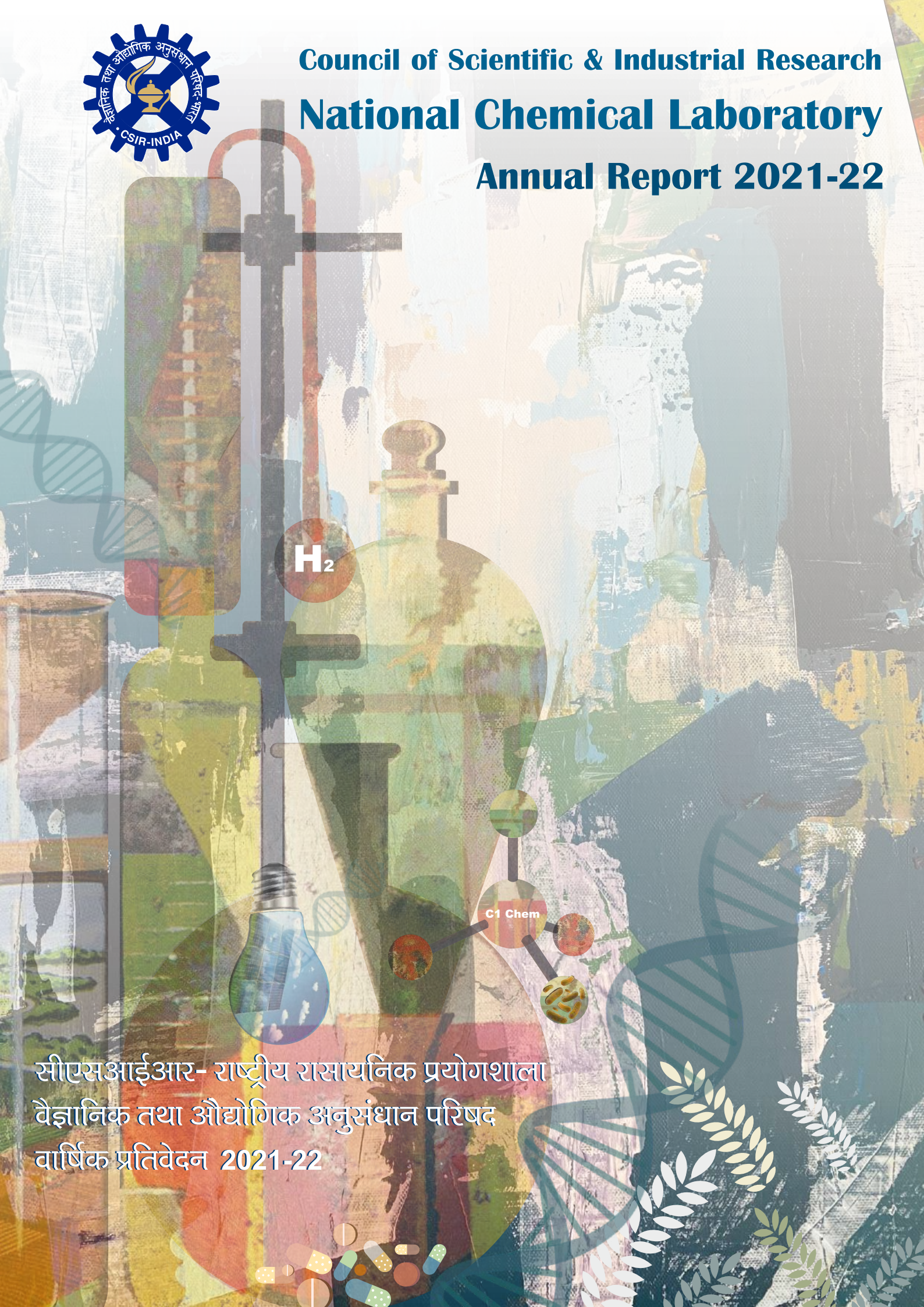
Council of Scientific & Industrial Research

National Chemical Laboratory

Annual Report 2021-22



सीएसआईआर- राष्ट्रीय रासायनिक प्रयोगशाला
वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद
वार्षिक प्रतिवेदन 2021-22

Published by
Dr. Ashish Lele
Director, CSIR-NCL

Produced by
Dr. Nikhlesh K. Yadav
Head, Publication and Science Communication Unit
CSIR-NCL

Compiled and Edited by
Mr. Ganesh S. Mane
Publication and Science Communication Unit
CSIR-NCL

Cover Page, Layout and Design by
Mrs. Manisha Tayade
Publication and Science Communication Unit
CSIR-NCL

Printed by
Typographica Press Services
Pune

CSIR-National Chemical Laboratory

With Best Compliments from...

Dr. Ashish Lele

Director, CSIR-NCL

CONTENT

Performance Indicators

Research & Development

CONTENT

Resource Centers

S&T Support Services

Annexures

निदेशक की कलम से...

सीएसआईआर-राष्ट्रीय रासायनिक प्रयोगशाला (सीएसआईआर-एनसीएल), पुणे में आपका हार्दिक स्वागत है। वर्ष 2021-22 के लिए प्रयोगशाला की वार्षिक रिपोर्ट प्रस्तुत है। यह रिपोर्ट वर्ष के दौरान प्रक्रिया और उत्पाद प्रौद्योगिकियों के नए ज्ञान और उनके अभिनव अनुवाद की जानकारी देते हुए प्रयोगशाला की उपलब्धियों को दोहराती है।

सीएसआईआर-एनसीएल ने 2020-2030 दशक के लिए एक प्रौद्योगिकी रोडमैप बनाया है। यह रोडमैप प्रयोगशाला की गतिविधियों पर अधिक ध्यान केंद्रित करने, विज्ञान और प्रौद्योगिकी के बीच तालमेल बिठाने और वितरण सुनिश्चित करने के लिए मानव और वित्तीय संसाधनों को संरेखित करने के लिए है। इस रोडमैप के द्वारा वैश्विक और राष्ट्रीय मेगाट्रेंड्स के संदर्भ में और प्रयोगशाला की मुख्य ताकत का लाभ उठाने के संदर्भ में भारत के लिए उनकी प्रासंगिकता के आधार पर सात महत्वपूर्ण एस एंड टी विषयों की पहचान की गई है। प्रत्येक विषय में यह प्रयोगशाला कम से कम एक बडी प्रभावशाली परियोजना पर काम करने की इच्छुक है, जिसमें विश्व स्तर पर बेंचमार्क और आईपी-संरक्षित उत्पाद या प्रक्रिया प्रौद्योगिकियों को वितरित करने पर स्पष्ट ध्यान दिया जाएगा, साथ ही नया विज्ञान भी तैयार किया जाएगा। परियोजनाएं विकास के शुरुआती चरणों में सभी प्रासंगिक भागीदारों और हितधारकों को एक साथ लाएंगी। यह रिपोर्ट सात पहचाने गए विषयों का सार प्रस्तुत करती है और कुछ बडी परियोजनाओं पर प्रकाश डालती है, जो पहले ही इन विषयों के अंतर्गत शुरू की जा चुकी हैं।

दूसरी कोविड-19 लहर के दौरान उत्पन्न हुई कई कठिनाइयों के बावजूद हमारी प्रयोगशाला ने काम करना जारी रखा और महामारी के खिलाफ लडाई में महत्वपूर्ण योगदान दिया। प्रयोगशाला ने एक जीनोम अनुक्रमण इकाई की स्थापना की और INSACOG में मूल्यवान डेटा अपलोड किया, पुणे शहर में देश के पहले सीवेज निगरानी कार्यक्रम में से एक की शुरुआत की, औंध सरकारी अस्पताल में CSIR - IIP की पहली ऑक्सीजन एकाग्रता इकाई शुरू की, एक इन-हाउस वित्त पोषित परियोजना शुरू की, ऑक्सीजन सघनता के लिए लिथियम जिओलाइट के निर्माण के लिए प्रक्रिया प्रौद्योगिकी का आरंभ किया, पुणे जिले के विभिन्न अस्पतालों में स्थापित पीएसए इकाइयों से ऑक्सीजन की शुद्धता का नियमित मापन किया और पुणे के बायोमेडिकल कचरे से एकत्र किए गए 100 किलोग्राम निपटान किए गए पीपीई किट के पुनर्चक्रण को प्रदर्शित करने के लिए एक पायलट परीक्षण पूरा किया।

मौलिक विज्ञानों में महत्वपूर्ण उपलब्धियों के बीच हमारी प्रयोगशाला ने 460 से अधिक शोध पत्रों को अत्यधिक मान्यता प्राप्त राष्ट्रीय और अंतर्राष्ट्रीय सहकर्मी-समीक्षित पत्रिकाओं में प्रकाशित किया, जिनमें कुछ उच्च प्रभाव वाली पत्रिकाएँ जैसे लैंसेट, एनर्जी एंड एनवायरनमेंटल साइंस, एडवांस्ड एनर्जी मैटेरियल्स, एसीएस एनर्जी लेटर्स, कैटालिसिस समीक्षा-विज्ञान और इंजीनियरिंग, आदि शामिल हैं। वर्ष के दौरान 20 भारतीय और 47 विदेशी पेटेंट प्रस्तुत करके इस ज्ञान को भी संरक्षित किया गया। सीएसआईआर-एनसीएल को 83 भारतीय और 59 विदेशी पेटेंट प्रदान किए गए। 71 शोध छात्रों ने सीएसआईआर-एनसीएल के वैज्ञानिकों के मार्गदर्शन में डॉक्टरेट की थीसिस पूरी की।

वर्ष के दौरान सीएसआईआर-एनसीएल ने श्री धर्मस्थल मंजुनाथेश्वर विश्वविद्यालय, धारवाड, स्काई इनोवेशन एलएलपी, ऑटोमोटिव रिसर्च एसोसिएशन ऑफ इंडिया (एआरएआई), पुणे इंटरनेशनल सेंटर, पुणे और यूपीएल यूनिवर्सिटी ऑफ सस्टेनेबल टेक्नोलॉजी सहित कई कंपनियों और संस्थानों के साथ समझौता ज्ञापनों पर हस्ताक्षर किए। सीएसआईआर-एनसीएल ने CSIR & NCL KNOWHOW के पायलट अध्ययन के लिए Reliance Industries Limited के साथ एक समझौता ज्ञापन पर हस्ताक्षर किए, जिसमें इस्तेमाल किए गए PPE किट (सूट) को मोल्डेड/एक्सट्रूडेड प्लास्टिक उत्पादों में पुनर्चक्रित किया जा सके। सीएसआईआर-एनसीएल, पुणे, सीएसआईआर-आईआईपी, देहरादून, और लिग्नोइल टेक्नोलॉजीज प्राइवेट लिमिटेड परस्पर सहयोग के लिए एक साथ आए है, जहां सीएसआईआर-एनसीएल सीएसआईआर-आईआईपी को प्रक्रिया विकास और जाइलिटोल उत्पादन के स्केल-अप के लिए जैव-उत्प्रेरक तैयार और आपूर्ति करेगा।

वैज्ञानिक समुदाय और उद्योगों के साथ संपर्क बढाने के लिए सीएसआईआर-एनसीएल ने प्रख्यात वैज्ञानिकों, नवप्रवर्तकों और विचारकों द्वारा दिए गए कई महत्वपूर्ण व्याख्यानों का आयोजन किया। इसका विस्तृत ब्यौरा रिपोर्ट में दिया गया है। सीएसआईआर-एनसीएल ने औद्योगिक समस्याओं का समाधान प्रदान करने के लिए प्रायोजित अनुसंधान, परामर्श, तकनीकी सेवा परियोजनाओं और लाइसेंसिंग तकनीक सहित विभिन्न मॉडलों के माध्यम से चालीस से अधिक औद्योगिक भागीदारों के साथ काम किया है। सीएसआईआर-एनसीएल के छात्रों ने अपने हालिया शोध परिणामों को प्रस्तुत करने और उन पर चर्चा करने के लिए एक ऑनलाइन वार्षिक सम्मेलन का आयोजन किया और व्याख्यान देने के लिए सीएसआईआर-एनसीएल से बाहर के विशिष्ट वक्ताओं को आमंत्रित किया। इस वर्ष के दौरान छात्रों ने उद्यमिता की भावना को विकसित करने के लक्ष्य के साथ 'प्रौद्योगिकी उद्यमिता क्लब' को फिर से शुरू किया। उन्होंने ज्ञान का विस्तार करने और करियर विकल्पों पर चर्चा करने के लिए साझा करने और सीखने की गतिविधि 'साइलॉजी' भी शुरू की।

विज्ञान संचार गतिविधियों के हिस्से के रूप में सीएसआईआर-एनसीएल ने विभिन्न प्रदर्शनियों में भाग लिया, जिसमें पणजी, गोवा में इंडिया इंटरनेशनल साइंस फेस्टिवल २०२१, महाराष्ट्र के फलटन में एक जागरूकता कार्यक्रम के तहत स्वराज फाउंडेशन और संसा फाउंडेशन द्वारा आयोजित 'शाइनिंग महाराष्ट्र-२०२२' शामिल है। प्रयोगशाला ने आईआईटी-बॉम्बे के सहयोग से जिज्ञासा वर्चुअल लैब विकसित करने और स्कूली बच्चों के लिए सीएसआईआर-एनसीएल वैज्ञानिकों द्वारा विशेष व्याख्यान सहित विभिन्न आउटरीच गतिविधियों का भी आयोजन किया।

मैं सीएसआईआर-एनसीएल के सभी वैज्ञानिकों, कर्मचारियों और छात्रों की प्रशंसा और आभार व्यक्त करना चाहता हूं, जिन्होंने प्रयोगशाला में उत्कृष्ट योगदान देने के लिए अथक परिश्रम किया है। मैं सीएसआईआर-एनसीएल की अनुसंधान परिषद और प्रबंधन परिषद, महानिदेशक-सीएसआईआर और सीएसआईआर मुख्यालय, नई दिल्ली के कर्मचारियों को उनके सहयोग और निरंतर समर्थन के लिए भी धन्यवाद देना चाहता हूं।

आशिष लेले

(आशीष लेले)

"From the **Director's** Desk"

A warm welcome to the CSIR-National Chemical Laboratory (CSIR-NCL), Pune. I take this opportunity to present to you the Annual Report of the Laboratory for the year 2021-22. The report recapitulates the achievements of the laboratory, creating new knowledge and innovative translation of knowledge into the process and product technologies during the year.

The CSIR-NCL has created a technology roadmap for the 2020-2030 decade. The roadmap is meant to bring sharper focus to the activities of the laboratory, synergize science and technology and align human and financial resources to ensure delivery. The roadmap has identified seven vital S&T themes based on their relevance to India in the context of global and national megatrends and leveraging the core strengths of the laboratory. In each theme, the laboratory will aspire to work on at least one large impactful project with a clear focus on delivering globally benchmarked and IP-protected product or process technologies while also creating new science. Projects will bring together all pertinent partners and stakeholders at the early stages of development. This report summarizes seven identified themes and highlights some of the large projects that have already been initiated under the themes.

Despite many difficulties that arose during the second Covid-19 wave, the laboratory continued to work and make important contributions to the fight against the pandemic. The laboratory established a genome sequencing unit and uploaded valuable data in INSACOG, initiated one of the country's first sewage surveillance program in Pune city, commissioned CSIR-IIP's first oxygen concentration unit in Aundh government hospital, initiated an in-house funded project for developing the process technology for manufacturing Lithium zeolite for oxygen concentration, undertook regular measurements of oxygen purity from PSA units, set up at various hospitals in the Pune district and completed a pilot trial to demonstrate the recyclability of 100 kg of disposed PPE kits collected from Pune's biomedical waste management company.

Among the significant achievements in fundamental sciences, the laboratory published more than 460 research papers in highly recognized national and international peer-reviewed journals, including a few high-impact journals such as *Lancet, Energy & Environmental Science, Advanced Energy Materials, ACS Energy Letters, Catalysis Reviews-Science and Engineering,* etc. This

knowledge was also protected by filing 20 Indian and 47 foreign patents during the year. 83 Indian and 59 foreign patents were granted to CSIR-NCL. Seventy-one research students completed their doctoral theses under the guidance of CSIR-NCL scientists.

During the year, CSIR-NCL signed MoUs with multiple companies and institutions, including Shri Dharmasthala Manjunatheshwara University, Dharwad, SKYi Innovations LLP, Automotive Research Association of India (ARAI), Pune International Centre, Pune, and UPL University of Sustainable Technology. CSIR-NCL signed a memorandum of understanding with Reliance Industries Limited for the Pilot Studies for CSIR-NCL KNOW HOW on recycling used PPE kits (Suits) into molded/ extruded plastic products. CSIR-NCL, Pune, CSIR-IIP, Dehradun, & Lignoil Technologies Private Limited have joined hands where CSIR-NCL will prepare and supply bio-catayst to CSIR-IIP for process development and scale-up of xylitol Production.

In order to increase interactions with the scientific community and industries, CSIR-NCL organized several important lectures delivered by eminent scientists, innovators, and thought leaders. A detailed account of the same is provided in the report. CSIR-NCL has worked with over forty industrial partners through various models, including sponsored research, consulting, technical services projects, and licensing technology to provide solutions to industrial problems. The students of CSIR-NCL organized an online annual conference to present and discuss their recent research outputs, and invited distinguished speakers from outside CSIR-NCL to deliver lectures. During this year, the students re-started the 'Technology Entrepreneurship Club' with the goal of inculcating the spirit of entrepreneurship. They also initiated 'SciLogy,' a sharing-and-learning activity to expand the breadth of knowledge and discuss career options.

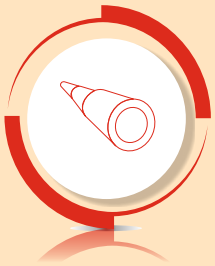
As part of science communication activities, CSIR-NCL participated in various exhibitions, including India International Science Festival 2021 at Panaji, Goa, 'Shining Maharashtra- 2022' organised by Swaraj Foundation & Sansa Foundation under an awareness program at Phaltan, Maharashtra. The laboratory also organized different outreach activities, including developing Jigyasa Virtual Lab in collaboration with IIT-Bombay and special lectures by CSIR-NCL scientists to school children.

I would like to place on record my appreciation and gratitude to all of the scientists, staff and students of CSIR-NCL who worked tirelessly to make outstanding contributions to the laboratory. I would also like to thank the Research Council and Management Council of CSIR-NCL, DG-CSIR, and the staff at CSIR HQ, New Delhi, for their cooperation and constant support.

(Ashish Lele)

Vision, Mission, Guiding principles & Values

Vision

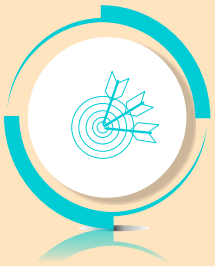


To be a globally recognized and respected R&D organization in the area of chemical sciences and engineering

To become an organization that will contribute significantly towards assisting the Indian chemical and related industries in transforming themselves into globally competitive organizations

To become an organization that will generate opportunities for wealth creation for the nation and, thereby, enhance the quality of life for its people

Mission



To carry out R&D in chemical and related sciences with a view to eventually deliver a product, process, intellectual property, tacit knowledge or service that can create wealth and provide other benefits to CSIR-NCL's stakeholders

To build and maintain a balance portfolio of scientific activities as well as R&D programs to enable CSIR-NCL to fulfill the demands of its stakeholders, present and future

To create and sustain specialized Knowledge Competencies and Resource Centers within CSIR-NCL which can provide support to all stakeholders of CSIR-NCL

To contribute to the creation of high quality Ph.D. students with competencies in the area of chemical, material, biological and engineering sciences

Values

To be deeply committed to the success of our stakeholders

To create and sustain a self - driven and self - managed learning organization with a high degree of internal and external transparency

To encourage a culture of collective and principle-centred leadership

To value the dignity of the individual and deal with people with a sense of fairness and without bias, prejudice or favour

To nurture the highest standards of integrity and ethical conduct

Organization Chart

Shri Narendra Modi
Prime Minister of India
& President, CSIR

Dr. Jitendra Singh
Union Minister for S&T and
Vice-President, CSIR

Dr. Shekhar C. Mande
Secretary, DSIR &
Director General, CSIR

Dr. Ashish K. Lele
Director, CSIR-NCL

Management Council | **Research Council**

Scientific Divisions

- Chemical Engg. Process Dev.
- Catalysis & Inorganic Chemistry
- Organic Chemistry
- Physical & Materials Chemistry
- Polymer Science & Engineering
- Biochemical Sciences

Resource Centers

- Catalyst Pilot plant
- Center for Materials Characterization
- Central NMR Facility
- Digital Information Resource Center
- National Collection of Industrial Microorganisms
- NCL innovations

S&T Support

- Human Resource Management
- Intellectual Property Group
- Publication & Science Communication
- Technology Management Group
- Safety Management
- Knowledge Resource Center
- Engineering Services
- Glass Blowing

Business Development

- Administration
- Finance & Accounts
- Stores & Purchase
- Contract & Legal Support
- Public Relations & Events Management
- Management Information System

Research Themes and Areas

Research Themes

- Clean Energy
- C1 Chemistry
- Circular Economy
- Sustainable Chemical Industry
- Biosimilars
- Biomass
- Agritech

Research Areas

Catalysis

- Heterogeneous Catalysis
- Organometallic Chemistry
- Surface Science

Chemical Engineering and Process Development

- Biochemical & Biological Engineering
- Energy and Environmental Engineering
- Industrial Catalysis and Catalytic Processes
- Industrial Flow Processes
- Mathematical & Computational Modeling
- Process Development and Scale-up
- Process Intensification and Engineering

Organic Chemistry

- Catalysis and new methods
- Chemical Biology
- Industrial Organic Chemistry
- Natural Product Chemistry
- Medicinal Chemistry
- Total Synthesis

Physical and Materials Chemistry

- Biomimetic Materials
- Materials for optoelectronics
- Magnetic and Gas storage
- Quantum electronic and structure theory
- Soft Matter: Theory and Simulation
- Synthesis of Materials including Nanomaterials

Polymer Science and Engineering

- Advanced Polymeric Materials for Energy
- Healthcare, Water, Security and Strategic areas
- Biomass Chemistry and Technology
- Polymer Chemistry
- Polymer Engineering
- Polymer Physics
- Membrane Science and Technology
- Colloids, soft solids and metastable materials

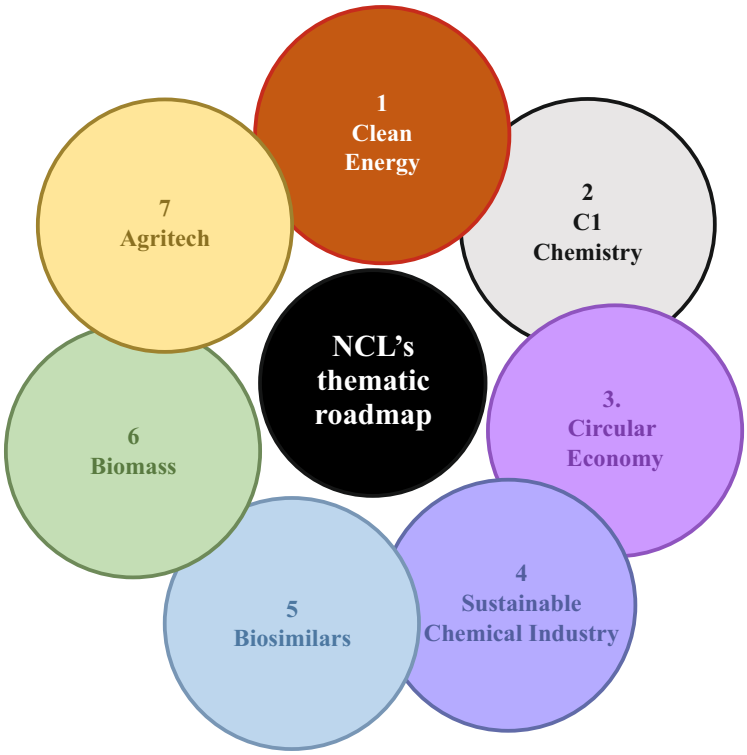
Biochemical Sciences

- Enzymology and Microbiology
- Plant Molecular Biology
- Plant Tissue Culture
- Proteomics and Metabolomics
- Structure Biology

CSIR-NCL Roadmap

Since its inception 72 years ago, the CSIR-National Chemical Laboratory has consistently striven to leverage high quality fundamental science to develop globally competitive product and processes technologies that are protected by strong intellectual property with the ultimate goal of creating wealth for the nation, contributing to its security and improving the quality of life of the citizens.

