रासायनिक विज्ञान में वर्ष 2019 के लिए सीएसआईआर यंग साइंटिस्ट अवार्ड डॉ। ससिधर बी एस को सम्मानित किया गया है।

The CSIR has introduced "CSIR Young Scientist Awards" in 1987, in order to promote excellence in various fields of science and technology and to recognize outstanding contributions made by them. Each award consists of a citation (signed by the Director General, CSIR and the Vice-President, CSIR), plaque, a cash prize of Rs.50000, and research grant of Rs 25 lakhs.

The CSIR Young Scientist Award for the year 2019 in Chemical Sciences has been awarded to Dr Sasidhar B S, for his significant contribution to organic synthesis, particularly in the area of pharmaceuticals, agrochemicals and specialty chemicals.

डॉ ससीधर बी एस ने डॉ हर्षवर्धन , विज्ञान और प्रौद्योगिकी, स्वास्थ्य और परिवार कल्याण और भारत के पृथ्वी विज्ञान और माननीय मंत्री डॉ शेखर चिंतामणि मंडे, डी जी-सीएसआईआर और प्रो के विजय राघवन ,प्रधान वैज्ञानिक सलाहकार, भारत सरकार से सीएसआईआर-यंग साइंटिस्ट अवार्ड -2019 प्राप्त किया।

Dr Sasidhar B.S receiving the prestigious CSIR- Young Scientist Award-2019 in Chemical Sciences from the honorable minister for Science & Technology, Health and Family Welfare and Earth Sciences of India, Dr Harsh Vardhan, DG-CSIR Dr Shekhar Chintamani Mande and Principal Scientific Adviser Govt of India Prof K Vijay Raghavan.

31/03/2020 को कर्मचारी समूह की सूची

डॉ ए अजयघोष

निदेशक

निदेशक का कार्यालय

श्री किरन जे एस

तकनीकी अधिकारी

श्री विष्णु गुर्जर

कनिष्ठ आशुलिपिक

कृषि प्रसंस्करण तथा प्रौद्योगिकी प्रभाग

डॉ के जी रघु

वरिष्ठ प्रिंसिपल वैज्ञानिक एवं प्रधान

डॉ बी एस दिलीपकुमार

वरिष्ठ प्रिंसिपल वैज्ञानिक

श्री वी वी वेणुगोपाल

वरिष्ठ प्रिंसिपल वैज्ञानिक

डॉ श्रीमती एम वी रेश्मा

प्रिंसिपल वैज्ञानिक

डॉ (श्रीमती) पी निशा

वरिष्ठ वैज्ञानिक

डॉ पी जयमूर्ती

वरिष्ठ वैज्ञानिक

डॉ(श्रीमती) प्रिया एस

वरिष्ठ वैज्ञानिक

श्री टी वेंकटेश

वैज्ञानिक

डॉ अन्जिनेयुलु कोत्ताकोटा

वैज्ञानिक

डॉ इंदू शर्मा

वैज्ञानिक

डॉ आर वेंकटेश

वैज्ञानिक

डॉ (श्रीमती) बीना जोय

प्रिंसिपल तकनीकी अधिकारी

श्री डी आर शोभन कुमार

वरिष्ठ तकनीकी अधिकारी (1)

श्रीमती दिव्या मोहन

तकनीकी अधिकारी

रसायन विज्ञान तथा प्रौद्योगिकी प्रभाग

डॉ पी सुजाता देवी

वरिष्ठ प्रिंसिपल वैज्ञानिक एवं प्रधान

डॉ के वी राधाकृष्णन

वरिष्ठ प्रिंसिपल वैज्ञानिक

डॉ सी एच सुरेश

वरिष्ठ प्रिंसिपल वैज्ञानिक

डॉ के एन नारायणन उण्णी

प्रिंसिपल वैज्ञानिक

डॉ ए कुमरन

प्रिंसिपल वैज्ञानिक

डॉ कौस्ताभ कुमार मैती

प्रिंसिपल वैज्ञानिक

डॉ बिश्वप्रिया देब

प्रिंसिपल वैज्ञानिक

डॉ करुणाकरन वेणुगोपाल

प्रिंसिपल वैज्ञानिक

डॉ सुनिल वर्गीस

वरिष्ठ वैज्ञानिक

डॉ वी के प्रवीण

वरिष्ठ वैज्ञानिक

डॉ यूसफ करुवात

वरिष्ठ वैज्ञानिक

डॉ एल रविशंकर

वरिष्ठ वैज्ञानिक

डॉ जोशी जोसफ

वरिष्ठ वैज्ञानिक

डॉ बी एस शशिधर

वरिष्ठ वैज्ञानिक

डॉ सी विजयकुमार

वरिष्ठ वैज्ञानिक

डॉ जुबी जॉन

वरिष्ठ वैज्ञानिक

डॉ डी श्रीदेवी

वैज्ञानिक

डॉ सूरज सुमन

वैज्ञानिक

डॉ इशिता नेगी

वैज्ञानिक

डॉ आदर्श अशोक

वैज्ञानिक

श्रीमती सौमिनी मैथ्यू

वरिष्ठ तकनीकी अधिकारी(1)

श्री रोबर्ड फिलिप

वरिष्ठ तकनीकी अधिकारी (1)

श्रीमती एस विजी

वरिष्ठ तकनीकी अधिकारी(1)

श्री किरन मोहन

वरिष्ठ तकनीकी अधिकारी(1)