CSIR-NCL has played a key role in the development and growth of Indian Chemical Industry in the areas of bulk chemicals, agrochemicals, dyestuff, pharmaceuticals, petrochemicals and polymers. CSIR-NCL has also been a trailblazer in filing and licensing patents, developing a vibrant start-up ecosystem, licensing technology to global clients and initiating mission mode programs on futuristic technologies. In the present decade of 2020-2030 the global chemical industry has to take bold steps to contribute positively to climate action. The Indian Chemical Industry must also strive to become more sustainable and environment friendly. At the same time, global megatrends spurred by the Covid pandemic has created new opportunities for Indian industry to enter global supply chains and help India become more self-reliant. From this perspective, the CSIR-NCL has developed a roadmap that aims to support the growth of Indian Chemical Industry by developing cutting-edge technologies in chemicals, energy, agri- tech and healthcare sectors. The roadmap aims to leverage the laboratory's scientific excellence and passion for translation along with key stakeholder connects to develop technologies for public, private, societal and strategic goods thereby also contributing to the national goals of make-in- India, innovate-in-India, and start-up India. A brief description of the seven thematic areas and the key projects envisaged in the NCL roadmap are given below:



CSIR-NCL Roadmap

Clean Energy (*Green hydrogen and rechargeable batteries*)

Green hydrogen is envisaged to be the future clean fuel as it can be produced from renewable primary energy sources such as solar, wind, geothermal and biomass. Green hydrogen is perhaps the best alternative for deep-decarbonization of difficult-to-abate sectors such as industry and heavy-duty commercial transportation. India is planning to replace 5 million tons per annum of grey hydrogen with green hydrogen by 2030. CSIR-NCL is the nodal laboratory for the CSIR's hydrogen mission that involves 19 laboratories and several industry partners which are working collaboratively to develop transformational technologies for reducing the cost of hydrogen production, and its distribution, storage, and utilization. CSIR-NCL has strong competencies in the areas of electrochemistry, catalysis, advanced materials and chemical engineering, which are central to hydrogen technologies. The laboratory has more than 10 years' experience in the field of fuel cells and has licensed the fuel cell technology co-developed with CSIR-CECRI to KPIT, an industry partner which has deployed it in India's first fully-indigenous fuel cell bus. Going ahead, the focus is on technology upgradation and development of manufacturing processes for core materials so as to enable globally competitive indigenous knowhow made in and for India. The global battery deployment will be reaching 2000 Gwh by 2030 and the annual lithium ion battery market in India is expected to reach 132 GWh by 2030. Successful deployment ofbattery technologies in India will depend on the development of advanced cell chemistries and large-scale manufacturing of affordable battery chemicals, cells, battery management systems, and power trains. CSIR-NCL has 10+ years of experience in battery research and is equipped with skilled human resource for the cell fabrication and testing. The primary objective of the CSIR program is to develop core material technologies for advanced Lithium and Sodium battery chemistries. CSIR-NCL has also licensed its sodium-ion battery technology to Recharge-ion, a start-up that has been created from the laboratory's lab-2-market program.

Projects:

Hydrogen: Anion exchange membrane (AEM); High performance fuel cells and core materials (LT-PEMFC), Hydrides, Liquid organic hydrogen carriers (LOHC), DST-Advanced Hydrogen And Fuel Cell Programme (DST-AHFC)

Battery: CSIR Mission TAPSUN, 4M, Energy Storage, DST-Nanomission, etc.

CSIR-NCL Roadmap

C1 Chemistry (*Dimethyl Ether, Methanol, CO2, CH4*)

The PM Ujjwala Yojana has benefitted nearly 10 crore rural households by enabling the use of clean burning LPG in kitchens instead of conventional fuels such as firewood, which produces health-compromising emissions. However, nearly 50% of LPG is imported in the country causing significant forex loss. Dimethyl ether (DME) is an interesting alternative fuel to LPG. Although it has half the calorific value of LPG, it liquefies under similar pressure - temperature conditions as LPG and therefore can be mixed without any changes in cylinders and regulators. A 20%substitution of LPG with indigenously manufactured DME can result in savings worth 5 million tons of LPG imports. DME is also miscible with diesel and can improve engine efficiency as well as reduce emissions because of the oxygen content of the molecule.

CSIR-NCL has developed an indigenous catalytic process technology to produce DME from methanol dehydration. NCL's patent protected catalyst is a notch better than several global benchmarks. The laboratory has demonstrated a continuous 24 L/day production of DME in its laboratory demo-plant. The plans ahead include scale up to 100 L/day lab pilot and a 2.5 ton per day industrial demo plant.

NCL is also working on catalytic processes for the conversion of other one-carbon (C1) compounds such as CO2 and CH4 to value added feedstocks and fuels such as syngas and methanol. The laboratory is strengthening its research expertise and infrastructure in heterogeneous catalysis and chemical engineering.

Project: FTT Program: Methanol to DME

CSIR-NCL Roadmap

Circular Economy (*Plastics and lithium battery circularity*)

India produces 3.4 million tons of plastic waste every year, 94% of which is thermoplastics and 67% comprises commodity plastics such as polyethylene and polypropylene. With increased enforcement of stringent environmental regulations, it is necessary to develop robust and viable technologies for mechanical and chemical recycling of hard-to-recycle single-use plastic waste. The PPE kit comprising suits, masks, caps and footwear used by health-workers during the Covid pandemic is an example of a single-use plastic which was mandated for incineration as perbiomedical waste disposal guidelines. CSIR-NCL and CSIR-IIP co-developed a process technology for converting this waste plastic into useful molded plastic components and demonstrated it in a 100 kg pilot project in Pune, which is scalable across India and elsewhere.

CSIR-NCL along with CSIR-IIP, CSIR-CEERI and CSIR-IICT have also initiated a mission mode program on the development of process technologies for segregation of (majorly) polyolefinic packaging waste and its pyrolysis into value-added products such as naptha and diesel.

CSIR-NCL along with ARAI has also developed a process for rejuvenation of end-of-life lithium ion batteries from the mobility sector. This process can be used to provide 'one more useful life' of the battery in smaller vehicles and stationary energy storage applications.

Projects:

Mechanical recycling of PPE (and other PP non-wovens) to useful/ high value products Nodal lab for mission program on depolymerisation of SUP waste

CSIR-NCL Roadmap

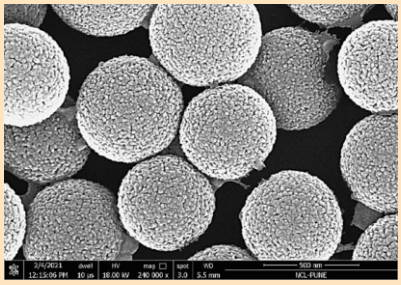
Sustainable Chemical Industry (*Continuous Flow Synthesis, Bulk chemicals*)

Indian Chemical Industry contributes about 16% of the manufacture sector GDP and 11% of exports. The specialty and fine chemical industry comprising pharmaceuticals, agrochemicals, dyestuff, pigments, intermediates, etc is witnessing rapid growth at present. However, the manufact-uring processes are increasingly required to become more sustainable, safer and self-reliant. CSIR-NCL has been developing process intensification strategies for the manufacture of specialty and fine chemicals. This is done by combining novel process flow chemistries with advanced process engineering to convert batch processes into continuous intensified processes. These technologies provide safer manufact-uring in assets having smaller footprint, much higher conversion and selectivity, with zero liquid discharge and low utility costs. NCL has developed, demonstrated and licensed several continuous flow process technologies at TRL 6-7 to the Indian Chemical Industry.

More recently, NCL is using novel continuous processes to make advanced materials. The laboratory has developed the world's most inexpensive technology for the continuous large-scale production of precision silver nanowires, which are suitable for printed and flexible electronics and used in the tightly controlled markets such as touch screen, conducting inks, thermal coatings, IR shielding sector, etc. With this technology developed at CSIR-NCL, Indian industries will be able to manufacture this precision material and supply the same globally. Similarly, NCL has developed continuous flow processes for manufacturing advanced materials such as monodisperse mesoporous/ non-porous silica microparticles and highly monodisperse polymers.

CSIR-NCL has also developed processes for continuous manufacturing of important bulk chemicals such as bisphenol-A (BPA), DCDA and cyclohexanone oxime. An important process developed by NCL this year has been that for BPA, which is a key feedstock for the production of epoxy resins, polycarbonate and number of other polymers. India imports about 1,35,000 TPA of BPA from a few major suppliers globally.

The NCL process offers novel downstream separation and purification strategy that provides better economics than conventional processes.



Projects:

CFS: Multiblock polymers, Dyes and colourants, Electronic chemicals, Agrochemicals & APIs

Bulk Chemicals: Catalytic process for production of BPA, Process for cyclohexanone oxime

CSIR-NCL Roadmap

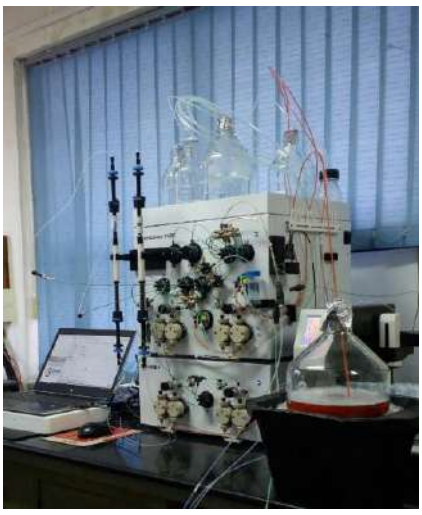
Biosimilars and Bio-Betters (*Monoclonal antibodies*)

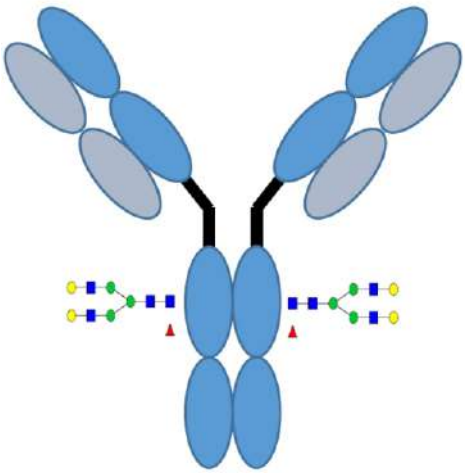
Biosimilars are the biomacro-molecular equivalents of small molecule generic drugs, and are increasingly being used for treating health conditions that are difficult to cure by the latter. The size of Indian biosimilar industry in 2022 is expected to reach 1.8 billion dollars. The National Biopharma Mission (NBM) was created by the DBT to promote time and cost effective development of biosimilar recombinant proteins and vaccines.

CSIR-NCL has established strong competencies in upstream and downstream process development for biosimilars, structural characterization of complex macromolecules, lab-scale proof-of-concept demonstration and development of larger scale basic engineering packages.

NCL works closely with the NBM and industry in two types of activities: (a) process development projects to provide de-risked intellectual property-based technologies, (b) structural and functional characterization of various recombinant proteins, which will lead to the development of biosimilars. The focus of the Biosimilars Group in NCL is to provide solutions for different process and product-related challenges in various recombinant protein manufacturing.

NCL also works on the development of novel bio-therapeutic molecules ('bio-betters') which can be produced by genetically engineered mammalian cells that allow rapid modulation of glycoforms of monoclonal antibodies.





Projects:

BIRAC-National Biopharma Mission program: On going four projects

DST-DPRP program on continuous processing for monoclonal antibody therapeutic manufacturing

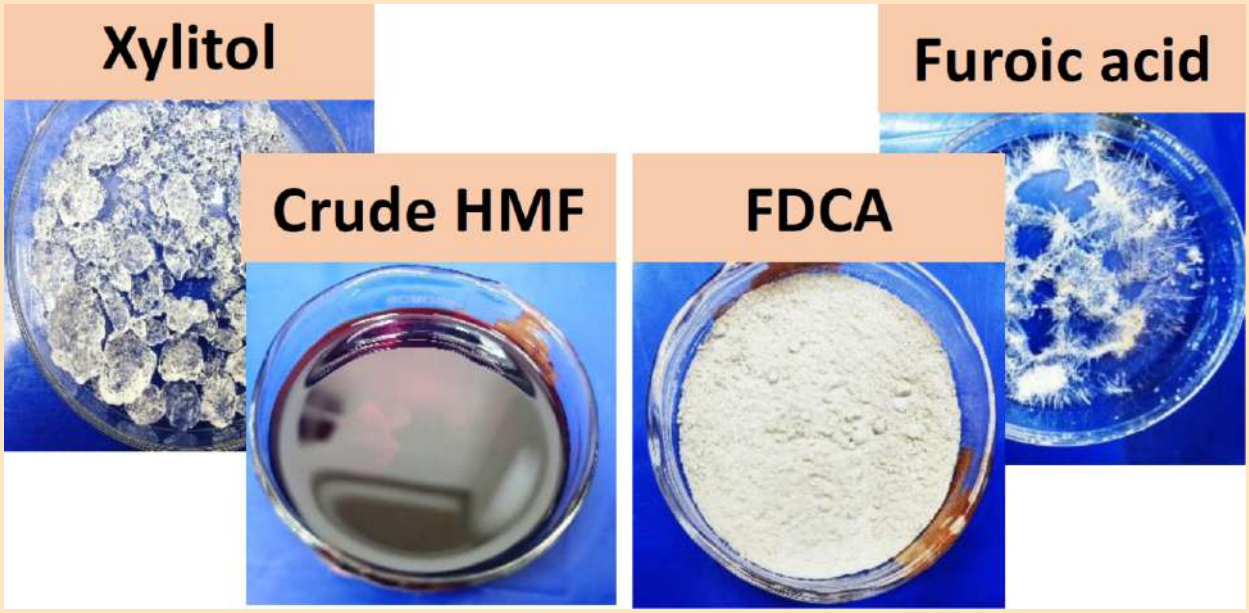
CSIR-NCL Roadmap

Biomass (*lignin, cellulosics, hemicellulosics, cashewnut shell liquid*)

Valorization of the abundantly available agro-waste and residues by converting them into chemicals, materials and fuels has become essential due to the need to reduce fossil based feedstocks that cause emissions and over-dependence on imports.

CSIR-NCL has been working consistently on designing and development of heterogeneous and homogeneous catalysts for the valorization of cellulose and hemicellulose into sugars and sugar derivatives (furfural, HMF, sugar alcohols etc.), and their oxidation into FDCA, gluconic acid, furoic acid, as well as hydrogenation into sorbitol, xylitol, furfuryl alcohol, DMF, etc. NCL has also been working on catalytic delignification of biomass, which avoids conventionally practiced and environmentally-unfriendly acid/alkali based processes.Further, NCL has developed lab-scale processes for depolymeri-zation of lignin into aromatic monomers and their further conversion via hydrodeoxygenation into hydrocarbons.

Scientists at NCL have also developed advanced materials like bacterial cellulose and nanocellulose and their novel applications ranging from reinforced Nafion membranes for fuel cells to burn-wound dressings. NCL also has created a considerable patent portfolio on converting cashewnut shell liquid (CNSL) into high value chemicals, monomers and initiators.



Projects:

Misson Mode/ Fast-Track Translation of cellulosics to sugars, furans (~80% yield), FDCA (90% yield), xylitol/sorbitol (~90% yield), nanocell.

CSIR-NCL Roadmap

Agritech (*Honey Mission, Edible Oils, Crop Protection*)

India produces about 1 lakh tons of honey annually and about 16 lakh people are engaged in bee- keeping and allied activities. While the Indian market is expected to nearly double from the present INR 21 billion to 38 billion by 2027, the export potential is even greater. However, Indian honey often does not qualify for export markets because of lack of compositional profiling capabilities that are essential for export certification.

To solve this problem, CSIR-NCL in collaboration with the Central Bee Research and Training Institute of the KVIC is developing critical NMR-based profiling methodologies and data analytics for a variety of unifloral and multifloral Indian honey. These techniques not only allow for identification of premium quality honey that is suitable for exports but also enables quantification of adulteration in commercial honey. The impact of this study is expected to be in many dimensions from increasing exports and raising farmer incomes to improving quality of honey in domestic markets, etc.

India has been in lead in the consumption of edible oils; on the other-hand its production falls short, eventually resulting in the huge imports. CSIR-NCL has developed several hybridvarieties of safflower whose seeds contain about 350% more quantity of the healthier omega-9 fatty acid (oleic acid). Current work in progress is for registration of these varieties and pilot scale cultivation trials. Besides edible oil usage, the oleic acid containing oil is also useful for producing high value chemicals through the continuous flow synthesis processes developed at NCL.

One of the focus of fundamental research in NCL's plant bioscience group is to understand the process of morphogenesis and transformation of crop plants, horticultural plants and forestry plants, biochemical and molecular processes in primary and secondary metabolites production in plants, and development of genetic tools using omics approaches for applications in agriculture and allied fields. The Microbial Technology group, in particular, is centered on using microbial diversity, including fungi, endophytes, extremophiles, and unculturable, to understand the basic microbial physiology and molecular processes leading to various applications. Instead of identifying one molecule - one microbe, a cell is being viewed as a source of multiple enzymes and metabolites beneficial for human health care, agriculture, and industry. The structural biology group is interested in solving the structure of biological macromolecules, primarily proteins, to understand biological function and apply this knowledge for various purposes.

Projects:

Honey profiling using sophisticated analytical techniques Altering fatty acid composition to improve edible oil quality New crop protection tools for biotic & abiotic stress tolerance

Research Council

Chairperson

Dr. Ajit V. Sapre
Group President - R&T,
Reliance Industries Limited,
Reliance Technology Group,
Reliance Corporate Park, 7B-Gr. Floor
Thane Belapur Road, Ghansoli,
Navi Mumbai – 400701

Director

- **Dr. Ashish Kishore Lele**
  Director,
  CSIR-National Chemmical Laboratory,
  Dr. Homi Bhabha Rd,
  Pune – 411008

CSIR HQrs. Invitee

- **Dr. Hari Om Yadav**
  Senior Principal Scientist,
  Innovation Management Directorate,
  Council of Scientific & Industrial Research,
  Rafi Marg, New Delhi – 110001

External Members

- **Prof. S. Ramakrishnan**
  Department of Inorganic &
  Physical Chemistry, Indian Institute of
  Science, Bangalore – 560012

- **Dr. N. Satyamurthy**
  Department of Chemical Science,
  Indian Institute of Science Education
  and Research, Mohali, MGSIPA Complex,
  Sector 26, City Mohali – 160019

- **Dr. Prathama Mainkar**
  Senior Principal Scientist,
  CSIR-Indian Institute of Chemical
  Technology, Uppal Road,
  Hyderabad – 500007

- **Shri Venkatadri Ranganathan**
  Chief Innovation & Digital Officer,
  Tata Chemicals Limited,
  Bombay House, 24, Homi Mody
  Street, Fort Mumbai – 400001

- **Dr. Vilas Sinkar**
  Formal Vice President, Unilever R&D,
  Hindustan Unilever Research Centre,
  64, 2nd Main Rd, Palm Meadows,
  Whitefield, Bengaluru – 560066

Agency Representative

- **Shri R. Ramanan**
  Mission Director,
  ATAL Innovation Mission (AIM),
  'B' Wing 5th Floor, NITI Aayog,
  New Delhi – 110001

DG's Nominee

- **Prof. Rinti Banerjee**
  Department of Biosciences
  & Bioengineering,
  Indian Institute of Technology,
  Powai, Mumbai – 400076

Sister Laboratory

- **Dr. Kannan Srinivasan**
  Director, CSIR-Central Salt & Marine
  Chemicals Research Institute,
  Gijubhai Badheka Marg,
  Bhavnagar – 364002

Management council

Chairperson

Dr. Ashish Kishore Lele
Director,
CSIR-NCL, Pune

Members: CSIR-NCL

- **Dr. Vijay Vasant Bokade**
- **Dr. Rajesh Ghanshyam Gonnade**
- **Dr. Durba Sengupta**
- **Dr. Mahesh Jagdishrao Kulkarni**
- **Shri Kishor Digambar Deshpande**
- **Shri G. Prabhakaran**
- **Shri M. Sekar**

Member Secretary

- **Mrs. Pooja Kulkarni**
  Controller of Administration

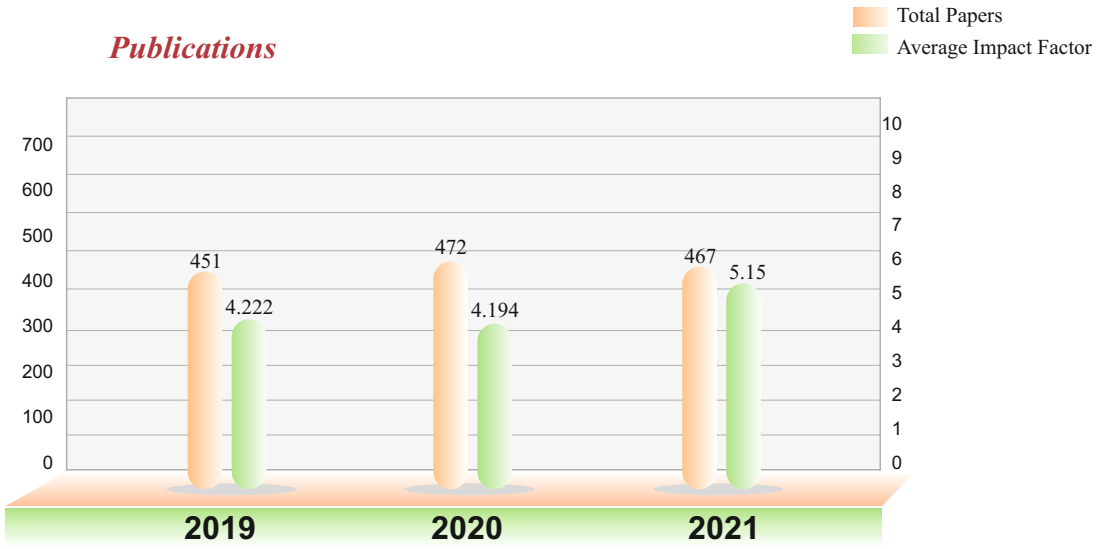
Sister Lab Director

- **Dr. G. Narhari Sastry**
  Director, CSIR-NEIST, Jorhat

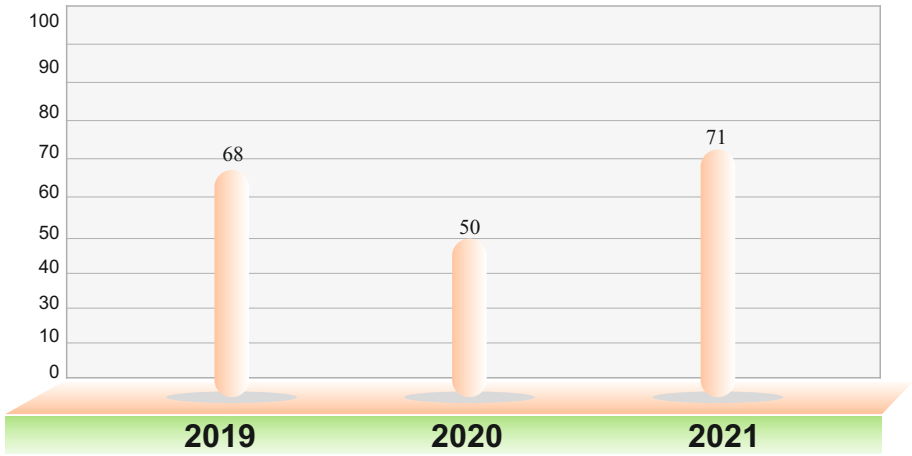
Performance Indicators

Research Output

Publications



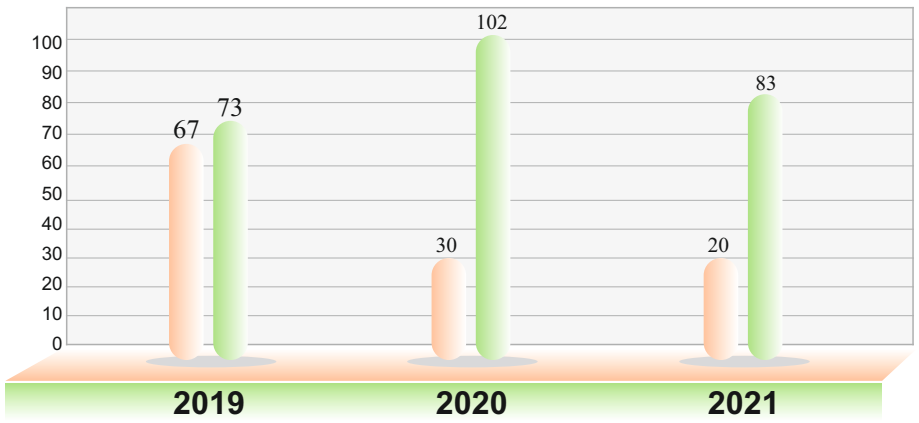
Ph.D. Theses



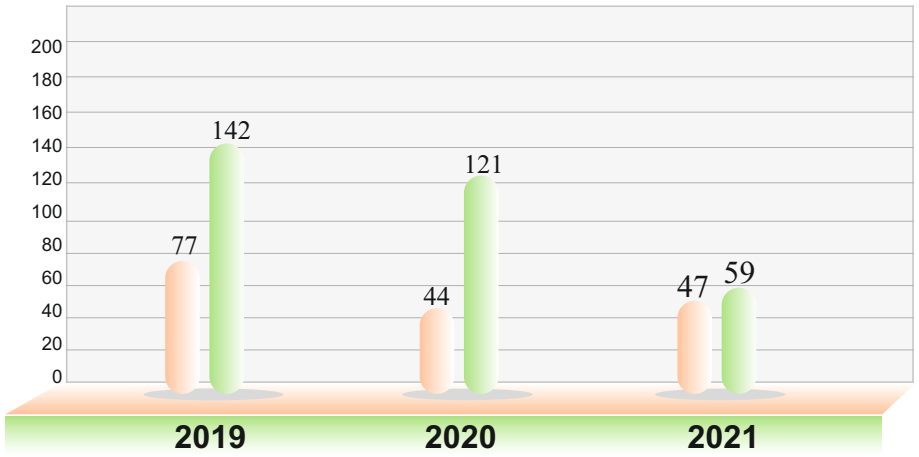
Technology Performance Indicators

NCL

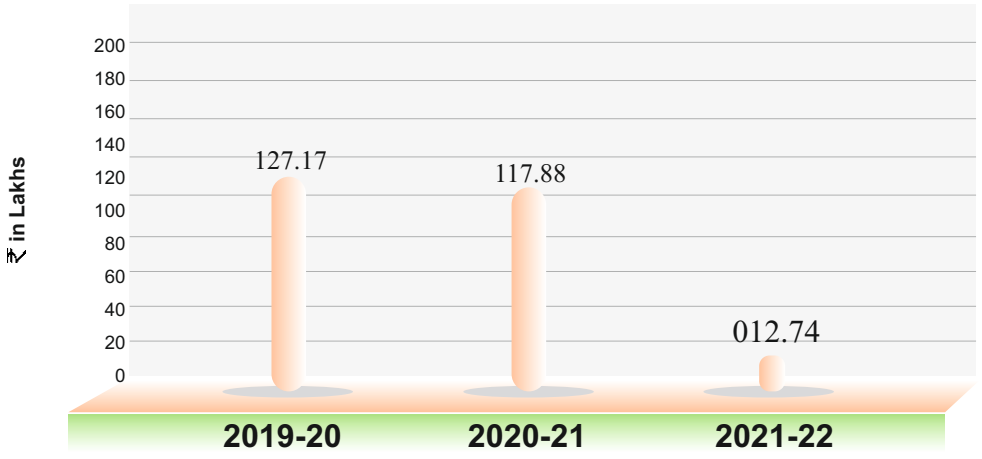
Indian Patents



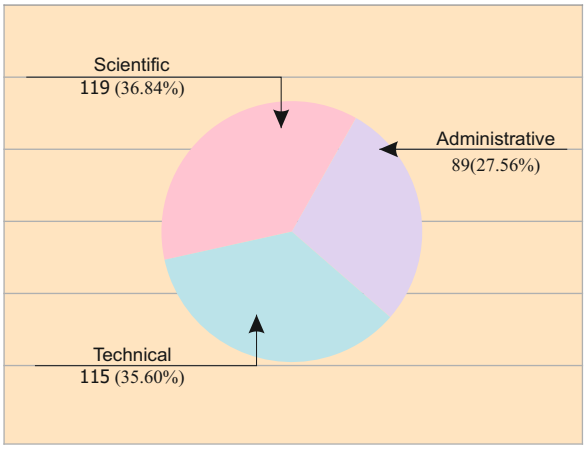
Foreign Patents



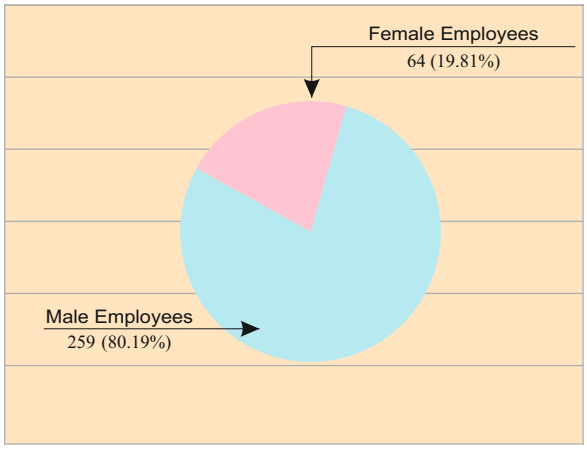
Premia/ Royalty Earnings



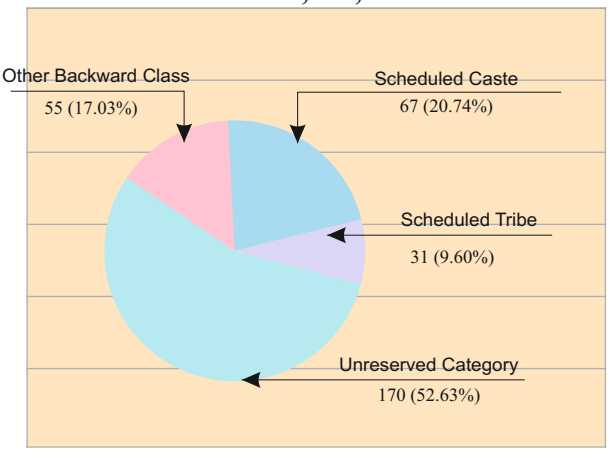
Total Staff: 332



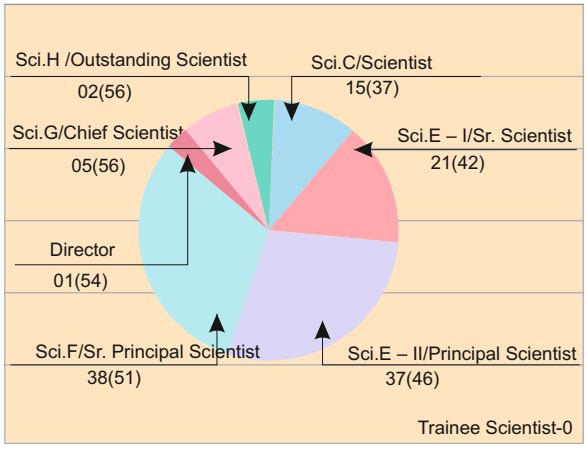
Male / Female Ratio



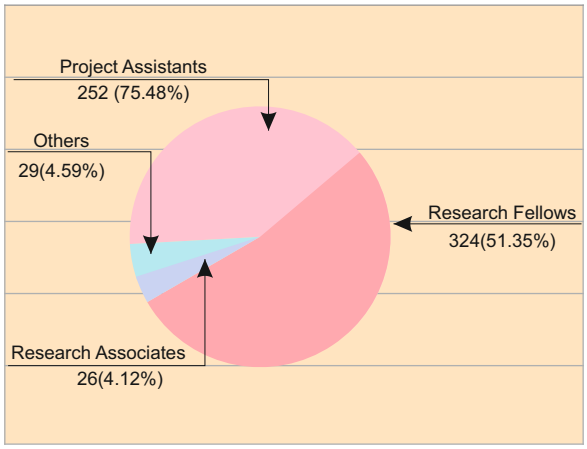
SC, ST, OBC & Others



Age wise distribution of Scientific Staff (Avg)



Students and Project Staff:631



We welcome NCL

Dr. Ashish Kishor Lele
DoJ: (01-04-2021)

Director, CSIR-NCL

- **Alternative energy systems with particular focus on hydrogen ecosystem**
- **Advanced materials for new manufacturing paradigms, sustainability and circular economy**
- **Structure-processing-property-performance relations in advanced materials**

- Senior VP and Head-Advanced Materials and Alternative Energy Group (2018-2021)
- Research Associate, University of Cambridge, UK (2000-2001)
- Scientist, CSIR-NCL (1993-2017)
- Ph. D., University of Delaware, USA (1988-1993)

Dr. Santosh Ghuge
DoJ: 15-03-2022

Chemical Engineering & Process Development

- **Process Risk Assessment**
- **Waste Water Treatment using AOPs**
- **Hydrogen Safety**

- Scientist, CSIR-NEERI, Nagpur (2006-2022)
- Ph.D., IIT Delhi, Delhi
- M.Tech, IIT Kanpur, Kanpur

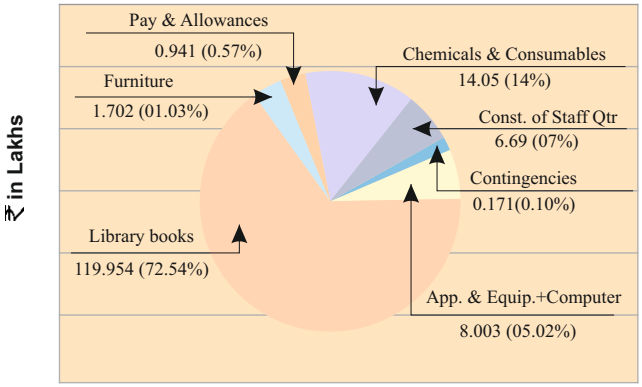
Dr. Rajesh V. Kanawade
DoJ: 01-12-2021

Physical and Materials Chemistry Division

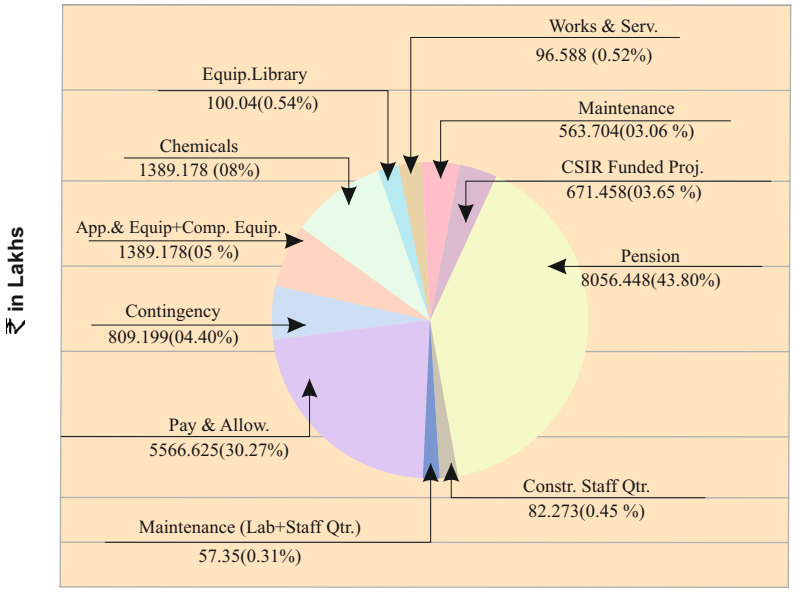
- **AEM Electrolyser and Hydrogen fuel cells**
- **Fiber optic sensors for various sensing applications**
- **Reflectance, Polarization, and Laser Induced Breakdown Spectroscopy (LIBS) applications**
- **Photoluminescence and phase fluorometric measurement**

- Scientist, CSIR-Central Scientific Instruments Organisation (CSIO-CSIO), Chandigarh (2017-2021)
- Dr. D. S. Kothari Fellow, Savitribai Phule Pune University, Pune (2016-2017)
- Post-Doctoral Fellow, Institute of Photonic Technologies, Friedrich-Alexander University, Germany (2013-2015)
- Ph. D., Friedrich-Alexander University, Germany (2008-2013)

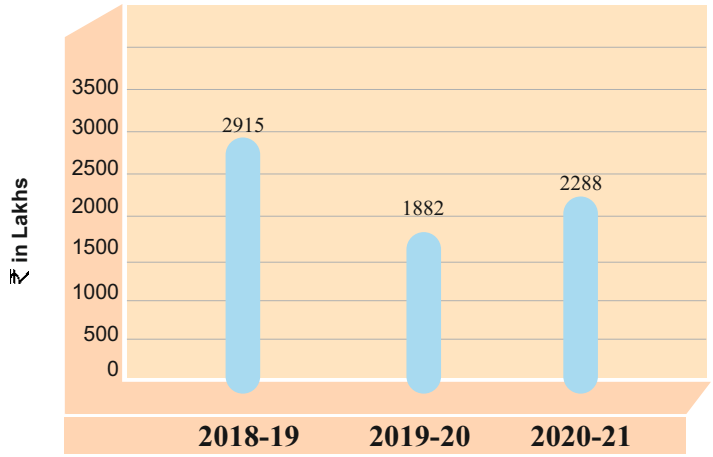
Laboratory reserve



CSIR and Network Projects



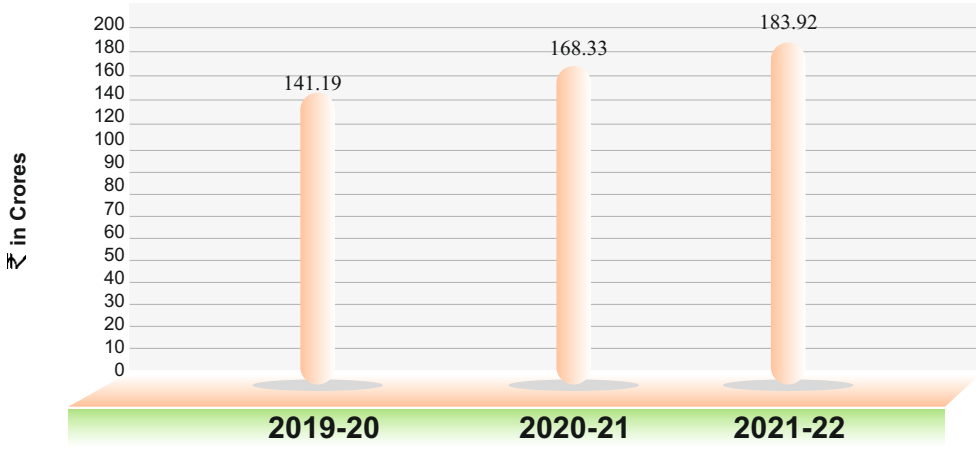
External Income



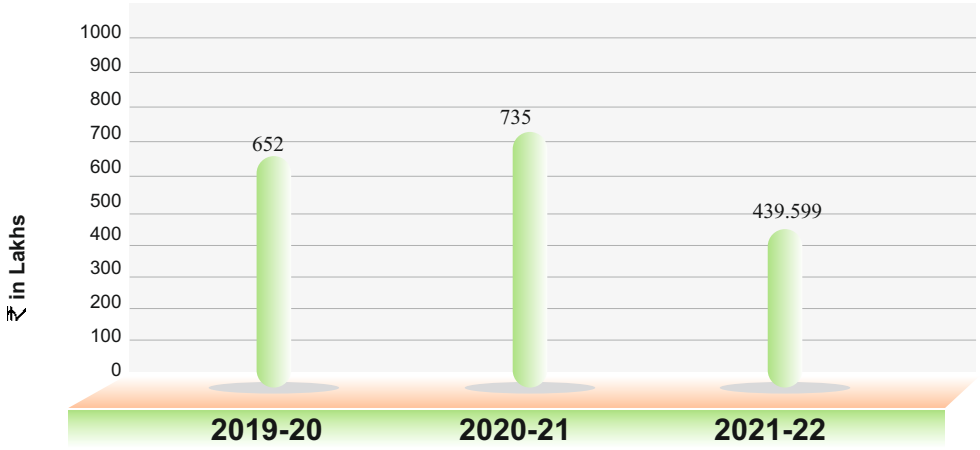
Financial Performance Indicators

NCL

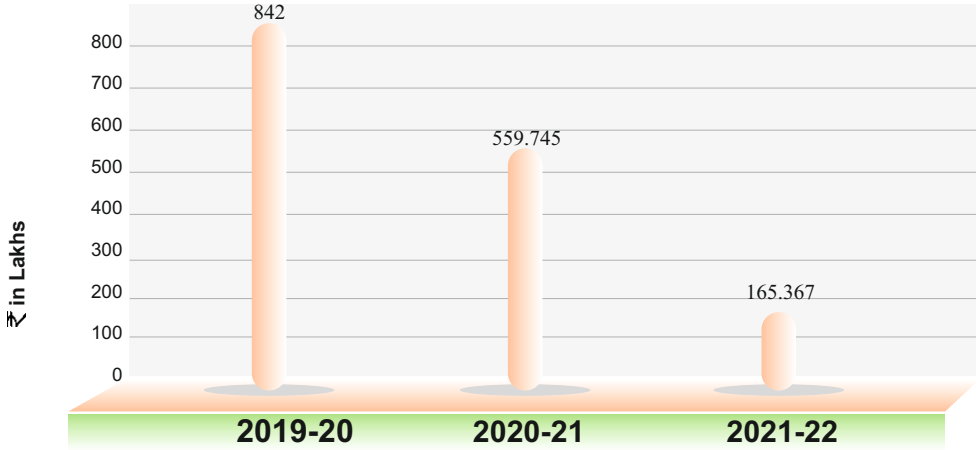
CSIR Budget



Laboratory reserve: Receipts

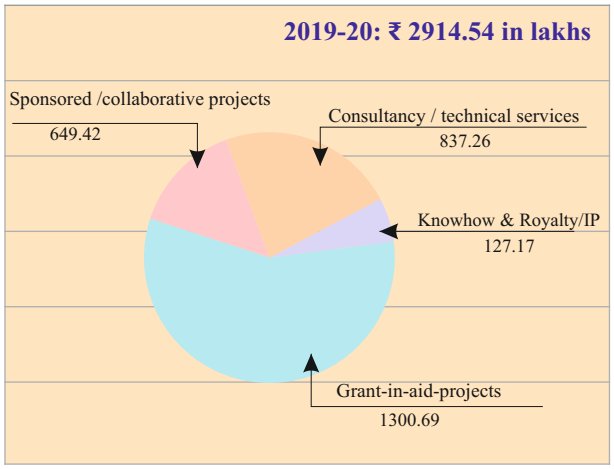


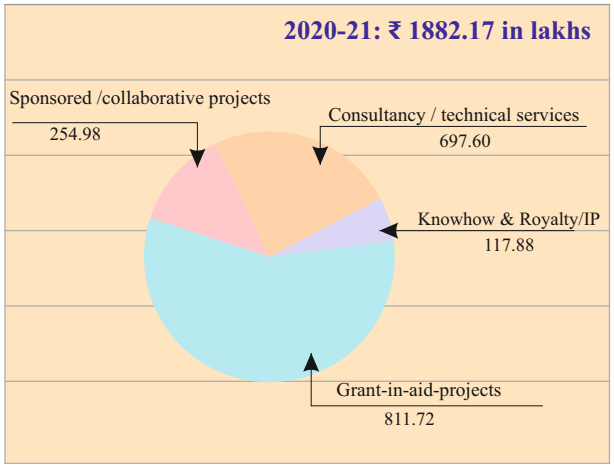
Laboratory reserve: Expenditure

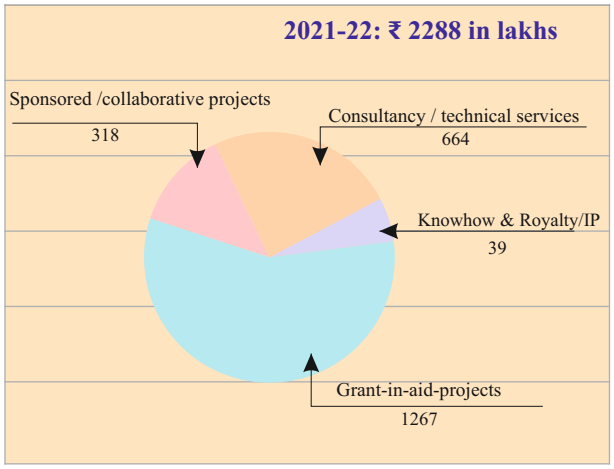


Knowhow & Royalty/IP
Grant-in-aid-projects
Consultancy / technical services
Sponsored / collaborative projects
Government Sector
Indian Industry (Private)
Indian Industry (Public)
Foreign Sector