पर्यावरण प्रौद्योगिकी प्रभाग

श्री जे अंसारी

वरिष्ठ प्रिंसिपल वैज्ञानिक एवं प्रधान, ईएसडी

डॉ (श्रीमती) एलिज़बत जेकब

मुख्य वैज्ञानिक

डॉ बी कृष्णकुमार

प्रिंसिपल वैज्ञानिक

श्री बी अब्दुल हलीम

वरिष्ठ वैज्ञानिक

डॉ पार्थ कुंडू

वरिष्ठ वैज्ञानिक

डॉ के पी प्रतीश

वैज्ञानिक

श्री सौरभ साकरे

वैज्ञानिक

श्री धानी बाबू तलाकाला

वैज्ञानिक

श्री अक्षय दिलीप शेंडे

वैज्ञानिक

श्री वी के षाजिकुमार

वरिष्ठ तकनीकी अधिकारी (2)

डॉ जोशी जोर्ज

वरिष्ठ तकनीकी अधिकारी(1)

श्रीमती पी एम सहरूबा

तकनीकी अधिकारी

पदार्थ विज्ञान तथा प्रौद्योगिकी प्रभाग

डॉ (श्रीमती) एस सावित्री

मुख्य वैज्ञानिक एवं प्रधान

डॉ मनोज रामावर्मा

वरिष्ठ प्रिंसिपल वैज्ञानिक

डॉ एम रवि

वरिष्ठ प्रिंसिपल वैज्ञानिक

डॉ एस अनन्तकुमार

वरिष्ठ प्रिंसिपल वैज्ञानिक

डॉ के आई सुरेश

वरिष्ठ प्रिंसिपल वैज्ञानिक

डॉ टी पी डी राजन

प्रिंसिपल वैज्ञानिक

डॉ एस वी शुक्ला

प्रिंसिपल वैज्ञानिक

डॉ यु एस हरीश

प्रिंसिपल वैज्ञानिक

डॉ ई भोजे गौड

प्रिंसिपल वैज्ञानिक

डॉ के जयशंकर

प्रिंसिपल वैज्ञानिक

डॉ ए श्रीनिवासन

प्रिंसिपल वैज्ञानिक

डॉ एम सुन्दराराजन

प्रिंसिपल वैज्ञानिक

डॉ के पी सुरेन्द्रन

वरिष्ठ वैज्ञानिक

डॉ सजु पिल्लै

वरिष्ठ वैज्ञानिक

डॉ सुव्रता दास

वरिष्ठ वैज्ञानिक

डॉ एस एस श्रीजाकुमारी

वरिष्ठ वैज्ञानिक

डॉ के जी निशांत

वैज्ञानिक

डॉ सुशांत कुमार साहू

वैज्ञानिक

डॉ अचु चंद्रन

वैज्ञानिक

श्री जे वेंकटेशन

वैज्ञानिक

डॉ वी एस प्रसाद

प्रिंसिपल तकनीकी अधिकारी

श्री एम ब्रह्मकुमार

प्रिंसिपल तकनीकी अधिकारी

श्री ए पीर मोहम्मद

वरिष्ठ तकनीकी अधिकारी (2)

डॉ एस रामस्वामी

वरिष्ठ तकनीकी अधिकारी (1)

श्री वी हरीश राज

तकनीकी अधिकारी

श्री एम पी वर्की

प्रयोगशाला सहायक

माइक्रोबियल प्रोसेस तथा प्रौद्योगिकी प्रभाग

डॉ राजीवकुमार सुकुमारन

प्रिंसिपल वैज्ञानिक एवं प्रधान

डॉ के माधवन नंपूतिरि

वरिष्ठ प्रिंसिपल वैज्ञानिक

डॉ पी बिनोद

वरिष्ठ वैज्ञानिक

डॉ एन रमेश कुमार

वरिष्ठ वैज्ञानिक

डॉ मुत्तु अरुमुगम

वरिष्ठ वैज्ञानिक

श्री एम किरन कुमार

वरिष्ठ वैज्ञानिक

डॉ लक्ष्मी राकेश कुमार यासरला

वैज्ञानिक

डॉ तिरुमलेश बी वी

वैज्ञानिक

डॉ पी ए बालकुमारन

वैज्ञानिक

श्री पी एन शिवनकुट्टि नायर

वरिष्ठ तकनीशियन (2)

एस एंड टी सेवा प्रभाग

इंजीनियरिंग एवं सेवा प्रभाग

श्री आर राजीव

वरिष्ठ अधीक्षण अभियंता

श्री जी चन्द्रबाबु

अधीक्षण अभियंता

श्री चन्द्रशेखर नीलम

सहायक कार्यपालक अभियंता

श्री बी कार्तिक

सहायक अभियंता (सिविल)

श्री पी अरुमुखम

सहायक अभियंता (सिविल)

श्री एम जयदीप

वरिष्ठ तकनीशियन (1)

श्री के एस प्रमोद

तकनीशियन (2)

श्री के सुरेश कण्णन

तकनीशियन (2)

श्री यु धरणीपति

तकनीशियन (2)

श्री टी वी सतीश

ग्रुप सी एन टी. (एमएसीपी)

नॉलिज रिसोर्स सेंटर

डॉ (श्रीमती) शीपी नि

वरिष्ठ प्रिंसिपल वैज्ञानिक तथा केआरसी और आरपीबीडी के प्रधान

श्री वी मणी

वरिष्ठ वैज्ञानिक

श्री एस बी रिबिन जोन्स

वरिष्ठ वैज्ञानिक

श्री एस पुश्किन

वरिष्ठ तकनीकी अधिकारी (1)

श्री जी नागश्रीनिवासु

वरिष्ठ तकनीशियन (2)

श्री पुष्पाकुमार के आर नायर

ग्रुप सी एन टी. (एमएसीपी)