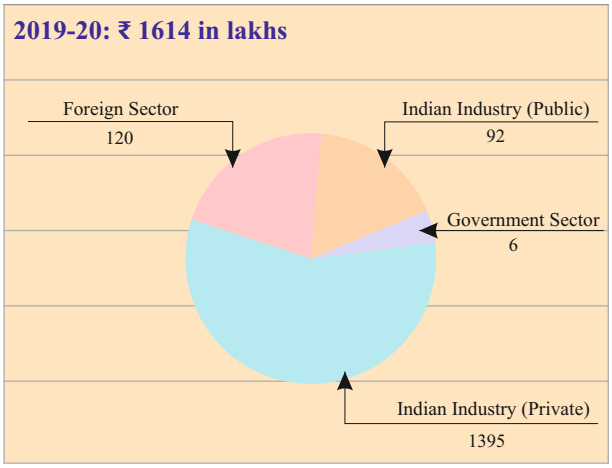
ECF by Source

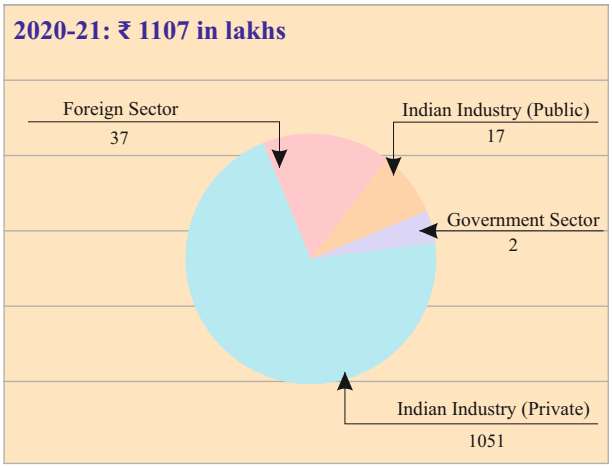


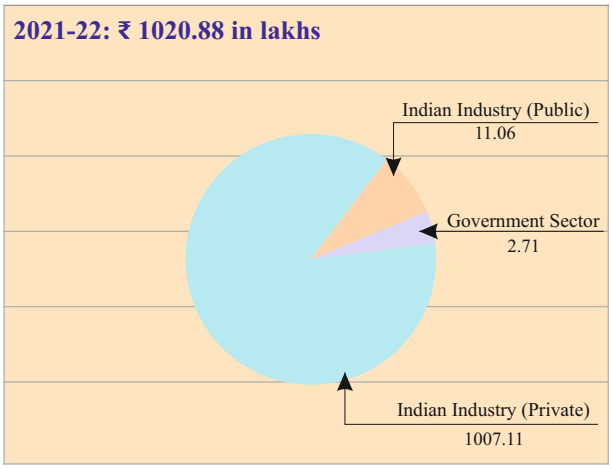




ECF from Industry







Outputs & Outcomes

NCL

Category of Benefits	Benefit	Indicators	2019-20	2020-21	2021-22
Public and social goods	Generation of and dissemination of generic knowledge	Number of papers published (Calendar year)	451	472	467
		Number of invention disclosure (Calendar year)	62	44	66
		Number of patents filed in India (Calendar year)	67	30	20
		No of foreign patents filed ** (Calendar year)	77	44	47
		Number of PCT applications filed (Calendar year)	15	25	13
		No of US applications filed	35	23	18
	Highly trained man-power	Number of PhD students as on 31 March, 2022	372	431	324
		Number of PhDs produced (Calendar year)	68	50	67
		Number of NET/GATE qualified students joined (including DBT JRF)	71	102	219
		Number of DST-Inspire students	7	14	40
	Science awareness, popularization etc.	Number of popular S&T articles published (in all languages)	6	4	2
		Number of national and regional workshops, seminars organized	4	2	4
	Pride and standing among nations; National image	Number of international awards won	-	-	-
		Memberships of major international academies and learned societies	12	12	12
		Number of foreign patents granted** (Calendar year)	142	121	63
	Representation in global affairs	Official(s) in global/ trans-national organizations like the UN, WHO etc - IUPAC (Cumulative years of office held) (Data given in no. of years)	8	8	8

1 Crore = 10 Million

Category of Benefits	Benefit	Indicators	2019-20	2020-21	2020-22
Private goods	Research, consulting, teaching and analytical services	Total earnings from projects done for Indian & Foreign businesses/ industry (₹ in Crore) (Industrial ECF, excluding Grant-in-Aid)	16.14	18.82	10.21
	Continuing education	Total earnings from continuing education/ training programs (₹ in Crore)	NA	NA	NA
	Licensing and technology transfer	Total earnings in the form of royalty, knowhow fees etc from Indian clients & contexts (₹ in Crore)	1.27	1.18	0.39
	Other tactical and strategic developments	Total earnings from patent related transaction (₹ in crore)	-	-	-
		No. of patents in new Licensing /assignment/ option arrangements	7	0	-
		No. of unique Licensing /assignment/ option cases	4	3	-
		No. of Indian patents granted (Calendar year)	73	102	57
		No of foreign patents granted** (Calendar year)	142	121	63
	Contributions to projects involving valuable opportunities in the form of technology options	Money inflow from NMITLI projects and other similar strategic projects (₹ in Crore)	5.40	-	-
		Money inflow from Technology Mission & GIA projects (other than NMITLI) projects (₹ in Crore)	13.01	8.12	12.67
Intellectual assets and reputation	Quality, reputation and standing of scientific man-power	No. of Indian patents granted (Calendar year)	73	102	57
		No. of foreign patents granted** (Calendar year)	142	121	63
		Number of scientists who are members of editorial boards of international peer-reviewed journals, covered by SCI	NA	NA	NA
		Number of PhDs granted where lab scientists were research guides	68	50	67
		Number of staff who are members of National academies (Cumulative)	33	33	33
		Number of Bhatnagar awardees (Cumulative)	17	18	18
		Number of Padma awardees (Cumulative)	6	6	6
	Lab's standing with industry	Total worth of projects with industry (only industry: both Indian & foreign) (excluding Grant-in-Aid) (Rs in Crore)	16.14	11.08	10.21

* - Individuals who are members of more than one academy have been counted only once

** - Foreign means all filings other than IN & WO 1 Crore = 10 Million

Research & Development

Anu Raghunathan
anu.raghunathan@ncl.res.in

COVID-19: Enhanced viral surveillance by viral genome sequencing to better track SARS Cov-2 today and monitor future threats tomorrow

A tale of two waves: COVID-19 genome surveillance in Pune

The leading edge of tracking a rapidly evolving SARS-CoV2 in the global pandemic necessitates continuous genome surveillance. The diversity of emerging lineages and novel variants potentially shape transmissibility, disease severity, and immune escape impacting public health. Pune, a tier-2 city in India with 4.1 million population, spiralled into the pandemic with its first case on March 9th 2020, an infected individual flying in from Dubai. Pune has recorded 1.1 million infection cases ever since with the death toll reaching 20,000. Critical to peak in case numbers and fatality rates through the waves of COVID19 infection are specific variants of concern (VOC) identified from the genomic sequencing and surveillance of the evolving virus. CSIR-NCL became a key player of the city-wide network of researchers, clinicians and pathology diagnostic laboratories; that was formed to investigate the changing landscape of genome of SARS-CoV-2 infection and its correlation to COVID-19 pandemic. We have sequenced a total of 5000 samples, collected from across Maharashtra and Goa with a focus on Pune (Figure 1) that spanned the time December-2020 till date.

We have detected VOCs and delineated the genomic landscapes of SARS CoV2 driving the last two waves through genome surveillance from infected people in Pune. The estimated proportions of variant lineages among circulating SARS-CoV2 viruses were tracked based on sample collection date. The rise and fall of VOCs were thus tracked as a function of time to identify prevalent VOCs during each wave (Figure 2).

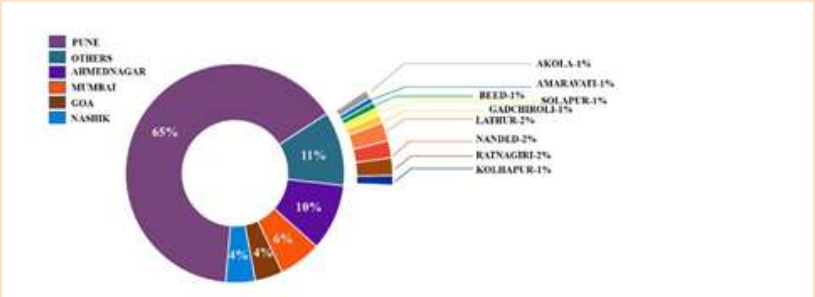


Figure 1: *Geographical distribution of samples sequenced at NCL*

The rise and fall of the VOCs through the course of the pandemic highlight the predominance of Delta and its sub-lineages during the second wave and Omicron in the third wave in Pune. A total of 156 lineages were identified at NCL in this period based on phylogenetic analysis (Figure 3). 27 lineages identified with prevalence greater than 1% were WHO/CDC determined Variants of Concern (VOC). We detected the first omicron VOC in Pune from an individual travelling back from Finland on December 7th 2021. The prevalence of Omicron in Pune has been 100% since end of January 2022.

We foresee workflows related to genome sequencing and surveillance integrated with outbreak analytics to play a significant role in pandemic preparedness in the future.

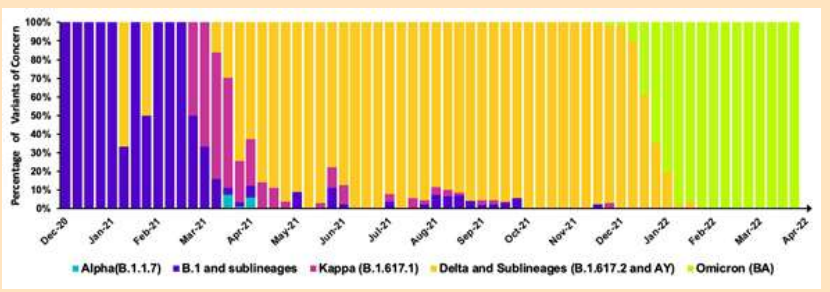


Figure 2: *Rise and fall of Variants of Concern "(VOC") in Pune during the time span Dec 2020 until April 2022*

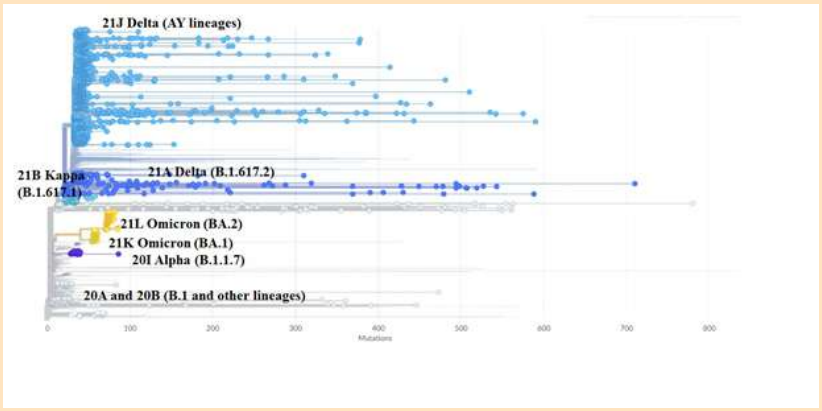


Figure 3: *Phylogenetic distribution of VOCs in Pune during the time span Dec 2020 until April 2022*

Vijay Bokade
vv.bokade@ncl.res.in

Zeolite for oxygen enrichment from air: Development of Na/Ca/Li-LSX zeolite granules for medical grade oxygen (>93% purity) from atmospheric air

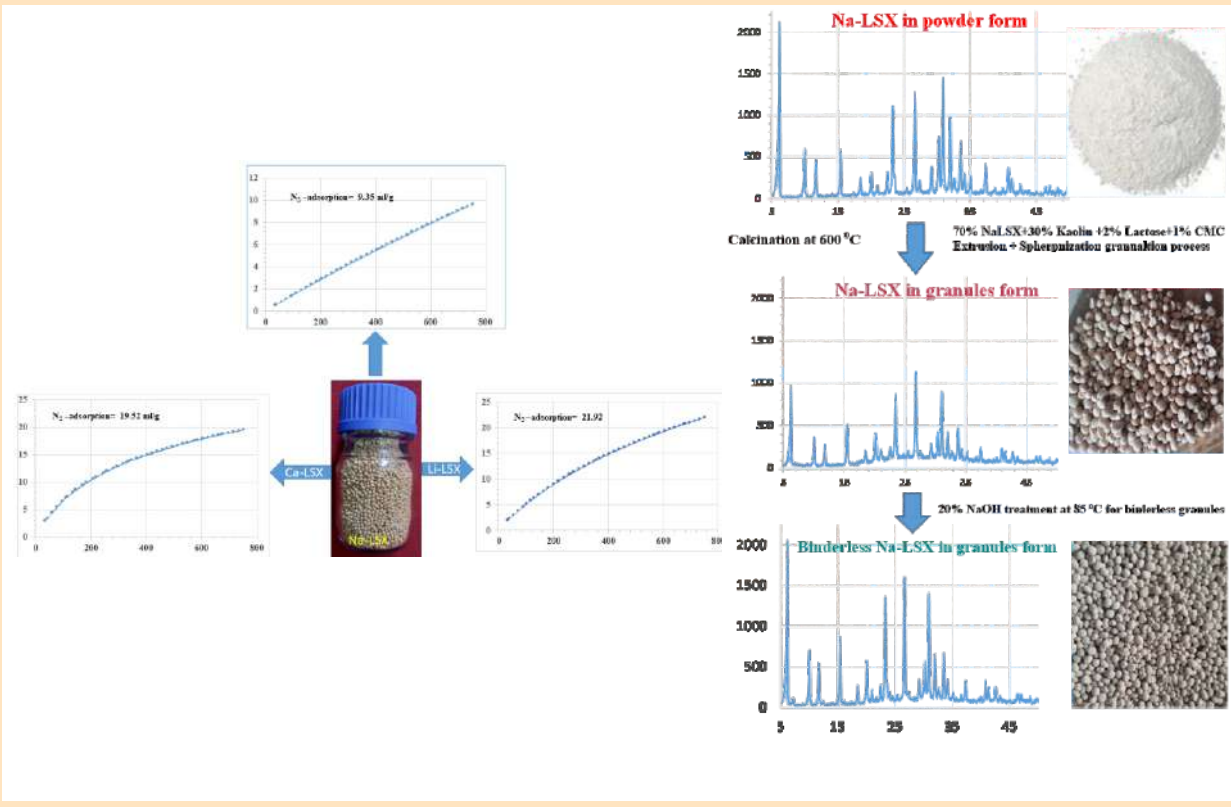
Oxygen is a vital element to surviving the life of a human. Indeed, Earth's atmosphere is composed of about 21% oxygen, which is enough to live for healthy humans. However, high purity (>93%) oxygen is needed for medical emergency/ICU cases. Medical grade (>+93%) oxygen demand has increased in India as well as in other parts of the world due to the Covid situation. Moreover, pure oxygen also have huge demand for other industrial applications.

Separation of O_2 from atmospheric air via Pressure Swing Adoption (PSA) is an effective technique. However, PSA needs a potential adsorbent (in granular form) to separate O_2 from nitrogen (N_2). Although, PSA is one of the powerful techniques to obtain high purity oxygen however, design and development of suitable adsorbents for selective adsorption of N_2 and reject O_2 from the air is still a challenge.

CSIR-NCL has developed an indigenous patented binderless-NaLSX synthesis process and further conversion into high crush-strength spherical granule which selectively adsorb N_2 from air. The zeolite has shown higher or equivalent N_2 adsorption as that of commercial absorbents. NaLSX zeolite in the powder was prepared by hydrothermal crystallization of gel with specific molar compositions at a relatively lower temperature (75 °C), time (17h) and without gel ageing in one step. Powder NaLSX was formulated into granules using Kaolin clay as a binder by extrusion and then spheronization method. Further alkali treatment was performed to convert the clay in to NaLSX zeolite to make it binderless NaLSX granules.

Final binderless NaLSX has shown N_2 adsorption > 9 ml/gm. Further modification of NaLSX granules into LiLSX and CaLSX exhibited 21.92 and 19.52 ml/g of N_2 adsorption, respectively with O_2 purity of >93%.

The process has been scaled up to the kg level. Besides medical use, high purity oxygen has wide industrial applications including gas cutting and welding, steel, pharmaceutical, petroleum, glass, ceramics, oxidation reactions, pulp, and paper.


Na-LSX in powder form
Calcination at 600 °C
70% NaLSX+30% Kaolin +2% Lactose+1% CMC
Extrusion + Spheronization granulation process
Na-LSX in granules form
20% NaOH treatment at 85 °C for binderless granules
Binderless Na-LSX in granules form
Ca-LSX
Li-LSX
Na-LSX

C.S. Gopinath
cs.gopinath@ncl.res.in

Launching CSIR's Hydrogen Technology (H2T) Program

In 2021, CSIR decided to launch a multi-laboratory Hydrogen Technology (H2T) program with the objective of developing a bouquet of selected key technologies in all three parts of the hydrogen value chain – production, storage and utilization. There are 19 CSIR labs working together in the program and CSIR-NCL was assigned the responsibility of nodal laboratory. NCL developed a detailed DPR comprising 14 projects, 3 of which are mission mode (MM) and remaining 11 are fast track translation (FTT) and niche creation projects (NCP) that are linked to the MM. Additionally, there are projects funded under DST's AHFC program. The first MM aims for system level development of three different electrolyzers, namely anion exchange membrane (AEM) electrolyzer, polymer electrolyte membrane (PEM) electrolyzer, and solid oxide electrolyzer (SOE). Of this, NCL will lead the development of AEM electrolyzer. The second MM is on hydrogen storage in indigenously designed and fabricated type III/IV tanks. In this, NCL's role is to develop specialty thermoset resins that can be recyclable. The third MM project is on developing high performance LT-PEMFC. The FTT, NCP and AHFC projects include bio-hydrogen, purple hydrogen from methane, compact autothermal reformer, LOHC and intermetallics.

NCL, in collaboration with CECRI has already made substantial progress in the development of LT-PEMFC. Indeed, the first version of this technology was licensed to the industry partner KPIT in 2021. In one of the FTT projects of the H2T program, it is planned to develop novel catalysts for improving the fuel cell performance. Towards this objective, in the year 2021-22, NCL has already initiated work on developing process-friendly electrodes for PEM Fuel Cells.

One of the interesting research along these lines is the development of an electrocatalyst based on three-dimensional (3D) interconnected bilayer graphitic carbon (3DFePDC) doped with nitrogen and iron, which can facilitate oxygen reduction reaction (ORR) both under acidic and alkaline conditions. The catalyst was synthesized from melamine sponge, polydopamine and an iron precursor via a controlled annealing process. The formed 3D architecture of the Fe3C core-shell assembly has structural features which ensure better exposure of the active sites and improved mass transfer characteristics. 3DFePDC exhibited promising activity towards ORR with a significantly small value of overpotential in both basic and acidic conditions. Thus, as a cost-effective electrocatalyst which can facilitate ORR under extreme pH conditions, 3DFePDC stands out as a system with great scope and uniqueness. Single-cell testing by engaging 3DFePDC as the cathode catalyst in a membrane electrode assembly, consisting of Nafion as the ionomer membrane, delivered a maximum power density of 278 mW cm-2. This value is inspiring and it paves the way for designing new approaches for the advancement of potential Pt-free electrocatalysts for PEMFCs.[1]

In an alternative strategy, NCL has developed a new protocol that involves Pt-supported 3D structured nitrogen-doped graphene (Pt/3DNG) and an in-situ grafted active "triple-phase boundary" which offers precise control on the formation of proton conducting ionomer interface at the active sites. The 3D catalyst was derived through the pyrolysis of GO-soaked melamine sponge, followed by Pt dispersion by the polyol method. The in-situ polymer interface was created by inducting a mixture of an acrylate monomer, a cross-linker, and a UV initiator in a solution by adequately controlling the viscosity and surface tension. Easy processability, low charge transfer resistance of the electrode, and promising performance during the HT-PEMFC mode of operation using phosphoric acid-doped polybenzimidazole (PBI) membr-ane are the key advantages of the developed strategy.[2]

References:

1. Pranav K. Gangadharan, Ajmal Pandikassala And Sreekumar Kurungot, Toward pH Independent Oxygen Reduction Reaction by Polydopamine Derived 3D Interconnected Iron Carbide Embedded Graphitic Carbon, ACS Appl. Mater. Interfaces., 13 (7), 8147 - 8158 (2021).

2. Pranav K. Gangadharan, Vidyanand Vijayakumar, Shijil A. Nediyirakkal, Roshni Tresa Fernandez, Adhrika V. Siddharthan And Sreekumar Kurungot, In situ preparation of ionomer as a tool for triple-phase boundary enhancement in 3D graphene supported Pt catalyst, Advanced Sustainable Systems., 5(1), 2000125 (2021)

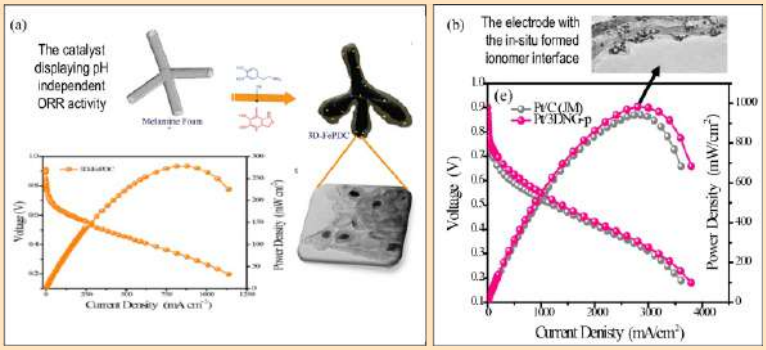
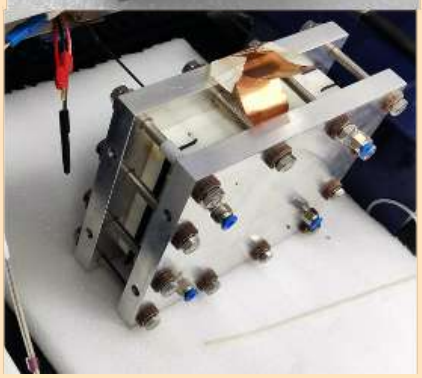


*Figure 1: **(a)** The Pt-free electrocatalyst for pH Independent Oxygen Reduction Reaction in PEMFCs and the single-cell polarization data obtained from a system based on the in-house catalyst and the Nafion membrane; **(b)** the single-cell polarization data obtained from the PEMFC electrodes derived through the in-situ polymerized ionomer interface and phosphoric acid doped PBI membrane.*

Project Highlight

In 2021-22, NCL also started preliminary work on the development of anion exchange membrane water electrolysis (AEMWE), a new emerging electrolyser technology. A few select players are in market with the first versions of AEM electrolyser. However, unlike the other matured technologies, such as alkaline, PEM, there are several unknowns in AEMWE. In this preliminary work, NCL has so far demonstrated the performance of AEM at 10 cm2 single cell level. The catalyst employed is based in Nickel alloys and is PGM-free. The final goal of this work is to develop a 2.5 kW AEM electrolyser operating at 1 A/cm2 current density at 2.0 V/cell that can deliver about 500 NL/h of 99.9% hydrogen. Additionally, the project envisages the development of polymeric membranes and bipolar plates.