अनुसंधान योजना तथा व्यवसाय विकास

श्री सी के चन्द्राकान्त

वरिष्ठ प्रिंसिपल वैज्ञानिक

श्री आर एस प्रवीण राज

प्रिंसिपल वैज्ञानिक

डॉ दीपा बालन

वैज्ञानिक

श्री राजकुमार

वैज्ञानिक

प्रशासन

श्री सी क्रिस्तु राज

प्रशासन नियंत्रक

श्री एन एस राजू
प्रशासन नियंत्रक

श्री के एफ जोसफ
अनुभाग अधिकारी(सा)

श्री जी पद्मकुमार
अनुभाग अधिकारी(सा)

श्री टी जे बाबु
वरिष्ठ सुरक्षा अधिकारी

श्री के पी कृष्णन
सहायक अनुभाग अधिकारी

श्रीमती मेर्सी जोसफ
सहायक अनुभाग अधिकारी

सुश्री नीतू इंदुचूडन
सहायक अनुभाग अधिकारी

श्री आर के रमेशकुमार
सहायक अनुभाग अधिकारी

श्रीमती पी एस पद्मिनी
वरिष्ठ आशुलिपिक (एमएसीपी)

श्री ओ वी शशिकुमार
वरिष्ठ आशुलिपिक (एमएसीपी)

श्री बी सतीशकुमार
वरिष्ठ. सचिवालय सहायक

सुश्री ए एल सजिता
वरिष्. सचिवालय सहायक

श्री प्रवीण कण्णाल
वरिष्ठ तकनीशियन (1)

श्री टी एच बशीर
वरिष्ठ तकनीशियन (2)

श्रीमती शाना एस नायर
स्टाफ नर्स

श्रीमती एम गीता
प्रयोगशाला सहायक

श्री के उण्णिकृष्णन
ग्रुप सी एन टी. (एमएसीपी)

श्री के मधु
बेयरर (एमएसीपी)

श्री ए श्रीकुमारन
वाशबॉय (एमएसीपी)

वित्त एवं लेखा

डॉ सोमू रॉय
वित्त और लेखा अधिकारी

श्री वी हरि कृष्णन
अनुभाग अधिकारी (वित्त एवं लेखा)

श्री संजीव सदानन्दन
सहायक अनुभाग अधिकारी

श्रीमती कोमला सोमन
सहायक अनुभाग अधिकारी

श्रीमती जी गीता
सहायक अनुभाग अधिकारी

श्री विष्णु वी एल

कनिष्ठ आशुलिपिक

श्री पी रजित
मल्टी टास्किंग स्टाफ

भण्डार एवं क्रय

श्री थॉमस टी कुरियाकोस
भंडार व क्रय नियंत्रक

श्री सी एम कृष्णदास
सहायक अनुभाग अधिकारी

श्री एम अनिलकुमार
सहायक अनुभाग अधिकारी

सुश्री शीबा सैतू
वरिष्ठ. सचिवालय सहायक

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 एन टी. (एमएसीपी)

श्री जी भक्तवत्सलम
ग्रुप सी एन टी.

Staff List as on 31/03/2020

Dr A Ajayaghosh
Director

DIRECTOR'S OFFICE

Mr J S Kiran
Technical Officer

Mr Vishnu Gurjar
Junior Stenographer

AGROPROCESSING & TECHNOLOGY DIVISION

Dr K G Raghu
Senior Principal Scientist & Head

Dr B S Dileep Kumar
Senior Principal Scientist

Mr V V Venugopal
Senior Principal Scientist

Dr (Mrs) M V Reshma
Principal Scientist

Dr (Mrs) P Nisha
Senior Scientist

Dr P Jayamurthy
Senior Scientist

Dr (Mrs)S Priya
Senior Scientist

Mr T Venkatesh
Scientist

Dr Anjineyulu Kothakota
Scientist

Dr Indu Sharma
Scientist

Dr R Venkatesh
Scientist

Dr Beena Joy
Principal Technical Officer

Mr D R Soban Kumar
Senior Technical Officer (1)

Mrs Divya Mohan
Technical Officer

CHEMICAL SCIENCES & TECHNOLOGY DIVISION

Dr P Sujatha Devi
Senior Principal Scientist & Head

Dr K V Radhakrishnan
Senior Principal Scientist

Dr C H Suresh
Senior Principal Scientist

Dr K N Narayanan Unni
Principal Scientist

Dr A Kumaran
Principal Scientist

Dr Kaustabh Kumar Maiti
Principal Scientist

Dr Biswapriya Deb
Principal Scientist

Dr Karunakaran Venugopal
Principal Scientist

Dr Sunil Varughese
Senior Scientist

Dr V K Praveen
Senior Scientist

Dr Yoosaf Karuvath
Senior Scientist

Dr L Ravi Shankar
Senior Scientist

Dr Joshy Joseph
Senior Scientist

Dr B S Sasidhar
Senior Scientist

Dr C Vijayakumar
Senior Scientist

Dr Jubi John
Senior Scientist

Dr Shridevi
Scientist

Dr Suraj Soman
Scientist

Dr Ishita Neogi
Scientist

Dr Adersh Asok
Scientist

Mrs Saumini Mathew
Senior Technical Officer (I)

Mr Robert Phillip
Senior Technical Officer (I)

Mrs S Viji
Senior Technical Officer (I)

Mr Kiran Mohan
Senior Technical Officer (1)

ENVIRONMENTAL TECHNOLOGY DIVISION

Mr J Ansari
Senior Principal Scientist & Head

Dr (Mrs)Elizabeth Jacob
Chief Scientist

Dr B Krishnakumar
Principal Scientist

Mr B Abdul Haleem
Senior Scientist

Dr Parthakundu
Senior Scientist

Dr K P Prathish
Scientist

Mr Saurabh Sakhre
Scientist

Mr Dhani Babu Talakala
Scientist

Mr Akshay Dilip Shende
Scientist

Mr V K Shajikumar
Senior Technical Officer(2)

Dr Joshy George
Senior Technical Officer(1)

Mrs P M Saharuba
Technical Officer

MATERIALS SCIENCE & TECHNOLOGY DIVISION

Dr (Mrs) S Savithri
Chief Scientist & Head

Dr Manoj Raama Varma
Senior Principal Scientist

Dr M Ravi
Senior Principal Scientist

Dr S Ananthakumar
Senior Principal Scientist

Dr K I Suresh
Senior Principal Scientist

Dr T P D Rajan
Principal Scientist

Dr S V Shukla
Principal Scientist

Dr U S Hareesh
Principal Scientist

Dr E Bhoje Gowd
Principal Scientist

Dr K Jayasankar
Principal Scientist

Dr A Srinivasan
Principal Scientist

Dr M Sundararajan
Principal Scientist

Dr K P Surendran
Senior Scientist

Dr Saju Pillai
Senior Scientist

Dr Subrata Das
Senior Scientist

Dr S S Sreejakumari
Senior Scientist

Dr K G Nishanth
Scientist

Dr Sushanta Kumar Sahoo
Scientist

Dr Achu Chandran
Scientist

Mr Venkatesan J
Scientist

Dr V S Prasad
Principal Technical Officer

Mr Brahmakumar
Principal Technical Officer

Mr A Peer Mohammed
Senior Technical Officer (2)

Dr S Ramaswamy
Senior Technical Officer(1)

Mr V Harish Raj
Technical Officer

Mr M P Varkey
Lab Assistant

MICROBIAL PROCESSES &TECHNOLOGY DIVISION

Dr Rajeev Kumar Sukumaran
Principal Scientist & Head

Dr K Madhavan Nampoothiri
Senior Principal Scientist

Dr P Binod
Senior Scientist

Dr N Ramesh Kumar
Senior Scientist

Dr Muthu Arumugam
Senior Scientist

Mr M Kiran Kumar
Senior Scientist

Dr L Rakesh Kumar Yasarala
Scientist

Dr B V Thirumalesh
Scientist

Dr P A Balakumaran
Scientist

Mr P N Sivankutty Nair
Senior Technician (2)

S & T SERVICES ENGINEERING & SERVICES DIVISION

Mr R Rajeev
Senior Superintending Engineer

Mr G Chandra Babu
Superintending Engineer

Mr Chandra Shekar Neelam
Assistant Executive Engineer

Mr B Karthik
Assistant Engineer (Civil)

Mr P Arumugam
Assistant Engineer (Civil)

Mr M Jayadeep
Senior Technician(1)

Mr K S Pramod
Technician (2)

Mr K Suresh Kannan
Technician (2)

Mr U Dharanipathy
Technician(2)

Mr T V Satheesh
Group C (NT) (MACP)

KNOWLEDGE RESOURCE CENTRE

Dr (Mrs) P Nishy
Senior Principal Scientist &
Head of KRC & RPBD

Mr V Moni
Senior Scientist

Mr S B Ribin Jones
Senior Scientist

Mr S Pushkin
Senior Technical Officer(1)

Mr G Nagasrinivasu
Senior Technician (2)

Mr Pushpakumar K R Nair
Group C (NT) (MACP)

RESEARCH PLANNING & BUSINESS DEVELOPMENT

Mr C K Chandrakanth
Senior Principal Scientist

Mr R S Praveen Raj
Principal Scientist

Dr Deepa Balan
Scientist

Dr Raj Kumar
Scientist

ADMINISTRATION

Mr C Christu Raj
Controller Of Administration

Mr N S Raju
Controller Of Administration

Mr K F Joseph
Section Officer (G)

Mr G Padmakumar
Section Officer (G)

Mr T J Babu
Senior Security Officer

Mr K P Krishnan
Assistant Section Officer

Mrs Mercy Joseph
Assistant Section Officer

Mrs Neethu Induchoodan
Assistant Section Officer

Mr R K Ramesh Kumar
Assistant Section Officer

Mrs P S Padmini
Senior Stenographer (MACP)

Mr O V Sasikumar
Senior Stenographer (MACP)

Mr B Satheesh Kumar
Senior Secretariat Assistant

Mrs A L Sajitha
Senior Secretariat Assistant

Mr Praveen Kannal
Senior Technician(1)

Mr T H Basheer
Senior Technician(2)

Mrs Shana S Nair
Staff Nurse

Mrs M Geetha
Lab Assistant

Mr K Unnikrishnan
Group C (NT) (MACP)

Mr K Madhu
Bearer(MACP)

Mr A Sreekumaran
Washboy(MACP)

FINANCE & ACCOUNTS

Dr Somu Roy
Finance & Accounts Officer

Mr V Harikrishnan
Section Officer

Mr Sanjeev Sadanandan
Assistant Section Officer

Mrs Komala Soman
Assistant Section Officer

Mrs G Geetha
Assistant Section Officer

Mr Vishnu V L
Junior Stenographer

Mr P Rejith
Multi-Tasking Staff

STORES & PURCHASE

Mr Thomas T Kuriakose
Controller Of Stores & Purchase

Mr C M Krishnadas
Assistant Section Officer

Mr M Anilkumar
Assistant Section Officer

Mrs Sheeba Saithu
Senior Secretariate Assistant

Mrs L Latha
Senior Technician(2)