Harshawardhan V. Pol
hv.pol@ncl.res.in

Anuya Nisal
aa.nisal@ncl.res.in

CSIR initiative on recycling of COVID-19 plastic waste into value-added products: Value creation from recycling biomedical waste

Large quantities of PPE kits (nonwoven polypropylene) are used for battling the COVID-19 pandemic. As per CPCB mandates, used PPE kits have to be incinerated or land-filled. This is an abject loss of monetory and energy values besides burdening the environment. Hence, CSIR-National Chemical Laboratory (CSIR-NCL) embarked on a project to develop an alternative process to manage the PPE waste gainfully.With funding from CSIR and early support from CSIR-IIP, initial lab-scale experiments at CSIR-NCL showed that the PPE plastic waste could be successfully converted into molded articles with quality comparable to those made from virgin polymers. To scale up the further development, Reliance Industries Ltd. (RIL) was on boarded as industry partner who then networked with other executing partners. The pilot scale development being presented here interfaced with regulatory, technical, logistics, manufacturing, testing and prototyping of useful plastic articles made from a polymer resource that would have otherwise been wastefully disposed. It involved the use of fundamental understanding of polymer science, plastics technology and understanding of supply chain. Although this project aimed at developing non-food contact articles of common use, we also produced high-performance automotive components. Attention was paid to build seeding points for further scaling-up and diversification of this recycling technology. These collaborative efforts have led to a recycling technology that can contribute to India's commitment of *Panchamrit* announced by Honourable Prime Minister at COP26, if widely adopted. To facilitate this, it has been decided to freely release this technology in the public domain with appropriate safeguards.

Figure 1: *Garden pots & plant grower trays made from decontaminated recycled PPE material*

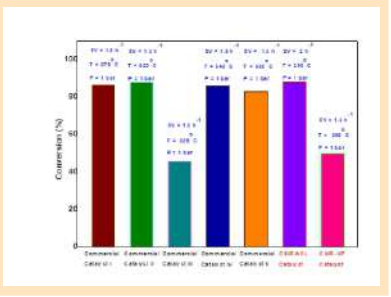
Figure 2: *Long glass fiber themoplastic composite molded structural automotive part made from decontaminated recycled PPE material*

T. Raja
t.raja@ncl.res.in

Process for catalytic dehydration of methanol to dimethyl ether

With growing population and its aspirations, India's demand in energy and fuel sector is increasing day by day. According to a report published by the economic times, India's fuel consumption jumped 23.8% in May from a year earlier. This is a situation of concern for India since we depend on other countries for crude oil and other fuels. It is therefore imperative for us to search for alternative and cleaner fuel options. Dimethyl ether (DME) is one such potential alternative. DME is a promising fuel as its combustion gives zero SOx and low NOX emissions. World has recognized DME as a viable fuel from last few decades. Countries like US, Russia and China have already developed automobile engines for using DME as a fuel. DME can also easily blend with LPG and CNG. Further, since the P-V-T properties of DME are similar to LPG, therefore the potential hazards associated with filling and utilization of domestic cooking-gas cylinders are almost similar for both fuels. Blending of 20% DME in LPG can reduce LPG imports by almost 5 million tons per annum and can thus have significant positive impact on the PM Ujjwala Yojana.In the previous year, we reported CSIR-NCL's success in developing a catalytic process at the scale of production of 24L/day of DME by dehydration of methanol. This year, the lab has designed, fabricated, installed and commissioned a 100 L per day DME lab-pilot plant. Operations of this plant will be commenced in the next year. Further, the team has also developed a complete basic engineering package for a 2.5 TPD pilot plant based on the experimental results obtained so far. Discussions are in progress with a large public sector oil company to set up the pilot plant in a suitable refinery complex that has a LPG bottling plant so that the DME produced in the pilot can be used immediately to blend with LPG and bottled.

On the applications side, the NCL team worked with ARAI, Pune to test DME blended CNG fuel in a 3-wheeler autorickshaw. Also, a domestic cooking range viz. 'Aditi Urja Sanch' having efficient burners for DME was developed by our team and its IP is protected. At present, the technology is ready at TRL 5.



Sanjay Kamble
sp.kamble@ncl.res.in

CSIR bulk chemical mission mode project: Development of catalytic process for production of bisphenol-A

4,4'Bisphenol-A (BPA) is an essential feedstock for producing epoxy resins, polycarbonate, and other polymers. The global market for Bisphenol-A estimated at 6.2 Million Tons in the year 2020, is projected to reach a revised size of 7.1 Million Tons by 2027, growing at a CAGR of 2% over the analysis period 2020-2027. India imports BPA of about 1,35,000 TPA. CSIR started Bulk Chemical mission mode projects in 2020. It aimed to develop cost-effective, eco-friendly processes for the production of Bulk Chemicals. Another critical aspect of the proposed project is to serve the country with its contributions to the 'Make in India' program and towards Aatma Nirbhar Bharat.

A catalytic batch process for preparing Bisphenol-A using phenol and acetone in the presence of a catalyst (ion resin) has been developed. Various parametric effects have been studied, and optimum reaction condition has been established. Two commercial catalysts (ion-exchange resins; IER) showed more than 95% conversion of acetone and 85-90% selectivity for BPA. Reusability and recyclability of IER have been studied to understand the stability of IER, and it was found that IER was robust. A batch pilot scale reaction was also performed using a 5 L high pressure reactor to understand the process's scalability and overall material balance. It was found that around 92-96% yield and 99.5-99.8% purity of Bisphenol-A was achieved in the batch pilot scale process.

Based on batch experimental data, a continuous catalytic pilot scale process was designed and developed for the production of BPA. The BPA pilot plant trials were taken continuously 24*7 for 20 days. Nearly complete conversion (90-99%) of acetone was achieved at steady-state operation. The continuous pilot plant trials found that the catalyst used in the process was very robust and produced a good yield for BPA without deactivation after more than 18 days of reaction. A highly pure colorless BPA was produced in the continuous process.

Bisphenol-A @ Process Development Laboratory, CEPD

A novel downstream processing technique has also been developed to get the highest purity colorless Bisphenol-A product. The physicochemical properties of synthesized BPA were compared with commercial BPA samples and found to match. Based on this project work, a patent disclosure has been filed #2022-INV-09.

T. G. Ajithkmar
tg.ajithkumar@ncl.res.in

Honey analysis using NMR: Fingerprinting and testing protocols of Indian Honey by NMR

Honey is nature's gift to mankind and has been consumed for millennia for its natural origin and immense nutritional and medicinal benefits. It also has a significant market for cuisines and confectionaries. India is a major Honey exporting nation and ranks 8th in global honey production (1.9 million tonnes) with a share of 1,00,000 metric tonnes of Honey. There is a significant mismatch between the total quantity of Honey sold in the market and the realistic estimate of the Honey producible from the existing beehives, implying adulteration. The practice of adulteration in Honey is either by adding sugar syrups or mixing with low-quality Honey. The current biophysical techniques used for honey characterization fail to detect the above adulteration. Furthermore, there is no systematic study or resourceful database of authentic Indian Honey. While several techniques are available to test Honey, NMR has recently proved its superiority for analyzing purity and the floral and geographical source of Honey. In line with this, M/s Bruker has demonstrated a honey NMR profiling method that depends on a database containing reference spectra of honey samples sourced from various countries and classified according to flower type, geographic location, etc. However, M/s Bruker's database is more specific to European-origin honey. It has data from only a tiny fraction of the wide variety of Honey originating from India, thus severely limiting its application for Indian Honey.

In this perspective, CSIR-NCL is working on the following objectives with an ultimate aim to establish an "NMR Centre of Excellence for Honey Analysis."

- Generating the first-ever systematic database resource of authentic Indian Honey charact-erized by all the analytical tests
- Geographical and floral-based NMR fingerprinting of authentic Indian Honey
- Development of testing methodologies and protocols for NMR analysis of Indian Honey
- NMR Testing of Indian Honey for adulteration, quality, geographical /floral source

The NMR center would develop the fingerprinting of Indian honeys, thereby complementing information from other analytical tests used for honey analysis such as LC-MS, HPLC, pollen micro-graphs, etc. This work is in progress with a strong collaboration between CSIR-National Chemical Laboratory (NCL) and KVIC-Central Bee Research and Training Institute (CBRTI).

The NMR center would develop the fingerprinting of Indian Honey, thereby complementing information from other analytical tests used for honey analysis, such as LC-MS, HPLC, pollen micrographs, etc. This work is in progress with a strong collaboration between CSIR-National Chemical Laboratory (NCL) and KVIC-Central Bee Research and Training Institute (CBRTI).

Chaitanya Sampat
Sayan Pal
Amol Kulkarni
in *Chemical Engineering Research and Design*

Effect of wettability on hydrodynamics and mass transfer in capillary microreactors

It is known that the mass and heat transfer rates can be increased by an order of magnitude in microreactors. This usually happens because such reactors provide enhanced surface area and better contact. Therefore, microreactors have been the focus of research on process intensifi-cation.

This article discloses how mass transport rates can be improved in a special but commonly encountered case of heterogeneous (immiscible) liquid phases being brought in contact for reactions or separations. Specifically, this article provides new knowledge on how 'wetting' i.e., the formation of a continuous film on the inner wall of a capillary microreactor by the continuous liquid phase improves the mass transfer rates.

The investigators found that though several correlations have been reported for estimation of mass transfer coefficients, they do not take into account the implications of varying wettability on mass transfer performance. During laminar flow of a heterogeneous liquid mixture in a capillary geometry, the immiscible phase forms rod-like structures (slugs) interspersed in the continuous liquid phase. In this flow pattern, the wettability and surface tension regulates the ease with which the slugs travel throughout the channels. Hence, further knowledge of these effects is required for designing micro and milli reactors to ensure good mixing performance. In the present work, the investi-gators have used a very precise experimental set up (Fig. 1) comprising two capillaries of the same inner diameter but having different wettability properties to measure mass transport performance. A conductivity meter was used to assess mass transfer rates and a digital camera was used to measure the slug flow pattern. Heterogeneous systems of water-kerosene and water-toluene were used as the heterogeneous liquid mixtures with propionic acid as a solute. By developing models and validating them using experimental data, the authors have provided deep understanding on how mass transfer coefficients in microfluidic segmented flow are influenced by wall-wettability, slug velocities and pressure drop. The extent of wettability decides the slip velocity at the wall (i.e. the difference in the velocity between the wetting fluid and the wall). Higher slip velocity results in sharp shear rate variation over the capillary cross-section and thus facilitates better mass transfer due to internal circulation in the slugs.

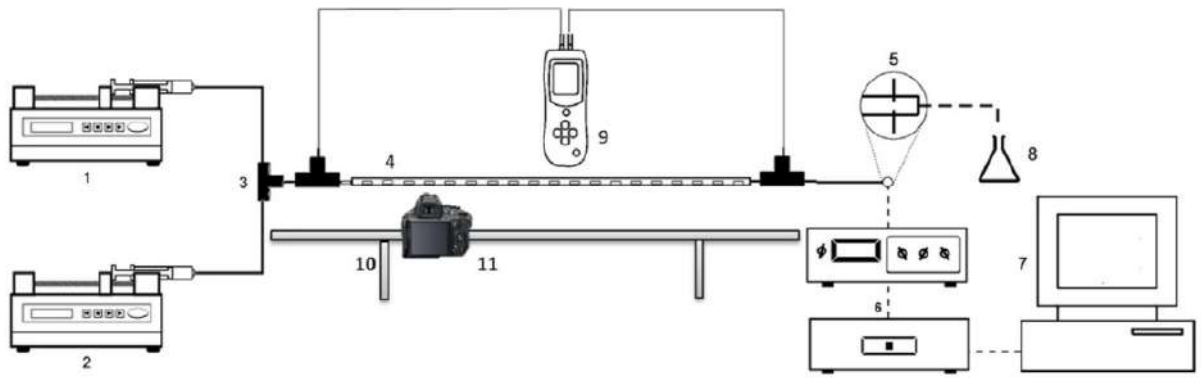


Figure 1: *The experimental setup. 1 & 2 - syringe pumps, 3 - T-junction, 4 - capillary. 5 - conductivity probe, 6 - conductivity meter and data translation unit, 7 - computer, 8 - outlet collection, 9 - manometer, 10 -camera rail, 11 - DSLR camera.*

	Kerosene - Glass	Toluene - Glass	Kerosene- Teflon	Toluene - Teflon
Uniform Slug Flow	$Q_W = 0.2$; $Q_K = 0.1$	$Q_W = 0.1$; $Q_T = 0.2$	$Q_W = 0.5$; $Q_K = 0.5$	$Q_W = 1$; $Q_T = 1$
Parallel Flow	$Q_W = 20$; $Q_K = 20$	$Q_W = 12$; $Q_T = 12$	Not Observed	$Q_W = 15$; $Q_T = 15$
Stagnant Boundary Layer	$Q_W = 0.25$; $Q_K = 0.5$	$Q_W = 0.5$; $Q_T = 0.5$	$Q_W = 1.75$; $Q_K = 1.75$	Not Observed

Figure 2: *Types of flows observed in 2.12 mm diameter capillaries. All flowrates Q are in mL/min. Subscripts W and K stand respectively for water and kerosene.*

Citation

Sampat C, Pal S, Kulkarni AA. Effect of wettability on hydrodynamics and mass transfer in small capillaries. Chemical Engineering Research and Design. 2021 May 1;169:265-74.

Atanu Das,
in The Journal of Physical Chemistry B

A protein-based indicator for the prediction of clinically-observable symptoms of Alzheimer's disease

In aged population, symptoms such as memory loss, moodiness, anxiety, depression, and agitation can sometimes be due to a progressive deterioration of the structure and function of neurons or brain cells. One of the ways the deterioration is seen to occur in the nerve cells is where the long chains of some protein molecules fold in inappropriate ways. At a younger age, the wrongly-folded structures get excreted out of the body, however, this process slows down with age, and the damaged structures continue to be deposited in or outside the cells as 'aggregates', creating further disfunction. Alzheimer's disease (AD) is one such neurodegenerative disease, in which the amyloid precursor protein gives amyloid-β peptide, a product whose wild-type and mutated forms self-assemble into the disease-causing fibrillar aggregates. Currently without a cure, this debilitating condition can only be managed with the help of pharmaceutical drugs that help slow down its progress. Particular challenges to the treatment are that the actual onset of AD is not known until the symptoms are clinically observed. Further, the doctors do not have a way to know how much time is available for the treatment as numerous novel harmful mutations continuously appear to add to the complexity of the disease. Such mutations to the misfolding protein molecules are seen to affect the progression of the disease in diverse unpredictable ways. If the clinicians could have the ability to predict the actual onset and 'survival time' of AD, based on body parameters other than clinical symptoms, they could treat and control the disease better. Further, if these parameters were such that they would not vary with geography, temperature, food, habits, and so on, then the prediction would be much more robust and reliable.

Dr. Atanu Das, a scientist at CSIR-NCL, initiated research work in this direction, by bringing to it his computational modelling expertise and research experience in protein dynamics; particularly with aggregates and proteins that 'misfold'. In the present study, he endeavoured to identify simple measurable physical parameters of the relevant protein, which could be correlated with the clinical observations and hence used to predict and control. As a first step, he explored the static properties of the protein sequence, such as polarity.

These however did not correlate. The next step was to examine the dynamic properties of the fibrillar structure. These too did not suggest any correlation with clinical data. The third level was the thermodynamic properties of the fibrillar structure. Dr. Das found a robust and statistically significant

negative correlation between the property of 'binding affinity' of a protofilament to its protofibril and clinical observables. For example, for the mutated (familial) amyloids, a lower value of age of AD onset means faster emergence of the disease; and a lower value of age of death means quicker maturation of the disease; all of which are contingent upon the higher binding affinity of the protofilament to its protofibril. Dr. Das and his colleagues are building on this research to explore if this kind of correlation can be seen for another protein related to AD, and even diverse proteins that are not related to the same disease. A general predictor such as this would be of immense help to clinicians and drug-designers. This work also highlights the long-term importance of advanced computa-tional power in any cuttingedge research. Though awareness about neurogenerative diseases is still low in India, and clinical data is not reliably documented, modern urban lifestyle suggests that the number of patients is going to rise significantly over the next decade. In order to provide timely treatment to the patients, collaborations that support smalls-cale experimental validation of the computationally-derived predictors is an essential next step, before going into full-fledged clinical trials.

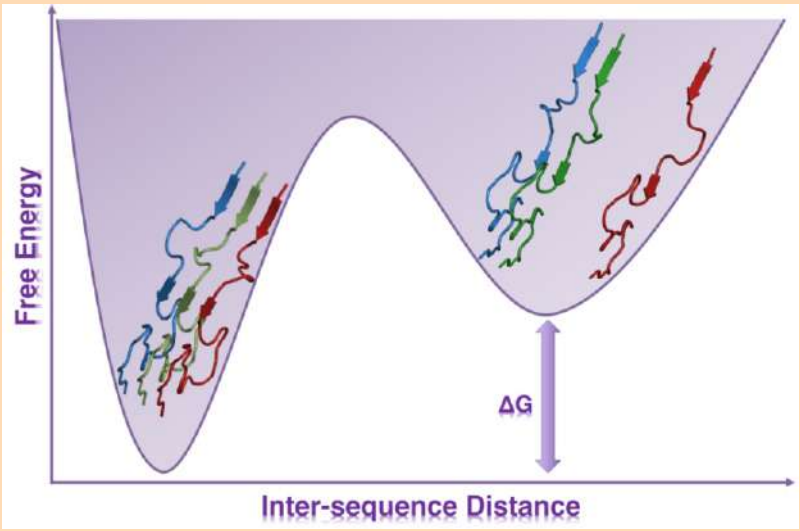


Figure 1: *The inter-sequence distance serves as the best reaction coordinate to exemplify the extent of protofilament affinity.*

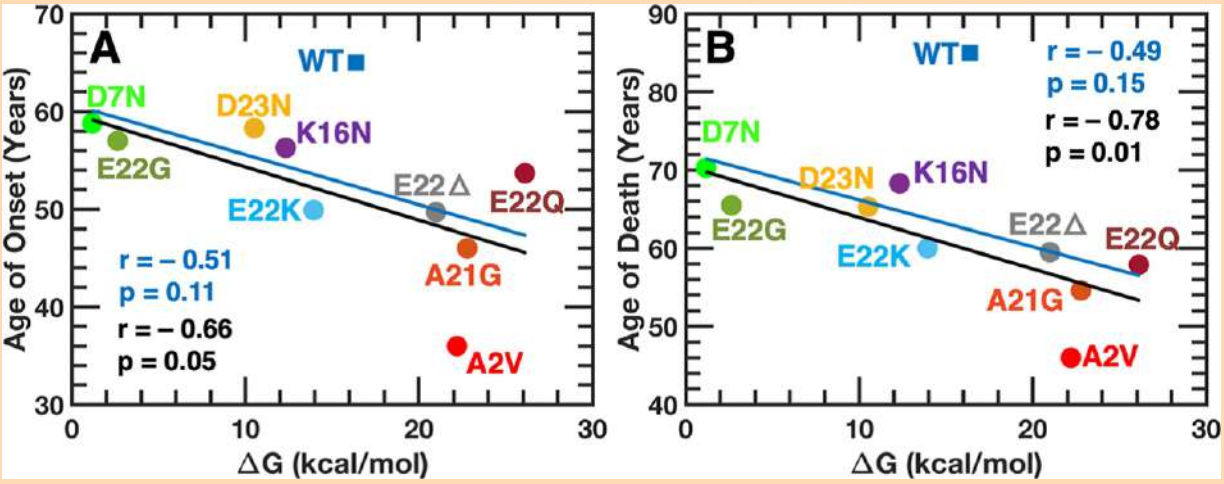


Figure 2: *Comparison between the simulated thermodynamic property - the binding free energy of a protofilament to its protofibril - G(kcal/mol) and the clinical observables of AD (A) age of onset and (B) age of death.*

Citation

Das A. Systematic Search for a Predictor for the Clinical Observables of Alzheimer's Disease. The Journal of Physical Chemistry B. 2021 Nov 1;125(44):12177-86.

Deepa Mehta,
Tejas Chirmade,
Aatir A. Tungekar,
Kayanat Gani, and
Rahul Bhambure, *in*
Biochemical Engineering Journal

Balancing the gene-expression of light and heavy chain polypeptides for better yield and lower costs of antibody fragment (Fab) drugs

Auto-immune disorders and cancer are increasingly being treated using complex but efficacious biosimilar pharmaceutical drugs that are manufactured inside host-cells such as bacteria. These drugs are essentially proteins, and some of the most important among these are monoclonal antibodies (mAbs) and smaller-sized fragments of antibodies (Fabs). Fabs offer many advantages over mAbs in terms of simpler production process, lower cost, and treatment. Manufacturing complex biosimilar drugs is more expensive that small-molecule drugs, and hence improving the manufacturing efficiency is a major area of cutting-edge research in order to bring the costs to within affordable range.

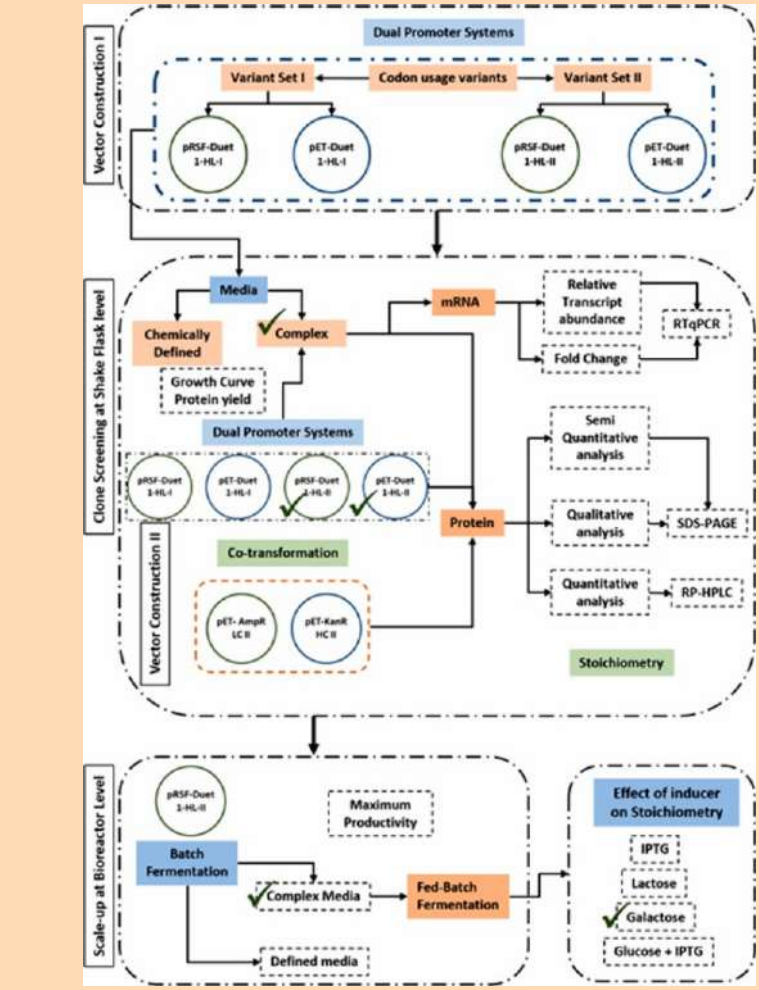
The production of Fabs in host cells involves synthesis of two polypeptide chains of Fabs, heavy chains (HC) and light chains (LC) . It is essential to balance the ratio of HC and LC to obtain a native and biologically active antibody fragment. If either of the two is produced more, it consumes the host cell's metabolic resources, leaving less available for the other. This results in wastage of resources and a lower overall process yield. A balance of both is thus essential for better manufacturing economics as well. This, however, may be easier said than done, as each of these polypeptides may have its own optimal level of production. This can lead to unequal expression of the two chains, and formation of contaminants which are difficult to purify. A balanced expression of each polypeptide chain is thus a critical challenge for large-scale manufacturing of the antibody fragments (Fabs).

Dr. Rahul Bhambure and his team of researchers at CSIR-NCL set out to understand the parameters affecting the (unequal) expression of the HC-LCs, and to develop a way to balance the stoichiometric ratio. For this investigation, they selected the drug ''rHu biosimilar Ranibizumab as the model protein, which is produced through gene expression in a derivative of the *Escherichia coli* bacterium called E. coli BL21 (DE3). Ranibizumab is a biosimilar Fab being engineered to treat diabetic retinopathy and age-related vision loss.

The researchers explored two co-expression strategies; in the first they generated two different dual-promoter vectors to select the most appropriate combination in terms of stoichiometry and protein expression. In the second approach, a single-gene construct of the HC and LC was designed in two different vectors and co-transformed to compare with the dual promoter expression strategy. The researchers found that dual promoter strategy offered two-fold higher protein yield as compared to co-transformed clones. Expression of protein synthesis using microbial host

cell system involves use of various chemical inducers like IPTG. The researchers investigated the influence of four induction strategies, namely, IPTG, IPTG with glucose, and lactose and galactose (IPTG free), on the total yield and stoichiometry of HC and LC gene expression. This is the first report where galactose has been used as an inducer for expression of a Fab molecule. They demonstrated that natural sugars like lactose and galactose offer a cost-effective induction strategy compared to IPTG in terms of protein yield for rHu biosimilar Ranibizumab expression. These findings have been patented.

Going forward, this technology can be developed into a 'platform technology' which will enable the production of different types of antibody fragments, to treat a wider array of disorders and diseases more effectively and efficiently. This is the first such development from India, and the scientists have initiated various sponsored projects with renowned pharmaceutical companies in India, to take the work forward. Moreover, building on this work and experience, the doctoral and other research scholars graduating from Dr. Bhambure's team have found good career opportunities in India and abroad in the areas of recombinant protein production and biopharmaceutical industries.



Citation

1) Mehta D, Chirmade T, Tungekar AA, Gani K, Bhambure R. Cloning and expression of antibody fragment (Fab) I: Effect of expression construct and induction strategies on light and heavy chain gene expression. Biochemical Engineering Journal. 2021 Dec 1; 176:108189.
2) IPTG free induction for expression of biosimilar rHu Ranibizumab antibody fragment using E. coli. Indian Patent Application 201911000314.
3) Cloning and expression of in-vivo refolded antibody fragment, Indian Patent Application 201911013248.
4) A cloning, expression and refolding platform for preparing antibody fragments. Indian patent application. Indian Patent Application: 201711010410. Published document WO2018211529A1.
5) A process for the purification of recombinant antibody fragment. Indian patent application. Indian Patent Application: 201711017654. Published document WO2018173075A1

Tanmay Dharmadhikari, Vinay Rajput, Rakeshkumar Yadav, Radhika Boargaonkar, Dhawal Patil, Saurabh Kale, Sanjay P. Kamble, Syed G. Dastager, and Mahesh S. Dharne,
in Science of the Total Environment

SARS-CoV2 Surveillance in Wastewater as a Cost-effective Early-warning System for Densely Populated Areas

SARS CoV2 pandemic raised an unprecedented health emergency and shortage of consumables for RT-PCR testing. The wide-spread transmission of SARS-CoV 2 also made it challenging to test every individual in densely populated countries. However, RNA fragments of SARS CoV2 are known to be shed in faeces, and such reports were published across the globe. The total number of individuals exposed to SARS-CoV2 based on the detected viral gene copies per litre of sewage water, and viral particle shedding per individual, suggest that sewage-based surveillance can be an effective approach to study the infection dynamics to help in an efficient management of the SARS-CoV2 spread. Testing of sewage/ wastewater can serve as a cost-effective early warning system and help officials keep track of coronavirus fragments at an early stage even among asymptomatic persons. Such wastewater surveillance has been utilized in the past for Poliovirus, Enterovirus, Influenza virus. Scientists at CSIR-NCL undertook the project to develop such a surveillance system, with support from Science Engineering and Research Board (SERB), in collaboration with Pune Municipal Corporation (PMC) and NGO Ecosan Services foundation. Four sewage treatment plants, a drain entering the river, and an STP plant at the NCL campus was selected for the study. Wastewater sample collection started in December 2020.

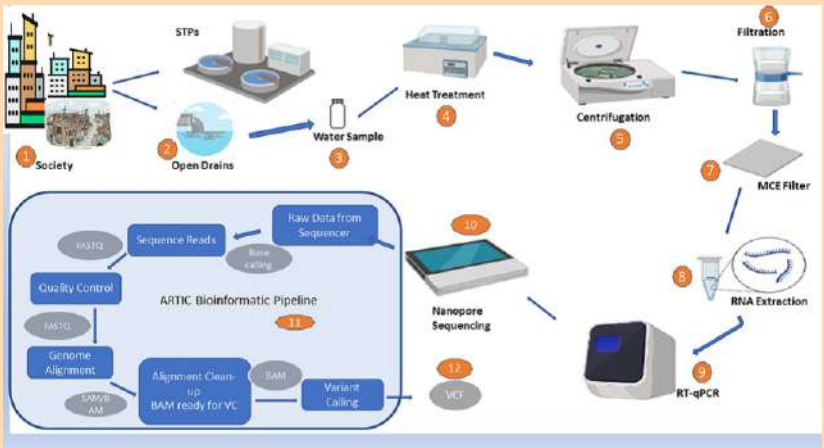


Figure 1: *Workflow for detection of SARS-CoV2 RNA fragments from sewage water*

NCL researchers detected the fragments of SARS-CoV2 RNA in sewage samples using quantitative RT-PCR assay. Positive sewage RNA samples during December 2020 to March 2021 were directly sequenced to understand mutations in the wastewater samples. ARTIC V3 based amplicon strategy and Oxford Nanopore sequencer were used for the sequencing.

The analysis revealed 108 mutations across six samples categorised into 39 types, spanning the whole genome of SARS CoV2. The scientists reported the occurrence of mutations associated with Delta variant lineage in March-2021 samples, a Variant of Concern (VoC) responsible for the rapid increase in infections. The study also revealed four mutations; S:N801, S:C480R, NSP14:C279F and NSP3:L550del not currently reported from wastewater or clinical data in India, but reported worldwide. Further, a novel mutation NSP13:G206F mapping to NSP13 region was observed from wastewater. Notably, S:P1140del mutation was detected in December 2020 samples while it was reported in February 2021 from clinical data, indicating the instrumentality of wastewater data in early detection. This is the first study in India to demonstrate utility of sequencing in wastewater-based epidemiology to identify mutations associated with SARS-CoV-2 virus fragments from wastewater as an early warning indicator system. The NCL team has been providing weekly reports of viral load in Pune's wastewater to the Municipal Authorities on a weekly basis for the past two years. The efficacy and utility of the methodology was also presented to policy makers in multiple forums, and the team's efforts were widely appreciated.

Citation

Dharmadhikari T, Rajput V, Yadav R, Boargaonkar R, Patil D, Kale S, Kamble SP, Dastager SG, Dharne MS. High throughput sequencing based direct detection of SARS-CoV-2 fragments in wastewater of Pune, West India. Science of The Total Environment. 2022 Feb 10;807:151038.

Durba Sengupta and Anu Raghunathan,
in Resonance

Rise of the Superbugs: What We Need to Know - Overview of Antimicrobial Resistance

NCL scientists often write articles with the intention of spreading an important scientific message to a wider audience. This paper on the important topic of antimicrobial resistance was published in Resonance, a popular science education journal that is read by undergraduates and teachers across wide ranging disciplines.

Many bacteria dwell inside the human body, and perform useful functions, including the digestion of food. However, some bacteria entering the human body can be harmful, causing illness, and requiring the help of medicines that control the infections. Antibiotics are such medicines that arrest the growth and functioning of the harmful bacteria. Natural antibiotics were discovered when Dr. Alexander Fleming accidently found that a fungus was killing the bacteria he was growing in his laboratory.

Commonly used antibiotics such as Penicillin target the proteins (enzymes) that make the components of the bacterial cell wall and cell membrane, thus stopping the bacteria from building or repairing them. Several other antibiotics try to block the synthesis and repair of DNA (deoxy-ribonucleic acid), the central molecule in all cells that encodes genetic information. Another target of antibiotic drugs (e.g. Erythromycin) is the ribosome, the machinery that makes more proteins. If the bacteria can no longer make their own cell components such as cell wall, DNA, or protein, they die.

However, bacteria adapt and evolve at a fast rate, and can develop resistance to the antibiotics. For instance, Staphylococcus gets resistant by building bacterial cell walls faster than the antibiotics can break them down. Other bacteria destroy the antibiotics before they are effective. Bacteria acquire such resistance due to random mutations in their DNA (or genome). They also exchange genes through the process of gene transfer, swapping their genes for resistant genes from other - even dead - bacteria. Efflux pumps are proteins, present in many organisms, that help 'good' bacteria pump out toxins such as heavy metals and pollutants. However, multidrug resistant bacteria use the efflux pumps to pump out different kinds of antibiotics. Salmonella containing the multidrug resistant pumps are a concern in the context of food-related infections. Bacteria such as Escherichia coli and Klebsiella pneumoniae synthesise a protein named 'New Delhi metallo-enzyme 1 (NDM-1)' that can modify the chemical structure of antibiotics (called beta-lactams). The gene to produce NDM-1 can spread through gene transfer, making it particular fast in spreading antibiotic resistance. Repeated and improper uses of antibiotics are the primary

causes of the increase in drug-resistant bacteria. Patients who do not consume the prescribed dose, expose the harmful bacteria inside their body to nonlethal quantities of the drug. The bacteria that survive the low amounts of antibiotics become stronger and thrive, developing drug resistance. Similarly, excess use such as antibiotics added to food (for preservation), livestock (for health of animals), and fisheries help in increasing bacterial antibiotic resistance.

This is a serious health risk, as the currently treatable bacterial infections, such as pneumonia or tuberculosis, will have no effective medicines if the harmful bacteria develop drug resistance. In India, a study led by Dr. Laxminarayan from the Center for Disease Dynamics, Economics and Policy (New Delhi) reported an increasing resistance to antibiotics that are used as a last-resort measure. Similarly, Dr. Sharma and co-workers from WorldHealth Organization (WHO) showed that in Salmonella typhi, the bacteria that causes typhoid, resistance to common antibiotics has increased from 8% to 28% in the last six years. Antibiotic resistant bacteria are present not just in hospitals and clinics, but were detected in chicken and fish as well. Several waste-water treatment plants were found to have high levels of antibiotic resistant organisms. CSIR-NCL researchers Deepanwita Banerjee and Dr. Anu Raghunathan conducted a survey among 500 individuals, in 2017-18. They found that even educated individuals were not sufficiently informed and careful about their responsibility in regarding antibiotic medicines.

1) Only 4 had the correct knowledge, attitude and practices related to the use of antimicrobials.

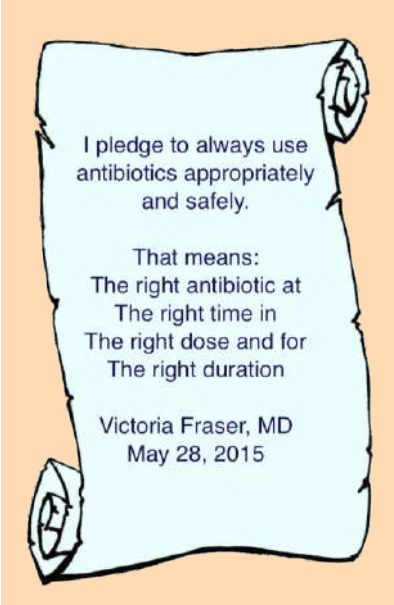
2) 1 in every 10 people self-medicated, without doctor's prescription.

3) 1 in 5 believed that antimicrobial resistance is not a serious issue.

4) 47% were unaware of the differences between over-the counter (OTC) drugs and antibiotics.

5) 20-25% bought antibiotics without prescription or started an antibiotic course by calling a doctor and believed dose-skipping does not contribute to antibiotic resistance in microbes.

In order to contain antibiotic resistance, a set of regulations were formulated by the Indian Health Ministry, to discourage and limit the over-the-counter sale of antibiotics. This is the Red Line campaign – which demands that prescription-only antibiotics be marked with a red line. Citizens need to join this effort by never taking antibiotics without doctor's diagnosis and prescription, and taking the correct amount of antibiotics at the correct time, to ensure that the harmful bacteria are killed, not allowed to evolve drug resistance.



Citation

Sengupta D, Raghunathan A. Rise of the Superbugs: What We Need to Know. Resonance. 2021 Sep;26(9):1251-66.
See also:
Banerjee D, Raghunathan A. Knowledge, attitude and practice of antibiotic use and antimicrobial resistance: a study post the 'Red Line' initiative. Current science. 2018 May 10:1866-77.

Ashley Sreejan,
Mugdha Gadgil,
and Chetan J. Gadgil,
in Journal of Biotechnology

Predicting the Cellular Uptake of Multiple Amino Acids For Better Quality and Lower Costs in Biosimilar Drug Production

Biosimilar pharmaceutical drugs are complex macromolecules that are similar to those found in nature, but are intentionally synthesized artificially inside cells. For commercial production of the drugs, these special 'recombinant' cells are carefully 'cultured' by supplying appropriate nutrients for their growth and performance. Amino acids (AA) play a major role in both nourishing the cells and in carrying out the process of synthesizing the required proteins (drugs) in these cells. In this billion-dollar industrial-scale process, it is very crucial to estimate the appropriate amounts of AAs in the culture medium, so as to maintain the nutrient quantities required by the cells. This is necessary to prevent depletion, improve efficiency, and thus minimize the cost of drug production. However, quantifying the required AA composition has proved challenging due to the complex nature of the mechanism of AA uptake by the cells, as well as the effect various AAs have on each other's uptake.

The uptake mechanism involves various proteins on the cell membranes that control the transport of AAs into the cell. These specialized proteins, called transporters, have diverse mechanisms of transport, some being unidirectional, others bidirectional, and so on. Quantify-ing AA would involve combining all these individual transport mechanisms and their impact on each other as well. This combinatorial nature of the problem makes it too complex and tedious to address experimentally.

Dr(s) Mugdha Gadgil and Chetan Gadgil, along with researcher Ashley Sreejan at CSIR-NCL, asked the question whether it would be possible to computationally predict the rate of AA entering the cells, if the composition inside and outside was known. They first selected the specific case of recombinant Chinese hamster ovary (CHO) cells, for which literature provided data of about 17 to 20 kinds of transporters and mechanisms involved in the AA transport. The team used an elegant way to simplify the complex kinetics, by focusing on a limited window where the concentration is constant. This enabled them to develop a novel mechanism-based computational/ mathematical model of CHO's AA transport system. It was the first such comprehensive model for AA transport in CHO cells, or any mammalian cell type.

The model was also validated by experimental data from literature, which was not used while developing the model. Using the model, they then designed a powerful software tool for combinatorial AA transport to predict uptake fluxes from the AA concentrations. This tool, available in open domain as a simple Excel

sheet, can also be used for cells other than the CHO cells, if the concentrations of AA are known.

[1]DNA, proteins, cells, or organisms made in laboratory, by combining genetic material from two different sources.

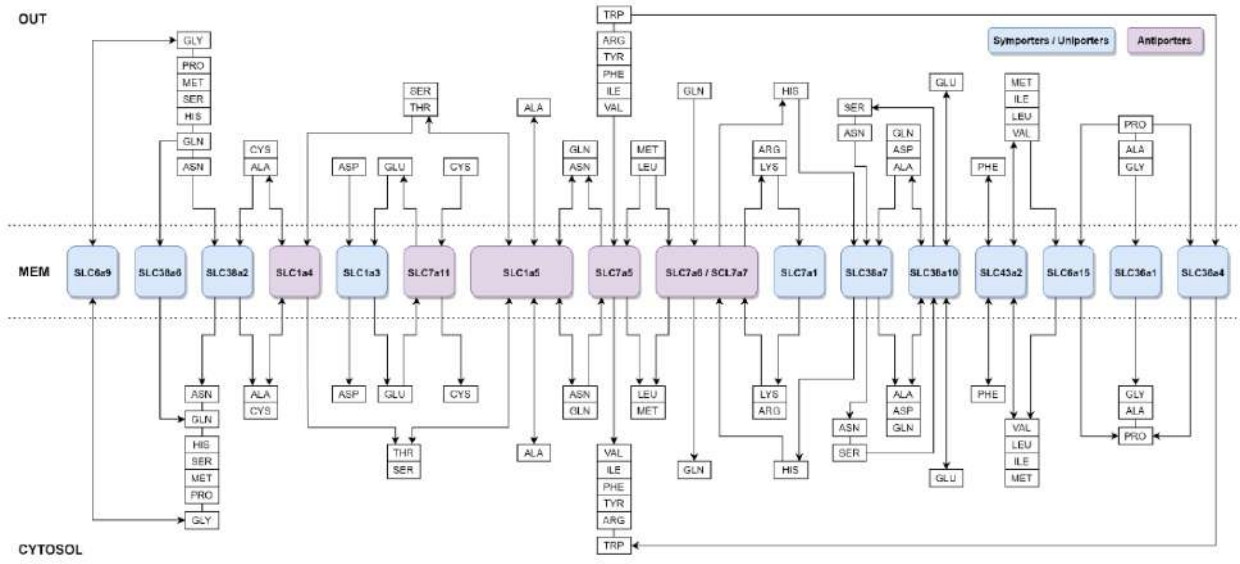


Figure 1: *Amino acid transport system in CHO cells.*

Indian pharmaceutical industry needs to import thousands of litres of the nutrient medium, and this reflects in the high cost of many drugs. Optimizing the use of the media will help the industry reduce the manufacturing costs, and make the medicines available at affordable prices. Moreover, ensuring exact quantities and processes will also be required by bio-pharma regulations, in order to maintain high quality. The current research makes a direct and concrete contribution in this direction.

Citation

Sreejan A, Gadgil M, Gadgil CJ. Mathematical model of the multi-amino acid multi-transporter system predicts uptake flux in CHO cells. Journal of Biotechnology. 2022 Jan 20;344:40-9.

Tanuja P. Gurav,
Bhushan B. Dholakia,
and Ashok P. Giri,
in Phytochemistry Reviews

Strategies to Improve the Quality and Yield of Essential Oil from Tulsi – A Review

Holi basil (commonly known as Tulsi) and Lemon basil, are only a few minty species from the genus Ocimum. These aromatic plants have useful medicinal properties. They also synthesize essential oils, which have a growing commercial demand in the food, health, and cosmetic industry.

In general, natural compounds are free of manufacturing defects and by-products (for example, racemic mixtures), which are prevalent in synthetic metabolites. Natural products however require severe extraction processes and also suffer from the diversity of chemical composition of the various species. It is therefore advantageous to improve the yield and quality of the naturally occurring compounds such as essential oils. In the present paper, a review of the chemical diversity of several Ocimum species has been presented by CSIR-NCL scientist Dr. Ashok Giri and researchers Tanuja Gurav and Bhushan Dholakia. They discuss the potential causes, mechanisms, and the role behind the vast diversity of Ocimum chemotypes. Along with the approaches of classical breeding, interspecific hybridization, and tissue culture, the review reports various biotechnological approaches to improve the Ocimum chemotypes for better essential oil yield and composition. This is the first such attempt to summarize all available chemotype data from Ocimum species since the 1999 review by Holm and Hiltunen.

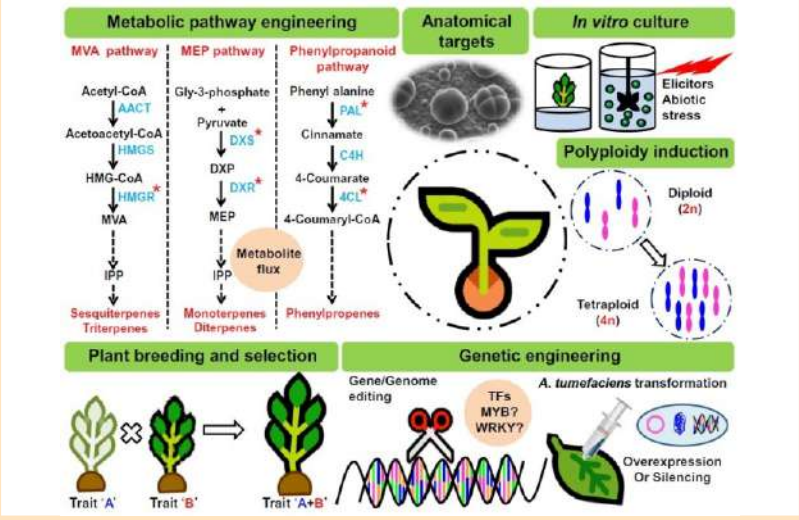


Figure 1: *Different strategies that can be employed for chemotype improvement in Ocimum species. This includes classical breeding methods and advanced biotechnological approaches, such as metabolic engineering, genome editing, transgenic, and in vitro culture approaches. *Indicates enzyme controlling metabolic flux and multi-steps indicated by dashed lines.*

This important review suggests that advanced biotechnological approaches, such as genome editing tools, will help in understanding the biosynthetic pathways of specialized metabolites and provide an ideal option to improve essential oil yield and quality. However, a comprehensive metabolomic profiling of various organs and organelles will be necessary for fine-tuning of the biosynthetic pathways for important specialized metabolites. The researchers emphasize the need for extensive research aimed at the functional analysis of genes involved in the biosynthesis, regulation, and transport of specialized metabolites to enhance the market value of several Ocimum species and their chemotypes.

Citation

Gurav TP, Dholakia BB, Giri AP. A glance at the chemodiversity of Ocimum species: Trends, implications, and strategies for the quality and yield improvement of essential oil. Phytochemistry Reviews. 2021 Aug 2:1-35.

Farsa Ram,
Bipul Biswas,
Arun Torris,
Guruswamy Kumaraswamy,
Kadhiravan Shanmuganathan,
in Cellulose

Directional aerogels based on cellulose nanocrystals exhibit better compressibility and piezoelectricity

Cellulose is a naturally found polymer with many traditional applications. Recent advances have made it possible to develop nano-sized cellulose materials of superior mechanical properties, which can be used to make films, fibers, organogels and reinforcements in polymer composites. Yet another advanced material made from nanocellulose is low-density aerogel, which finds applications in adsorption, separation, energy storage, thermal insulation, electromagnetic interference shielding, and biomedical devices. However, these are constrained by the moderate compressibility and weak elastic recovery of the aerogels. In the present study, the researchers modified an ice-templating process and developed a new class of elastic nanocellulose aerogels that exhibit more than 90% elastic recovery at 50% strain, even after 100 cycles of compression. In an earlier work, Dr. G. Kumaraswamy et al. (Chem. Mater. 2014) at CSIR-NCL demonstrated that crosslinking a polymer during ice-templating rendered the polymer aerogels highly elastic to large compression, even at high inorganic loadings. Dr. K. Shanmuganathan and Dr. G. Kumaraswamy wanted to extend this to bio-derived nanomaterials such as cellulose nanocrystals (CNCs), which also exhibits piezoelectric behavior. Further, they hypothesized that if the aerogel walls comprised of piezoelectric CNCs that were aligned (anisotropic) in the direction of stress, they would exhibit better piezoelectricity compared to ones not so aligned (isotropic). Piezoelectricity is the phenomenon where materials generate electric charge due to change in electric polarization upon mechanically deformation. Applying a directional ice-templating process developed by Dr. G. Kumaraswamy et al. (Chem. Mater. 2014) to a CNC aerogel, Dr. K. Shanmuganathan and his team at CSIR-NCL developed an anisotropic CNC aerogel. This directionally-frozen aerogel as well as that prepared by isotropic freezing was then compressed and tested for decompression as well as piezoelectricity. It was found that the anisotropic aerogels generated at least twice as much voltage (0.84 V) as isotropic aerogels (0.32 V), especially, when force was applied in the direction of pore orientation. The force sensitivity of anisotropic aerogels was 89 mV/N, which is 3.7 times higher than that of isotropic aerogels.