Mr B Ajayakumar
Senior Technician (2)

Mr T R Suresh Kumar
Senior Technician (2)

Mr T K Ghosh
Group C (NT) (MACP)

Mr G Bhakthavalsalam
Group C (NT)

Events and Celebrations

National Symposium on Minerals and Energy Materials Technology (MEMT 2019)

Dr. P.V. Venkitakrishnan, Director, Capacity Building and Programme Office, Indian Space Research Organization, Bangalore and Dr. S.C. Sharma, Deputy Director, VSSC, Thiruvananthapuram releasing the MEMT-2019 Souvenir

MEMT-2019 provided a common platform for experts from various R&D laboratories, academic institutions and industries to share their scientific and technical experience in the areas of the beach sand mineral processing, electronic materials, energy materials for generation, conversion, storage and emission. The symposium held on April 8, 2019 was inaugurated by Dr. P.V. Venkitakrishnan, Director, Capacity Building and Programme Office, Indian Space Research Organization, Bengaluru. Keynote lecture was delivered by Dr. S.C. Sharma, Deputy Director, VSSC, Thiruvananthapuram. Invited lectures were delivered by Dr. S.V.S. Narayana Murty, VSSC, Thiruvananthapuram, Dr. K. G. Gopachandran, Head, Opto Electronics, University of Kerala, Mr. Antony Francis, KMML, Kollam, Dr. Sibi K.S., University of Kerala, Dr.P. Prabhakar Rao, CSIR-NIIST, Thiruvananthapuram and Dr.K. Harikrishna Bhat, CSIR-NIIST, Thiruvananthapuram. Dr. M. Ravi, Senior Principal Scientist of Materials Science and Technology Division was the convener of the symposium.

R & D Industry meet

R&D Industry meet inauguration

The third R&D Industry meet was held for enhancing and deepening partnership with Industry on 12th April 2019. The R & D Industry meet commenced with the Welcome address by Dr. S. Savithri, Chairman of I2M @ CN (Institute-Industry Meet @ CSIR-NIIST) followed by the Presidential address by Dr.A. Ajayaghosh, Director, CSIR-NIIST. Dr. Saji Gopinath, CEO, Kerala Startup Mission inaugurated the meet and delivered the Key Note address. Dr.Roshan Paul, Director, Indo-German Science & Technology Center (IGST), New Delhi spoke on "Indo-German Industrial Partnership" . Mr.R.S.Praveen raj, Principal Scientist at CSIR-NIIST, highlighted the research activities and business opportunities at CSIR-NIIST. There were parallel sessions on various themes namely Food, Nutraceuticals and Biotechnology; Energy materials and devices; anti-counterfeiting materials and products; Waste management solutions; Minerals and materials.

The industry participants were encouraged to visit the

divisions and facilities available at NIIST. There were one to one interactions with Scientists, Technologists and Industry representatives to focus on translational research and tune the R&D programmes to industry requirements. An exhibition of products, technologies and processes developed in CSIR-NIIST was also arranged as part of the meet. More than sixty industries from various sectors including Micro, Small & Medium Enterprises took part in the R&D Industry meet to identify the issues of mutual interest and to forge alliances. Among the industries that visited, a few were our existing clients and the majority were new participants.

National Technology Day

The National Technology Day was celebrated at CSIR-National Institute for Interdisciplinary Science and Technology (CSIR-NIIST), Thiruvananthapuram on May 10, 2019. Dr. A. Ajayaghosh, Director, CSIR-NIIST, delivered the welcome address and introduced the Chief Guest of the day. Dr Vijay Kumar Saraswat, Member, Niti Aayog and Chancellor, Jawaharlal Nehru University and former Secretary, DRDO delivered the National Technology Day Lecture. The genesis of the National Technology Day is to commemorate the significant milestones in the history of Indian technological innovations. This day memorialize the major achievements of successful nuclear test (Pokhran II) held from 11 to 13 May 1998 in Pokhran, Rajasthan. India also conducted a successful test firing of Trishul missile by DRDO and testing of Hansa 3 by CSIR, India's first indigenous aircraft on May 11, 1998.

During the National Technology Day Lecture, Dr. Saraswat emphasized the importance of interdisciplinary research to address the societal problems and solving the complex issues of population, urbanization, energy, environment, health, safety and transport. Scientific and technological advancements is the answer for many societal problems.

Dr. Vijay Kumar Saraswat, Member, Niti Aayog and Chancellor, Jawaharlal Nehru University and former Secretary, DRDO delivering the National Technology Day Lecture

He mentioned that the boundaries of disciplines are fused to create new inter, multi and trans-disciplinary subjects for future engineering which will make life better. Problems of society in future can be solved by graduates who are highly creative with bright ideas. He also added that Universities, National laboratories and industries have to play a pivotal role to create more advanced technologies in various engineering sectors for the progress of India. Dr. T.P.D. Rajan, Chairman, Academic Programme Committee proposed the vote of thanks. Dr. Saraswat also visited the new research facilities including the solar energy lab and biofuel pilot plant of CSIR-NIIST and encouraged the scientists involved in interdisciplinary research activities related to renewable energy.