Such highly compressible and elastic anisotropic CNC aerogels could be potentially used in a wide variety of applications in microenergy generation and powering of small electronic devices, as pressure sensors, impact detectors etc.

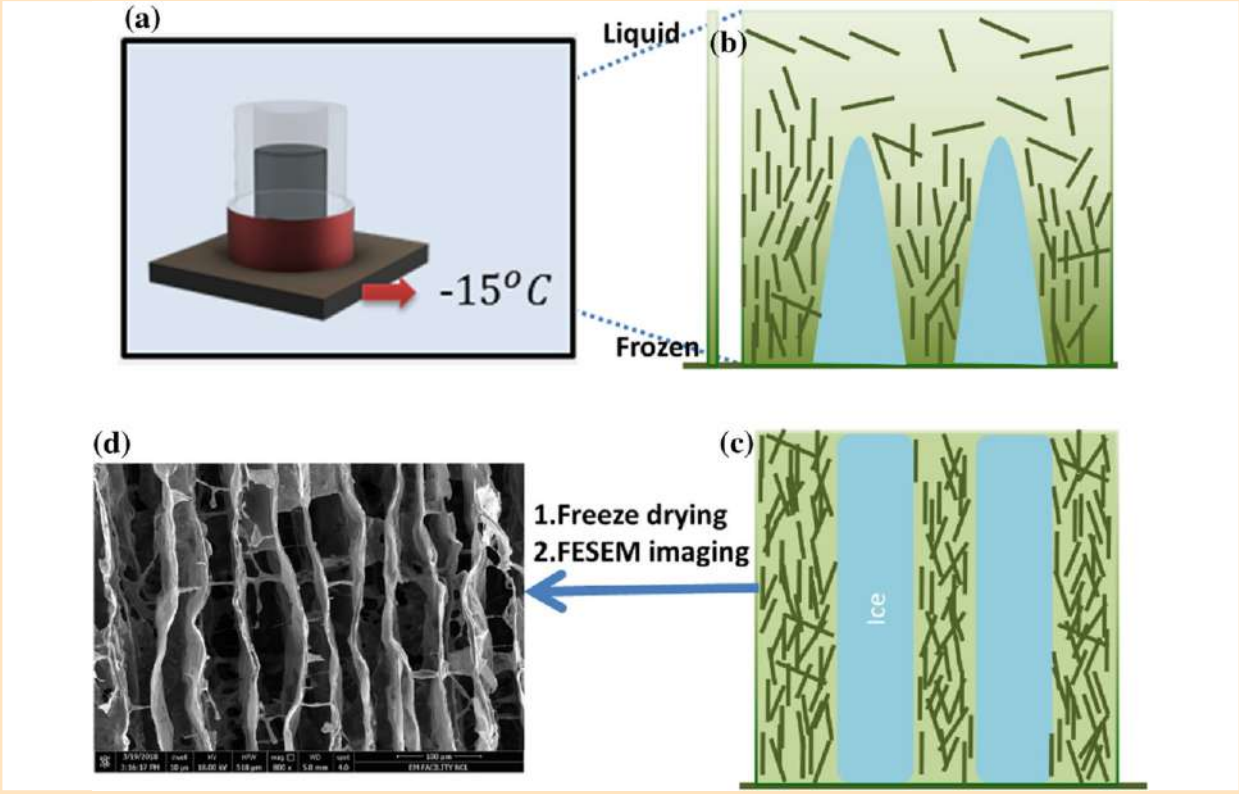


Figure 1: *Preparation of anisotropic aerogels, a setup, b and c mechanism and d FESEM image*

Citation

Ram F, Biswas B, Torris A, Kumaraswamy G, Shanmuganathan K. Elastic piezoelectric aerogels from isotropic and directionally ice-templated cellulose nanocrystals: comparison of structure and energy harvesting. Cellulose. 2021 Jul;28(10):6323-37.

Santosh Kumar Meena and Chandrakala Meena

In [Nanoscale, 2021, 13, 19549]

Shape control of gold nanoparticles: A microscopic perspective

Gold nanorods [GNR] are promising candidates for cancer therapy, medical imaging, sensing, and catalysis due to their tendency to self-assemble into complex 2D or 3D supramolecular structures, and facet specific chemical reactivity

These GNRs are synthesized by seed mediated crystallization, which facilitates the slow and asymmetric deposition of metal atoms using a mild reducing agent onto already existing small metal nanoseed particles (typically 3–4 nm) in the presence of an excess of surfactants. Shape modulation of nanoparticles is crucial for their tailored applications; however, it depends on surfactants, ions, reactants, and other additives present in the growth solution.

Here the authors have investigated the role of surfactants, their counterions (halide ions), silver ions, and gold reactant in the anisotropic growth of gold nanoparticles on polarizable surfaces of nanoseeds using molecular dynamics simulation models.

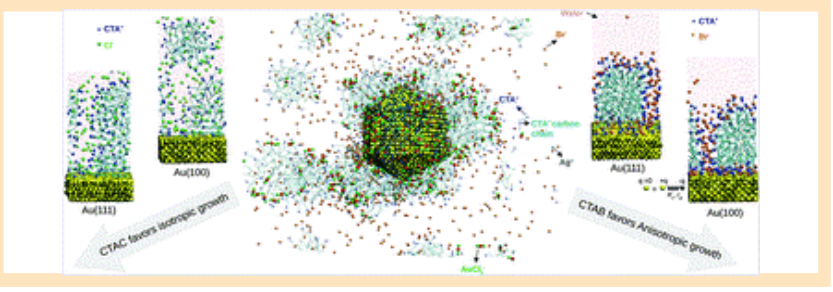
The planar surface models predict **a)** a 14%–16% increment in cetyltrimethylammonium bromide (CTAB) coverage on Au(111) and Au(100) due to the surface polarization effect. The CTAB micelle adsorbs compactly similar to that observed on non-polarizable surfaces.

b) The ethyltrimethylammonium chloride (CTAC) micelle remains in solution leaving the polarizable gold surfaces unprotected, similar to that observed with the non-polarizable surfaces, which favor isotropic growth.

c) The cetyltrimethylammonium iodide (CTAI) micelle adsorbs with higher surface densities than CTAB on all the surfaces.

The surface polarisable penta-twinned nanoseed model predicts the total surface coverage of the cetyltrimethylammonium cation (CTA+), Br– and Ag+ to be around two times higher on the side as compared to the tip of the nanoseed, leading to a 2.6 times higher initial rate of adsorption of $AuCl_2^-$ on the tip than on the side.

Predicted CTA+ surface densities on the tip and the side of the nanoseed are consistent with experimental results. The simulations explain the growth mechanism of anisotropic nanoparticles and the microscopic origin of their controlled shapes.



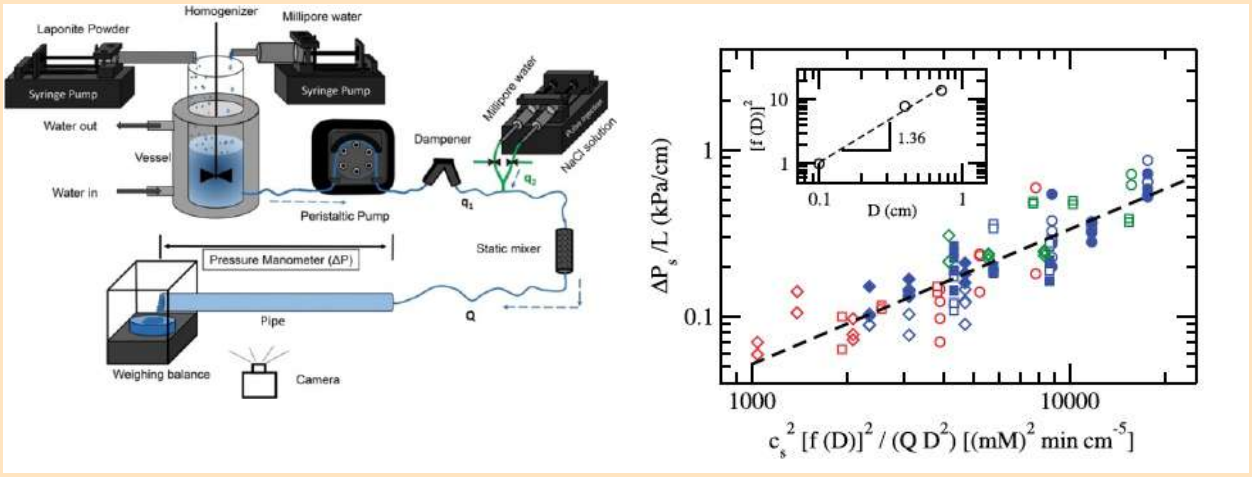
Prophesar M. Kamdi, Ashish V. Orpe, and Guruswamy Kumaraswamy

Slip behaviour during pressure-driven flow of Laponite suspension

Physics of Fluids May 2021 Typically, the oil or petroleum products get transported through pipelines which are laid over several kilometres across different regions. The flow in these pipelines is amenable to clogging over a period of time due to solidification of some of the transported constituents which accumulate over a period of time. The solidification happens due to variable temperature conditions experienced by the flowing material in different regions at different times. Such solidification followed by clogging is also observed in vastly different systems, for instance biliary tracts or cell flows in arteries in human bodies. Again, the solidification in such systems is due to accumulation of material over a period of time. The clearance of clogging in both these applications, then, requires introduction of some mechanical device in the system.

Motivated by the above phenomena, the investigators of the above article decided to explore the process of flow and clogging in a laboratory scale pipe through controlled experiments in the system as shown in the figure. The suspension of Laponite clay in water was used as a model material which is known to undergo gelation or solidification with time. The objective of the work was to understand the flow of such a material flowing through a pipe under an applied pressure for varying pipe diameters, lengths, Laponite concentrations and flow rates. The experimental results exhibited a decrease in the measured pressure drop with an increase in the flow rate. This was found to be in contrast with the well-known behaviour in fluid mechanics literature. The investigators reasoned that this possibly occurs due to the slippage of the material near the pipe wall and were able to explain this behaviour using theoretical considerations. The slippage was found to be due the yielding of the material at the pipe wall. The simplification of the theoretical model resulted in a simple scaling law to correlate the pressure drop with flow rate for different pipe diameters, lengths and Laponite concentrations as shown in the figure. The suspension of Laponite clay in water was used as a model material which is known to undergo gelation or solidification with time. The objective of the work was to understand the flow of such a material flowing through a pipe under an applied pressure for varying pipe diameters, lengths, Laponite concentrations and flow rates. The experimental results exhibited a decrease in the measured pressure drop with an increase in the flow rate. This was found to be in contrast with the well-known behaviour in fluid mechanics literature. The investigators reasoned that this possibly

occurs due to the slippage of the material near the pipe wall and were able to explain this behaviour using theoretical considerations. The slippage was found to be due the yielding of the material at the pipe wall. The simplification of the theoretical model resulted in a simple scaling law to correlate the pressure drop with flow rate for different pipe diameters, lengths and Laponite concentrations as shown in the figure. The scaling law, though a result of different ad-hoc assumptions, is seen to capture the behaviour correctly thereby allowing for the prediction of the material flow rate for specified operating conditions duly confirming the merit of the considered underlying physics. While the investigations in this work do not directly address the clogging problem mentioned above, it nevertheless lays the foundations for a more rigorous treatment of this very interesting and relevant problem in future.



***(Left)** Experimental set-up to investigate flow of Laponite suspension in a pipe*
***(Right)** Scaling law correlating pressure drop with several system and operating parameters.*

TS Khan,
D Singh,
PP Samal,
S Krishnamurty, and
P Dhepe, in
ACS Sustainable Chemistry & Engineering

Catalytic synthesis of high value chemicals from lignin

Replacing fossil fuels with biomass as the feedstock for the synthesis of high value intermediate chemicals is gaining importance and urgency in the context of climate change and sustainable development. Biomass - available in one form as abundant crop waste - has lignin, cellulose, and hemicellulose as its major constituents. Of these, lignin chemistry is the most challenging, and very few research groups in India focus on lignin valorization. Dr. Paresh Dhepe's research program at CSIR-NCL has proactively focused on this area, and has succeeded in generating new insights as well as patented processes over the last twelve years. Their pioneering work is also relevant for providing a circular economy pathway in the context of processing lignin that is generated as a byproduct in the paper and ethanol industries. Lignin comprises long chains of many different aromatic molecules. Breaking down (or 'depolymerizing') the long chains provides a mixture of aromatic monomers, which can be converted into valuable intermediate chemicals that can be used to make materials, drugs and fuels.

Various processes and catalysts have been developed across the world to convert the lignin monomers into chemicals. One such pathway is using molecular H_2 to carry out hydrodeoxygenation (HDO) reaction of oxygenated compounds such as lignin-derived phenolics. However, the need to run the HDO reaction at high pressure in expensive reactors discourages its use on an industrial scale.

To overcome this problem, the researchers investigated a different route namely, catalytic transfer hydrogenation (CTH) by using a catalyst based on Ruthenium (Ru) metal. The substrate used to demonstrate this concept was guaiacol, an aromatic oil derived from lignin. By performing HDO reaction of guaiacol using Ru/Al_2O_3-acidic catalyst, they

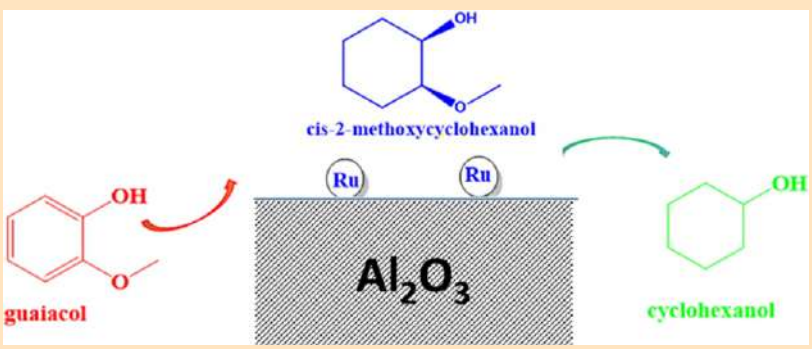


Figure 1: *Catalytic transfer hydrogenation of lignin-derived monomers over Ru catalysts*

achieved a significant yield of cyclohexanol at 225 °C in the presence of isopropyl alcohol (IPA) as the hydrogen source. The product cyclohexanol, currently produced from the fossil feedstock (phenol), is in high demand as an intermediate chemical for materials including nylon. The team also calculated the rate and activation energy of guaiacol conversion and correlated it with the catalyst morphology. They observed that the reaction intermediate is 2-methoxycyclohexanol, the cis-isomer of which rapidly transforms into the final product than the trans-isomer. This observation was further corroborated through a detailed density functional theory calculation done in collaborating with Dr. Kumar Vanka of the modelling and simulations group.

The researchers have designed the catalyst such that it can be recovered and reused. Further tests are necessary before it can be scaled up.

Citation

Khan TS, Singh D, Samal PP, Krishnamurty S, Dhepe PL. Mechanistic Investigations on the Catalytic Transfer Hydrogenation of Lignin-Derived Monomers over Ru Catalysts: Theoretical and Kinetic Studies. ACS Sustainable Chemistry & Engineering. 2021 Oct 13;9(42):14040-50.

S Rani,
SR Dash,
A Bera,
MN Alam,
Kumar Vanka, and
Pradip Maity,
in Chemical Science

An unprecedented chemistry approach for sustainable synthesis of pharmaceutical drugs

Pyridine, a single nitrogen-containing cyclic molecule, is a bulk chemical that was originally isolated from coal tar, but today it is industrially manufactured using ammonia and biomass-derived aldehydes. Pyridines containing chiral alkyl functional groups at different carbons and their corresponding saturated heterocycles are widely used as pharmaceutical drugs and biologically active compounds. While different functional groups can be readily attached to the nitrogen atom in pyridine, however it is extremely difficult to selectively functionalize the carbons in the cycle. Thus, imparting the functionalities to pyridine carbons is not only challenging due to the chemistry of carbon-hydrogen bonds, but the process also needs to be sustainable.

Dr. Maity's research group at CSIR-NCL focusses on developing new strategies and concepts for direct and diverse functionalization of such naturally abundant and functionally unmodified materials to make valuable chiral products. The effort is to reduce the required energy, materials, wastage, and cost; using a sustainable process. One important strategy to achieve this is using organic catalysts instead of transition metals that are expensive, scarce, and often toxic. This is one of the areas at the very cutting-edge of chemical sciences research. a mixture of aromatic monomers, which can be converted into valuable intermediate chemicals that can be used to make materials, drugs and fuels.

Various processes and catalysts have been developed across the world to convert the lignin monomers into chemicals. One such pathway is using molecular H_2 to carry out hydrodeoxygenation (HDO) reaction of oxygenated compounds such as lignin-derived phenolics. However, the need to run the HDO reaction at high pressure in expensive reactors discourages its use on an industrial scale.

To overcome this problem, the researchers investigated a different route namely, catalytic transfer hydrogenation (CTH) by using a catalyst based on Ruthenium (Ru) metal. The substrate used to demonstrate this concept was guaiacol, an aromatic oil derived from lignin. By performing HDO reaction of guaiacol using Ru/Al_2O_3-acidic catalyst, they In 2021, the Nobel Prize in Chemistry was awarded to two chemists for devising organo-catalysts, "An ingenious tool for building molecules". The growing interest in this area is primarily to drive asymmetric catalysis, which allows selective synthesis of only one of the chiral structures (mirror image) of a target molecule that is bioactive while the other is not.

In the present study, Dr. Maity's group attached alkyl functional

groups at pyridine nitrogen to form pyridinium salt, and then devised a sustainable catalysis platform to transfer the alkyl groups from nitrogen to different positions (carbon atoms) in the molecule. They investigated several known organo-catalysts with the aim of synthesizing chiral pyridines from pyridinium salts at quantitative conversion. After persistent efforts they selected organic phosphite based on its reactivity, and found it to perform effectively. Though already used in bio-active molecules, this was the first time organic phosphite was used as a catalyst in this kind of reaction. The reaction had a challenge however: The migration of a functional group from a nitrogen atom to C2 carbon anion (carbanion), as is the case in a pyridine reaction, requires highactivation energy and hence does not work easily (intermediate 5 from 3, Figure 1). However, the researchers succeeded in transferring a functional group from nitrogen to the second carbon in chiral pyridinium salt 1 by coupling this step (3 to 5) with an subsequent step (5 to 6, Step 5, Figure 1) that led to the formation of a far more stable aromatic molecule. This is an unprecedented reaction, and while the reactive interme-diates were too transient to be experimentally isolated, the C-N bond dissociation energy could be calculated and validatedthe catalytic role of phosphite computationally, in collaborations with Dr. Vanka's group. For another pathway of the reaction that starts with a racemic pyridine instead of a chiral one, the researchers also synthesized a new Phosphite molecule, to perform as a chiral catalyst. Unlike transition metals, the phosphite catalyst can be isolated and recovered for reuse after the reaction.

https://www.nobelprize.org/prizes/chemistry/2021/press-release/

The research group plans toexplore further, for a wider diversity of reactions, in order to establish if it is a general/ widely-applicable organic catalyst. They are also working to selectively transfer different functional groups from the nitrogen of pyridinium to the third carbon (C3) by developing the appropriate reaction conditions. Currently they are into developing new phosphite organo-catalysts, and want to expand the use of the 'new key' they have found, to unlock new knowledge.

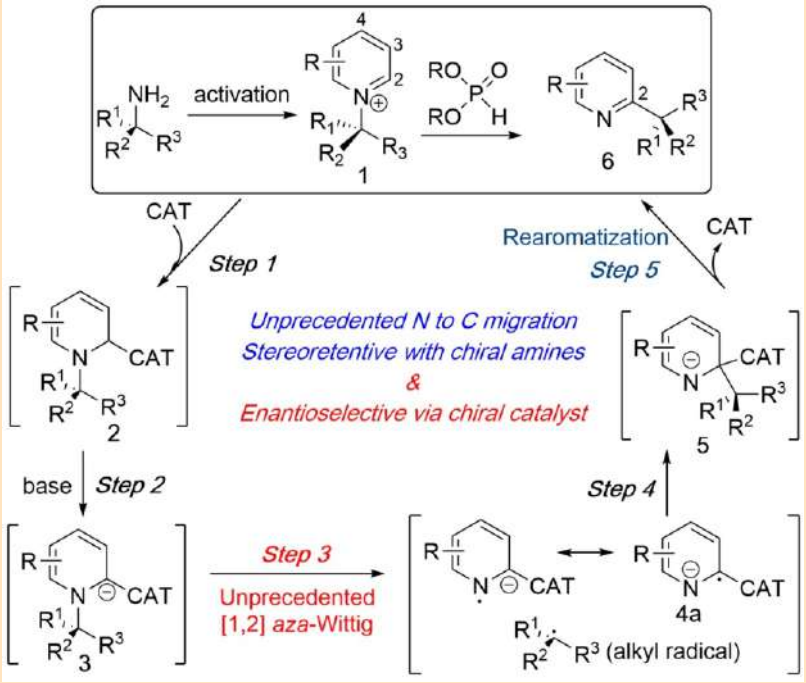


Figure 1: *Proposed N to C dissociative alkyl migration*

The paper was selected as Front Cover Art (14 July 2021, issue 26); in 2021 ChemSci Pick of the Week collection; and 2021 Chemical Science HOT Article Collection.

Citation

Rani S, Dash SR, Bera A, Alam MN, Vanka K, Maity P. Phosphite mediated asymmetric N to C migration for the synthesis of chiral heterocycles from primary amines. Chemical Science. **2021**; 12(26):8996-9003.

Pawan Dhote and Ramana CV,
in Advanced Synthesis & Catalysis

Efficient and Modular Synthesis Strategies for Natural Product Compounds

Natural products play an important role in the development of pharmaceutical drugs for a number of diseases. This paper reports an interesting synthetic methodology developed by CSIR-NCL scientist Dr. Ramana and AcSIR doctoral scholar Pawan Dhote, in the domain of developing simple catalytic tools for synthesis of diversified natural products.

Compared to randomly synthesized small molecules, natural products and natural product-like small molecules can move fast across critical pharmaco-kinetic and bioavailability barriers in biological systems and processes. For this reason, in the vital area of medicinal chemistry research, developing simple methods that aid the construction of the complex scaffolds of natural products and natural product-like small molecules holds a crucial position. In this context, designing efficient synthetic methods and flexible, modular design strategies that generate complexity along with the skeletal diversity are warranted. Dr. Ramana's research group has been engaging with this domain and developing such tools for more than a decade, where they have contributed several methods and synthesized a variety of natural products and their pharmaceutically-important analogues. In this particular study, the researchers asked the question if they can modulate the well-documented cyclization of 2- alkynylphenyl-azides to attain the skeletal diversity. The traditional methods focus on intra-molecular cyclization of 2-alkynylphenyl-azides, where gold salts play a unique role as catalysts. Dr. Ramana and Dhote showed - for the first time - that it is possible to interrupt the established intra-molecular cyclization process, and carry out an inter-molecular "nitrene transfer" by reacting 2-alkynylaryl azides with anthranil (or 1,2-benzisoxazole) to result into advantageous product diversification. In addition, the studies using 1,2-benzisoxazole derivatives revealed how the electron-withdrawing groups present on either of the substrates causes a switch in the competition between intra and inter molecular cyclization. Overall, the design and outcome of the current work is expected to provide a fresh perspective on the interruption of the metal carbene/ cyclization in the process of controlling the selectivity and expanding the scope of these reactions to construct diverse heterocyclic scaffolds. At the outset, a catalytic method for the synthesis of highly functionalized quinazoline/ (spiro)indol-3-ylidene derivatives has been developed. Considering the importance of the quinazoline core in medicinal chemistry, especially in the anticancer segment, this simple catalytic method of their synthesis is an important advancement

An example of this reaction is given in the following schematic.