Indo-German Science and Technology Centre (IGSTC) Project Launch Meeting and Mini Symposium on Advanced Composite Materials

Indo-German Science and Technology Centre (IGSTC) funded collaborative project on 'Advanced fibre reinforced metallic composite' was launched at CSIR-National Institute for Interdisciplinary Science and Technology, Thiruvananthapuram on July 19, 2019. The joint programme of Near Net Manufacturing of Aluminum Composites (NearNetMAC) aims to develop light weight near-net shape carbon fibre reinforced aluminum composites and components for automotive and aerospace applications. The project consortium partners are CSIR-NIIST as the Indian Institute participant, Fenfe Metallurgicals, Bengaluru, the Indian Industry, Institute of Textile Technology, RWTH Aachen University as the academic partner of Germany and CIKONI Gmbh, Stuttgart as the German Industrial partner.

Dr. S. Savithri, Chief Scientist and Head of Materials Science and Technology Division delivered the welcome address. Dr. A. Ajayaghosh, Director, CSIR-NIIST delivered the presidential address and emphasized that the International collaborations between the institutes can lead to development of high-end technologies. Dr. Amool

Dr. Amool Raina, Head of Aerospace and Manufacturing Program of RWTH Aachen University delivering inaugural addresses

Raina, Head of Aerospace and Manufacturing Program of RWTH Aachen University during his inaugural address highlighted that the present programme will lead to new process and material development for making connecting rods and thermal management heat sinks useful for transport sectors. Dr. H. Sundara Murthy, the President of Fenfe Metallurgicals and Former President of the Institute of Indian Foundrymen, Kolkata said during his address that the joint collaborations between India and Germany can lead to advanced technology and product development and its manufacturing in India, which can add to the 'Make in India' program of Government of India catering the domestic and international markets. The principal investigator of the project from Indian side Dr. T.P.D. Rajan, Principal Scientist said that this programme brings in the expertise of hi-tech fibre technology and preform processing of German Institute and the liquid metal processing of light weight metal matrix composite of CSIR-NIIST to develop components with superior mechanical and physical properties catering both the automotive and aerospace industries. Mr. Philipp Huber, Ms. GoezdemDittel and Mr. Yanick Schlesinger, the research scientists from RWTH Aachen University delivered technical lectures during the mini-symposium on advanced composite materials organized during the programme.

Hindi Week Celebrations 2019

Inaugural session in progress

The Institute observed 16th September 2019 as Hindi Day and the week succeeding it (16-20 September 2019) as Hindi Week. On this occasion various programmes/ competitions were organized for the benefit of Staff members/ Research fellows/ Project staff and their school going children. The Hindi Week Celebrations started with the inauguration and Hindi Quiz on 16th September 2019. Various competitions like Hindi Antakshari, Hindi debate, Hindi essay Writing, Hindi Quiz for Children of the staff members. The Valedictory function was held on 20th September 2020. The Chief Guest Dr.R. Jayachandran, Prof & Head, Dept. of Hindi, Kerala University enlightened the audience with his talk and also gave prizes to the winners of various competitions.

CSIR Foundation Day - 2019

The Chief Guest Dr. S. Sivaram delivering the CSIR-Foundation Day Lecture

CSIR Foundation Day was celebrated at CSIR-NIIST on 27th September 2019. The day was observed as an open day for show-casing the activities of the Institute and about 400 students from various educational institutions visited the R&D facilities. Dr. A. Ajayaghosh, Director, CSIR-NIIST delivered the welcome address and presided over the CSIR Foundation Day function. Dr. S. Sivaram, Honorary Professor and INSA Honorary Scientist, Indian Institute of Science Education and Research, Pune and Former Director, CSIR-National Chemical Laboratory, Pune, the Chief Guest for the function, delivered the CSIR Foundation Day lecture. The superannuated employees of CSIR-NIIST during 2018-19 and the employees who completed 25 years of service in CSIR were felicitated and the studentship award 2018-19 was distributed. Dr. T.P.D. Rajan, Chairman, Academic Programme Committee proposed the vote of thanks.

NIIST Foundation Day - 2019

The CSIR-NIIST Foundation Day was celebrated at CSIR-NIIST on 9th October 2019. The day was observed as an open day and about 350 students from various educational institutions visited the R&D facilities. Dr. A. Ajayaghosh, Director, CSIR-NIIST delivered the welcome address and presided over the CSIR-NIIST Foundation Day function. Prof. Jarugu Narasimha Moorthy, Director, Indian Institute of Science Education and Research, Thiruvananthapuram was the Chief Guest for the function. He appreciated the scientific achievements of the lab. The Annual Report of CSIR-NIIST for the year 2018-19 was released by the Chief Guest. Dr. B.S. Sasidhar, CSIR Young Scientist Awardee 2019 (Chemical Sciences) was felicitated. Dr. T.P.D. Rajan, Chairman, Academic Programme Committee, CSIR-NIIST, Thiruvananthapuram proposed the vote of thanks.

The Annual Report of CSIR-NIIST for the year 2018-19 being released by the Chief Guest

First Indo-Swiss Workshop on Building Integrated Solar Energy Systems (BiSe-2019)

First Indo-Swiss Workshop on Building Integrated Solar Energy Systems (BiSe-2019) is an Indo-Swiss initiative to share knowledge on solar architecture and Building Integrated Solar Energy (BISE) systems. Transition to renewable energy resources is vital for human development without contributing to the carbon footprint. The Government of India has announced its Intended Nationally Determined Contribution (INDC) for mitigating climate change, aimed at a reduction of carbon emission by 33%-35% by 2030. To meet the targeted INDC, NITI Aayog advocated an ambitious plan in the energy domain for increasing the share of non-fossil fuel-based capacity in the electricity mix above 40% by 2030, and 175 GW of renewable energy capacity by 2022. Besides, it is noteworthy that Indian residential and commercial building area is expected to increase by four and thirteen-fold respectively.

In this purview, India has a huge opportunity for building new renewable energy infrastructure in a more decentralized manner via the integration of solar energy systems to the new building designs. The integration of solar energy systems in the built environment and in building skin can represent a huge potential to join renewables and urban growth.

In this context, the workshop aimed to bring together Indian and Swiss Government academic and industry experts to share recent innovations and products in the area of Building Integrated Solar Energy (BISE) systems including photovoltaics, photothermal, and passive/active solar control systems. The workshop was organised on 17th October 2019 at CSIR-NIIST with the support from Swiss Federal Office of Energy (SFOE), University of Applied Sciences and Art of Southern Switzerland (SUPSI) and Swissnex India (Consulate General of Switzerland). There were 84 participants for the workshop.

Vigilance Awareness Week 2019

Valedictory session in progress

Vigilance Awareness Week 2019 was observed from 28th October 2019 to 4th November 2019. The week started with the Administration of Pledge to all staff members by the Director. Various Competitions like Essay Writing, Debate, Quiz Competition, Slogan writing were held for Staff and students. The Valedictory function was held on 4th November 2019. Mr.R.Sukesan, IPS gave the Vigilance Day Lecture followed by distribution of Prizes to the Winners of various competitions

International Conference on New Horizons in Biotechnology

CSIR-National Institute for Interdisciplinary Science and Technology, Thiruvananthapuram organized an International Conference on New Horizons in Biotechnology (NHBT-2019) during November 20-24, 2019. The conference was jointly organized in association with the Biotech Research Society, India (BRSI). The conference was attended by nearly 500 delegates from 33 countries. NHBT-2019 focused on the recent developments on the frontier areas of Biotechnology and brought together scientists, engineers and other experts from across the world to deliberate on global developments in this area, especially on internationally and nationally relevant areas such as green energy and materials through biotechnology, emerging threats of multidrug resistant drugs and the strategies to combat them, microbial products, genomics and molecular biology, industrial microbiology and biotechnology and environmental biotechnology. The conference had four parallel sessions during 21st - 23rd November where the delegates presented and discussed multiple topics. There were also two mini symposia, one on Biofuels and Biorefineries and the other on Healthcare Biotechnology as part of the conference. Some 267 posters were presented in the different topics on 21st and 22nd November at YMCA hall adjacent to the main venue.

NHBT-2019 was formally opened on 20th November 2019 in which eminent speakers, including Prof TP Singh, Chairman, BRSI; Prof C Larroche, Administrator, IBA-IFIBiop, France; Prof RD Tyagi, INRS, Quebec, Canada; Prof Alok Dhawan, Director, CSIR-IITR, Lucknow; Dr Anjan Ray, Director, CSIR-IIP, Dehradun; Prof Ashok Pandey, Chief Mentor, BRSI, General Chair, NHBT-2019 & Distinguished Scientist, CSIR-IITR, Lucknow addressed the audience.

The conference was unique in offering two workshops,

and an Industry- Young Researcher Interactive session. Among the two workshops, one was on scientific writing mentored by Dr. Eldon Rene from Institute of Water Education, Delft, Netherlands and the other on how to do rapid fire presentations by Prof Michel Saur, Institute of Natural Resources and Life Sciences, Vienna, Austria. The Industry-Young Researcher Interactive Session was attended by leading Biotech companies of the country and their officials/R&D heads would interact with students and young scientists on the Biotechnology R&D Scenario of the country and the opportunities, challenges and employment possibilities in this area. This was moderated by Dr Raghavendra Gaikaiwari, CMD, Hitech Biosciences, Pune and supported by Dr Vivek Agarwal, CMD, CDC India, Jaipur; Dr Vivek Morya, CEO, Aditha Biotech, Lucknow and Dr Ramesh Shettar, Godawari Biorefineries, Bangalore. The closing session of NHBT-2019 was held on 23rd November 2019 in which awards were conferred by Prof CG Dussap, Charter President, IBA-IFIBiop, Prof RD Tyagi, Vice-President, IBA; Dr R Gaikaiwari, CMD, HTBS, Pune and Dr V Agarwal, CMD, CDC India to winners under different category, including Research Excellence awards sponsored by Khanal Foundation, Nepal and by the Centre for Energy and Environmental Sustainability-India, Lucknow. Also, awards for best presentation under RFP and posters were conferred.

International Conference on Advanced Functional Materials (ICAFM 2019)

Third International Conference on Advanced Functional Materials (ICAFM 2019) was organized by CSIR-NIIST, Thiruvananthapuram in association with the InCerS-KC, Thiruvananthapuram and Materials Research Society of India (MRSI), Thiruvananthapuram during 9-10 December 2019. The conference was attended by around 300 delegates which covered diverse applications of functional materials and comprised of 5 plenary lectures, 25 invited talks and presentations from young researchers, distributed in 13 technical sessions. There were delegates from premier R&D

Inauguration of ICAFM 2019

institutions of CSIR, ISRO, Sree Chitra Thirunal Institute, DRDO, and DST. Premier educational institutes like IIT, IISER, NIT and CUSAT were also well represented. Oral and poster awards (three best presentations each) were given to research scholars in the respective categories. This year ICAFM 2019 Distinguished Lectureship Award was introduced to honor an internationally acclaimed expert in the field of advanced functional materials. Prof. Takeo Yamaguchi, Tokyo Institute of Technology, Japan was this year's recipient of the award for his outstanding contributions in the research areas of fuel cells and membrane development.

National Conference on Innovations and Technologies for Ceramics (InTeC-2019)

The National Conference on Innovations and Technologies for Ceramics (InTeC-2019) was organized by the Indian Ceramic Society Kerala Chapter (InCerS-KC) in association with CSIR-National Institute for Interdisciplinary Science and Technology (NIIST), Thiruvananthapuram, during 11-12 December 2019, as the part of 83rd Annual Session of InCerS. The objective of the Annual Session was to provide a common forum and an opportunity for a large number of delegates, working in the various fields related to ceramics, glass, refractories, and allied materials to exchange and intake ("InTeC") the enriched thoughts and ideas. Dr. V. K. Dadhwal, Director, Indian Institute of Space Science and Technology (IIST), Thiruvananthapuram was the Chief Guest during the inaugural session of the National Conference. The annual event brought together around 200 delegates, involving the young researchers, scientists, and industrialists to discuss and exchange innovations and technologies, thus creating an environment for collaborative endeavors in multi as well as interdisciplinary areas related to ceramics. About 100 participants from various parts of India presented results from their respective areas, explaining new findings and discussing future R&D strategies.

Inaugural session of InTeC-2019

There were 2 Memorial Lectures, 2 Plenary Lectures, 5 Keynote Lectures, 8 Invited Lectures, 1 Special Lecture, 7 Contributed Lectures, 6 Students' Lectures and 68 Poster Presentations. Total six best presentations awards (which included cash prize, certificate and memento) were provided during the Students' and Poster Sessions. Some of the well-established ceramic industries put up the exhibition stalls to display their traditional as well as advanced ceramic products during the National Conference. The ceramics fraternity honored Dr. K.G.K. Warrier, (Retd.) Chief Scientist and Former Head, MSTD, CSIR-NIIST, on the occasion, for his lifetime work spanning over 41 years in the allied field. Overall, InTeC-2019 was a highly successful event which was primarily sponsored / supported by the major ceramic industries within India as well as the Government Organizations such as DRDO and CSIR.

International Conference on Ecomaterials (ICEM-14)

The 14th International Conference on Ecomaterials (ICEM-14) brought together eminent scientists, peers, policymakers, students and stakeholders over a three-day-long forum from February 5-7th, 2020. The meeting was organized by CSIR-NIIST with support from Japanese Ecomaterials Forum. The inauguration of the ICEM-14 was held in the presence of Prof. JN Murthy, Director, IISER, Thiruvananathapuram, Dr. Usha Titus, Principal Secretary, Department of Environment and Climate Change, Govt of Kerala, Prof. Yishikazu Shinohara, Deputy Director, Center for Green Research on Energy and Environmental Materials, National Institute of Materials

Inaugural session of ICEM-14

Science, Japan, Dr. Ajayaghosh, Director, CSIR-NIIST and Dr. Biswapriya Deb, Convener of ICEM-14. The symposium was on interdisciplinary approaches that integrate

advanced materials science and engineering methods for the green industry, environmental technologies and socio-eco-systems.

Ecomaterials are designed to have minimal impact on the biosphere, fabricated by methods that preserve and recycle resources, and implemented for the betterment of society. Consequently, wide-ranging topics were discussed in ICEM-14 covering aspects of recyclable/ renewable materials, functional and energy materials, green processing, structural materials, natural materials extraction, biofuels/biomaterials, water/waste/ e-waste management, urban mining, remediation materials, polymers/composites, eco-innovation policies etc. The conference comprised of 11 technical sessions, 6 plenary lectures, 16 invited lectures, 3 short presentations, 2 poster sessions and 10 flash talks.

The meeting benefitted a large number of attendees across India and abroad, who shared their knowledge and rich experience about the latest developments in the field of ecomaterials, environmental considerations and related policies. The meeting promoted an exchange of ideas and created an environment for collaborative R&D endeavors in the emerging frontiers of interdisciplinary areas having national and international significance.

National Science Day Celebrations - 2020

The National Science Day was celebrated in CSIR-NIIST on February 28, 2020. Dr. A. Ajayaghosh, Director, CSIR-NIIST delivered the welcome address and introduced the Chief Guest of the day. The National Science Day Lecture was delivered by the chief guest, Prof. T. Pradeep, Institute Chair Professor and Padma Shri Awardee, Department of Chemistry, Indian Institute of Technology Madras, Chennai. During his lecture he highlighted the importance of translational research and shared his experience in technology transfer and start-ups related to clean water and nanomaterials technology. Dr. T.P.D. Rajan. Chairman, Academic Programme Committee proposed the vote of thanks.

Activities of Vigilance, RTI and Women Cell in CSIR-NIIST

The institute has a full-time vigilance officer who deals with all vigilance matter pertaining to CSIR-NIIST, Thiruvananthapuram. The vigilance officer furnishes certain reports/returns to the Chief Vigilance Officer on regular basis. No vigilance case is pending or contemplated against any employees of CSIR-NIIST during 2019-20.

The institute has a Central Public Information Officer (CPIO) who furnishes information under Right to Information Act (RTI) 2005. During the year 2019-20, seventy RTI applications and one appellate were received and replies were sent both online and in hard copies. The institute filed all the RTI quarterly returns for the year 2019-20 in the central information commission (CIC) RTI annual return information system.

CSIR-NIIST has Internal Complaints Committee (ICC) to receive complaints on sexual harassment at the workplace from an aggrieved woman, as well as to inquire into and make recommendations to the employer on the action required pursuant to its inquiry of such complaint made. No complaints were filed to the ICC during the year 2019-20.

ANNUAL REPORT

CSIR-NIIST

राष्ट्रीय अंतर्विषयी विज्ञान तथा प्रौद्योगिकी संस्थान

(वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद्)

तिरुवनंतपुरम

National Institute for Interdisciplinary Science & Technology

(Council of Scientific & Industrial Research)

Thiruvananthapuram