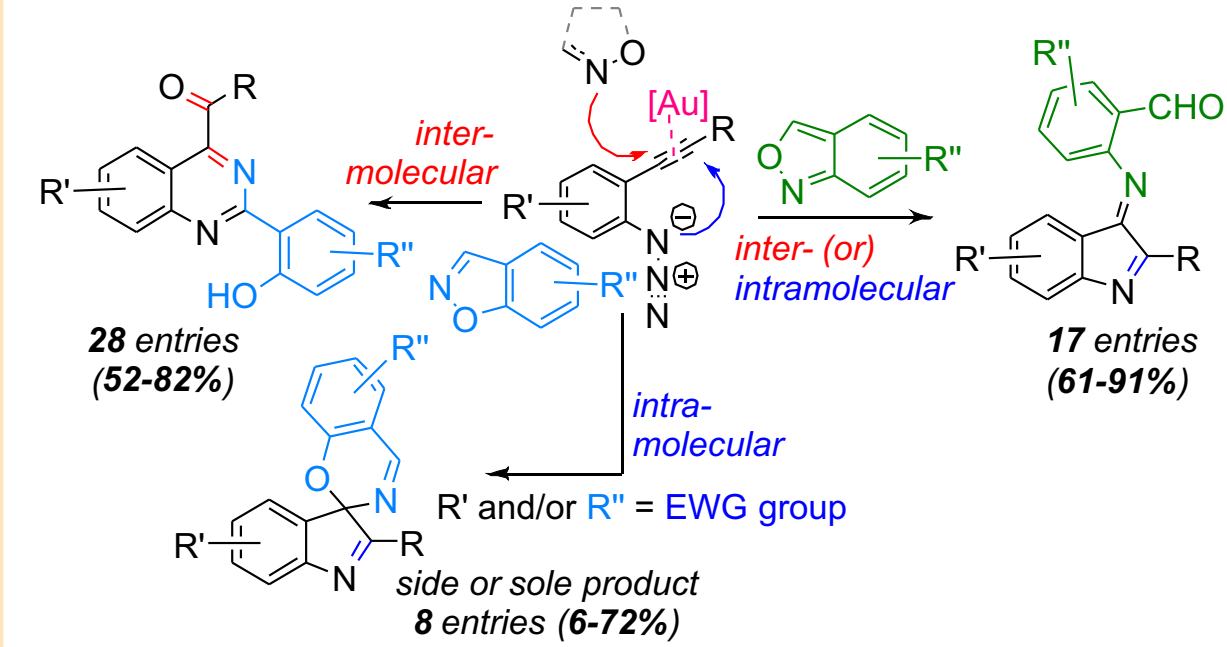


Figure 1: *Competing intra vs inter molecular nitrene transfer can happen when 2-alkynylaryl azide reacts in the presence of anthranil or 1,2-benzisoxazole thereby leading to different products*

Citation

Dhote PS, Ramana CV. Competing Intra-vs Intermolecular Nitrene Transfer in the [Au]-Catalysed Reaction of 2-Alkynylphenylazides. Advanced Synthesis & Catalysis. 2022 Mar 15;364(6):1122-33.

Aviral Kumar,
Amarnath Singam,
Guruprasadh Swaminathan,
Naresh Killi,
Naveen Kumar Tangudu,
Jedy Jose,
Rathna Gundloori VN, and
Lekha Dinesh Kumar,
in Nanoscale

A drug for combined delivery of gene silencing RNA and nano particles of Curcumin to treat solid tumors

CSIR-NCL scientist Dr. Rathna and CSIR-Centre for Cellular and Molecular Biology scientist Dr. Kumar along with their teams collaborated in this interdisciplinary study related to drug delivery for breast and colon cancer. The study provides empirical proof that the combinatorial approach involving RNA interference technology and nanotechnology is a promising alliance for next-generation cancer therapeutics.

Although different treatment modes are possible for cancer, most of them are associated with debilitating side effects and lower patient survival. More specific and targeted alternative therapies are necessary to overcome these limitations. RNA interference (RNAi), a post-transcriptional gene silencing phenomenon, is one possible way to target multiple genes involved in tumor progression, improving the therapeutic effect while minimizing the side effects. One of the significant tyrosine kinase receptors overexpressed in various cancers is the Ephb4 receptor. In the present study, the researchers aimed at silencing this Ephb4 receptor using the RNAi approach. In order to overcome the lack of safe and effective delivery methods for RNAi molecules; they used nanoparticles to deliver RNA-based therapeutics to the cancer site. They designed a combinatorial approach of using chitosan encapsulated nano-curcumin immobilized with Ephb4 shRNA and coated with Eudragit for enhanced targeting and uptake by the cancerous cells at the tumor site.

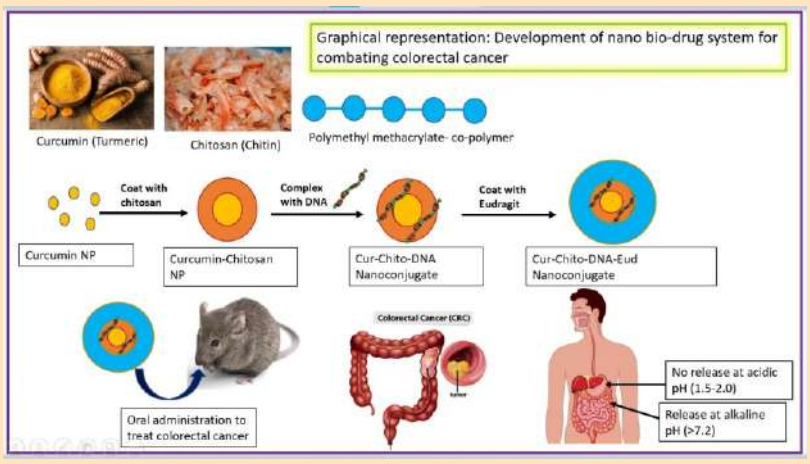


Figure 1: *Development of nano bio-drug system for combating colorectal cancer*

Dr. Kumar and team first made the RNAi conjugate; however, it was necessary to deliver it to the tumor site in a non-toxic manner. Towards this, Dr. Rathna and her team designed a curcumin-based conjugate

using electro-spraying technique to obtain a large yield. Since RNAi gets degraded in acidic pH, the conjugate needed an outermost coating to protect it in the oral pathway to colon through the acidic stomach. The coating also needed to dissolve when it reached the colon, in order to release the coated drug at the tumor site. While many polymers, such as Sodium alginate and Carboxy methyl cellulose (CMC), are suitable for this purpose, literature indicated that Eudragit (polymethyl methacrylate co-polymer) is a preferred and approved one. The researchers investigated and confirmed that it performed well for the present application. Yet another coating was provided inside the Eudragit shell. This comprised of positively-charged Chitosan, which dissolves in the slightly acidic pH near the tumor cells thereby releasing Curcumin. Its nano-size enables the drug particles to enter the tumor vascular openings. Curcumin nano-particles arrest the multiplication of the cancer cells, while RNAi silences the gene that causes cancerous behavior in cells. Both materials are bio-based; Curcumin is a natural plant extract, and the drug is a bio-molecule. The unique contribution of this study is the design that uses FDA-approved, non-toxic polymers to deliver the bio-drug to effectively suppress the tumor. The results demonstrated that the nano-RNAi bio-drug formulation efficiently regressed the tumors by effective knockdown of target genes with a corresponding increase in survivability, in mice models. This is the first report of a combinatorial drug, bringing together the synergistic effect of a natural compound (curcumin) with gene silencing using shRNA in solid tumors. This pre-clinical study puts forth a promising approach for using non-synthetic nanomaterials with RNA interference in biological systems for cancer therapeutics. The team has also filed a patent, in order to support technology transfer to interested pharmaceutical companies for clinical trials and commercialization.

Citation

Kumar A, Singam A, Swaminathan G, Killi N, Tangudu NK, Jose J, Rathna GVN, Kumar LD. Combinatorial therapy using RNAi and curcumin nano-architectures regresses tumors in breast and colon cancer models. Nanoscale. 2022;14(2):492-505.

Milan Kumar Bisai,
Tamal Das,
Kumar Vanka,
Rajesh G. Gonnade, and
Sakya S. Sen,
in Angewandte Chemie

Synthesizing doubly-bound silicon compounds that support a diversity of substituents on the two silicon atoms

Carbon-carbon double-bond compounds, such as ethylene, propylene, and similar alkenes are ubiquitous and provide essential and important industrial chemicals. Scientists have been exploring whether the next Group-14 and abundant element - Silicon, exhibits similar double-bonded compounds - called disilenes. The potential applications of these compounds as replacement to transition metal catalysts is based on their low energy gap. Disilenes could be used to activate substrates such as hydrogen or ammonia at ambient conditions. Another possible application of these coloured compounds is in the area of photoluminescence and optoelectronic devices. At a broader level, the abundance of silicon makes it an element of interest, and fundamental insights into its behaviour and properties will help in future sustainability.

A pertinent scientific challenge is how to synthesize disilenes. Unlike the carbon double-bond compounds that support a diversity of substituents on the two carbons, synthesizing similar unsymmetrical silicon compounds is difficult. In the present study, Dr. Sakya Sen and his research group at CSIR-NCL showed that it is possible to design and synthesize a series of unsymmetrical disilenes, where the substituents for the two doubly-bound silicon atoms are different. Moreover, the coordination number of one silicon is four, while that of the other is three, the hybridization being sp^3 and sp^2. This kind of double-bond versions with different coordination numbers are so far unknown in alkenes.

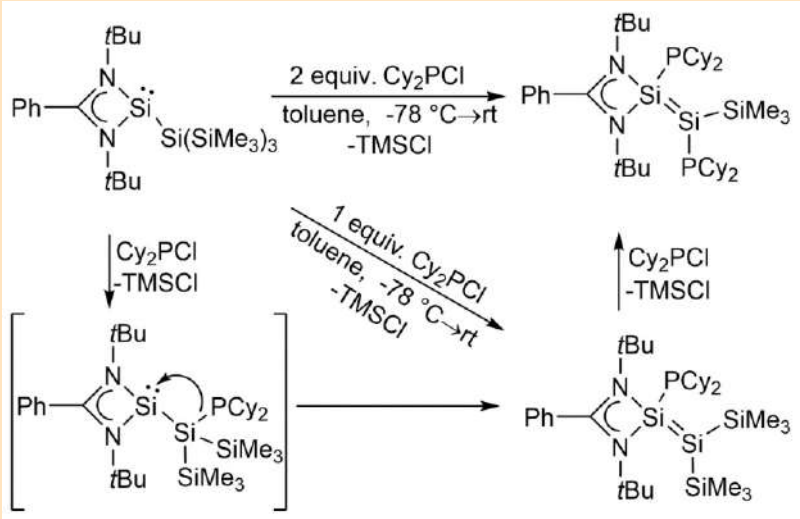


Figure 1: *Synthesis of unsymmetrical disilenes via Me_3SiCl elimination*

The researchers also presented a novel and high-yield protocol to synthesize these unsymmetrical disilenes. The method involves treating a silicon compound (hypersilylsilylene) with a phosphorus reagent (alkyl chlorophosphine), and elimination of the Me_3SiCl group from the silicon compound. An advantage of this novel method is that it does not require hazardous chemicals such as sodium or potassium. However, it is important to carry it out in air-and-water-proof conditions, as silicon is highly sensitive to moisture.

Another important insight from the study was that changing the R-group (the substituent) - from an aliphatic ((iPr_2PCl and Cy_2PCl) to an aromatic (Ph_2PCl) chlorophosphine compound - changes the reactivity. It was observed that the same reaction with Ph_2PCl resulted in the formation of an entirely new and unprecedented compound - tetraphosphinosilane.

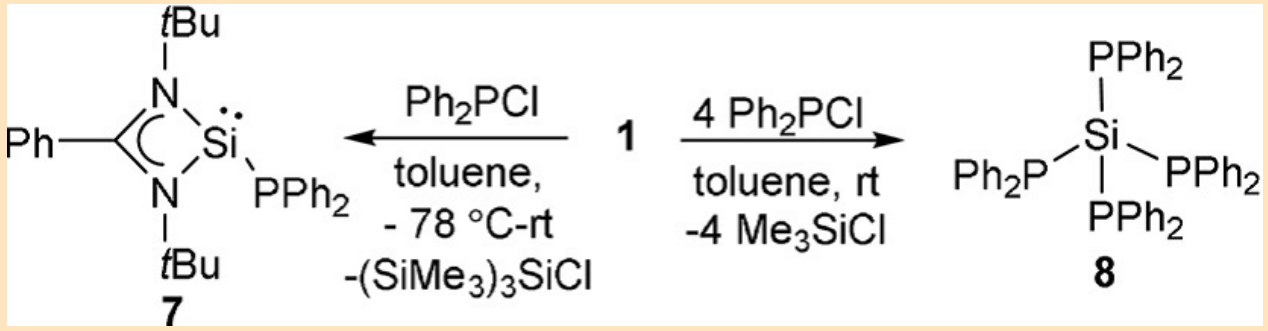


Figure 2: *Formation of tetraphosphinosilane (8) from hypersilylsilylene.*

An interesting outcome of this study could also be that the reaction intermediates and products might be the intermediates for other silicon-based reactions, where it has not been possible to isolate them. This could lead to a better understanding of the reaction mechanisms of organic chemistry, and further improvements of those pathways. Silicon also opens the doors to d-orbital chemistry, which is central to the chemistry and the resultant popularity of rare and unsustainable transition metals. While the first-row main-group elements (of the periodic table) are abundant and good for sustainability, they are limited to the s and p orbitals. Due to this reason, the potential of replacing carbon with silicon offers great advantages for reaction efficiencies as well as sustainability. Towards this, Dr. Sen's research group continues to explore the abundant main-group elements and uncover their mysteries.

Citation

Bisai MK, Das T, Vanka K, Gonnade RG, Sen SS. Unsymmetrical sp^2-sp^3 Disilenes. Angewandte Chemie International Edition. 2021 Sep 13; 60, 20706-20710.

Swagata Mondal,
Jacob J. Lessard,
Chhuttan L. Meena,
Gangadhar J. Sanjayan,
and Brent S. Sumerlin,
in Journal of American Chemical Society

Novel recyclable, self-healing and durable thermoset polymers

Epoxy, silicone and polyurethane are some common examples of thermoset polymers in which the macromolecular chains are cross-linked, creating an irreversible three-dimensional network. The cross-links enhance the stability and durability of the thermosets in extreme conditions, thus making them popular and widely useful in diverse applications. However, a major limitation of the cross-links is that the conventional thermoset polymers cannot be easily recycled, reprocessed, or even healed when damaged. One way to overcome this limitation, especially towards improving sustainability, is by developing cross-links that can be broken and reformed reversibly. An example of such a polymer in nature is the spider silk, where weak but numerous hydrogen-bonded cross-links (β-sheet assembly) between proteins provide high tensile strength to the spider silk threads. Taking inspiration from such natural reversible cross-links, in the present study, Dr. Sanjayan's research group at CSIR-NCL in collaboration with Dr. Sumerlin and his team at University of Florida, succeeded in presenting non-covalent polymer networks comprised of two-faced (Janus) hydrogen-bonded cross-links[1].

In their earlier work, Dr. Sanjayan and colleagues developed a novel triazine-based guanine-cytosine base (GCB), comprised of two opposite faces, each representing the respective functionality of the guanine-cytosine DNA base pair[2]. GCB exhibits a self-complementary hydrogen bonding sequence but with the added benefit that self-assembly of these moieties extends beyond 1:1 pairing, allowing the formation of extended ribbonlike structures. The researchers hypothesized that incorporating the Janus GCB pendent groups into polymers would dramatically increase the complexity of the hierarchical assembly of polymers which can strongly influence their material properties.

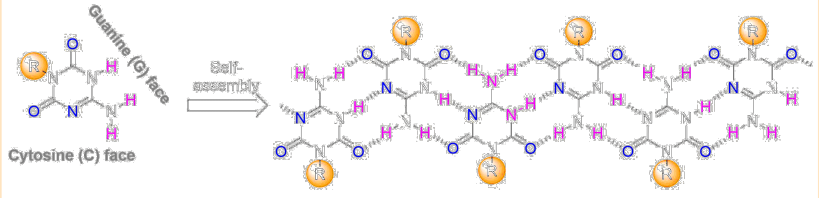


Figure 1: *Triazine-based Janus guanine-cytosine base (left) and its self-assembled supramolecular ribbon structure (right)*

Based on this concept, the researchers incorporated triazine-based GCB into poly(butyl acrylate) (GCBA). This yielded a spectrum of materials from viscoelastic liquid to solid that possess a tunable elastic rubbery plateau depending on the incorporation of GCBA cross-linkers. The network with the highest incorporation of GCBA, though only 15 mol %, displayed a rubbery behavior across the widest temperature range yet reported for any supramolecular network.

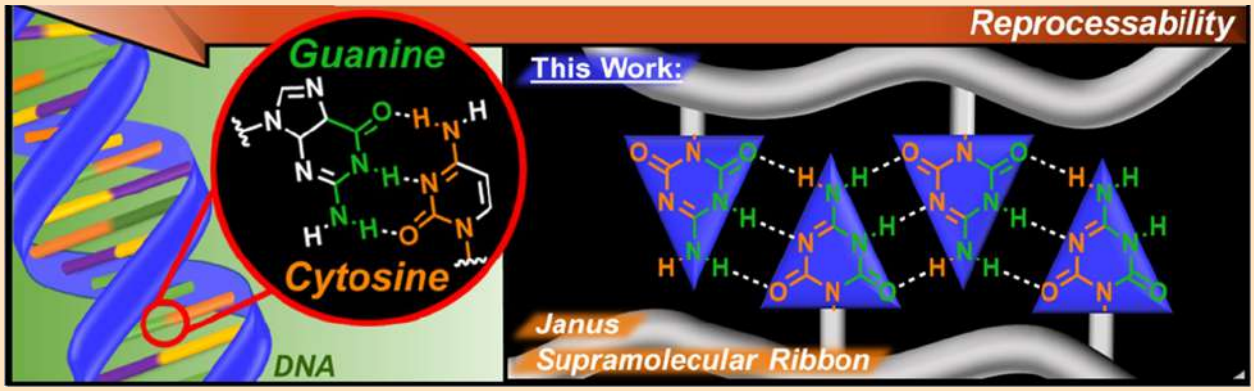


Figure 2: *Cartoon representation of DNA GC base-pairing (left) and self-complementary hydrogen bonding of Janus guanine-cytosine base (right).*

This is the first report of the synthesis of extremely robust and tunable supramolecular networks with cross-linkers containing multiple binding sites per unit. The cooperative nature of Janus-faced noncovalent bonding can be a powerful technique for the development of thermally robust supramolecular networks and will have a bearing on practical applications.

Citation

1. S. Mondal, J. J. Lessard, C. L. Meena, G. J. Sanjayan, and B. S. Sumerlin. Janus Cross-links in Supramolecular Networks. *J. Am. Chem. Soc.* **2022**, 144, 845–853.

2. C. L. Meena, D. Singh, B. Kizhakeetil, M. Prasad, M. George, S. Tothadi, and G. J. Sanjayan. Triazine-Based Janus G–C Nucleobase as a Building Block for Self-Assembly, Peptide Nucleic Acids, and Smart Polymers. *J. Org. Chem.* **2021**, 86, 3186-3195.

Manoj Kumar Nandi and Sarika Maitra Bhattacharyya,
in *Physical Review Letters*

Explaining the "softness" of a supercooled liquid

Chocolates, window panes, toothpastes, and shaving gels are just a few everyday examples of materials that behave like solids but actually are quite different than a typical crystalline solid. These materials are called 'supercooled liquids' because they are cooled very fast from liquid state; and due to which they do not crystallize into solids. Supercooled liquids exhibit many liquid-like properties, and if cooled further, undergo a phase transition to become amorphous glasses. Understanding the glassy state of matter has been one of the most challenging theoretical problems in soft condensed matter physics. Supercooled liquids are also difficult to handle industrially because they exhibit such mixed properties; of solids as well as liquids.

Theories that explain the behaviour of either solids or liquids exclusively are not entirely applicable to the supercooled liquids. For example, small changes in their structure often lead to major changes in the dynamics. Therefore, a key question that physicists have been asking for these systems is whether structure plays any role in the dynamics. From the viewpoint of applications of these materials, an important corollary to this question is: can the dynamic properties of supercooled liquids such as ductility or the force required to flow the material be controlled by tailoring their structure. However, for many decades, the answers to these questions have eluded researchers. Dr. Sarika Bhattacharya's research group at CSIR-NCL has been developing the fundamental theoretical basis for understanding structure-dynamic relations in supercooled liquids for over a decade. After years of work, they are now able to show that a small change in the structure of supercooled liquids can result in a large change in entropy, which then translates to large changes in the dynamics. This indicates that it is possible to derive meaningful quantities from the structure to predict the dynamics. This work has attracted other researchers world-wide to revisit the problem and has motivated more studies including those using machine learning (ML).

In one such ML study, a research group proposed that a parameter called 'softness' correlates well with the dynamics. This parameter is obtained by first classifying the local structure of a large ensemble of particles into two groups: fast- and slow-moving particles, and then comparing the local structures experienced by a random particle in terms of this classification. However, this classification cannot explain the physical origin of the connection between the structure and the softness parameter. In their present work, Dr. Bhattacharya and Dr. Nandi advanced their theoretical formulation. They derived a microscopic theory which can

describe the confining potential for a liquid particle in terms of the structure of the liquid around it. The curvature of this confining potential describes a microscopic softness parameter. They showed that for different kinds of liquids the dynamics can be described in terms of this microscopic softness parameter. However, according to their study, this correlation between the dynamics and microscopic softness is system dependent.

Having successfully established the correlation between the average structure and the average dynamics Dr Bhattacharyya's group took up the next challenge to correlate the local per particle dynamics with local structure. Unlike in normal liquids, where all the particles have similar dynamics in the super cooled liquid regime, the dynamics of the particles are heterogeneous. The origin of this dynamic heterogeneity is a topic of intense research. In analogy with crystals, where regions with structural defects show a higher probability of rearrangements, it is often suggested that in supercooled liquids, such structural defects may also be present, giving rise to the dynamic heterogeneity. However, while identifying structural defects in crystals with otherwise well-defined structure is trivial, doing the same in a supercooled liquid where particles are arranged in a disordered manner is a non- trivial task. Moreover, both softness and dynamics can have a local microscopic variation, and it is well known in statistics that the correlation between average quantities does not guarantee a correlation at an individual level.

They extended the theory to individual particle level and showed that the local structure and thus the curvature of the confining potential varies over a range. This range becomes wider at lower temperatures, leading to increased structural heterogeneity. The study further showed that in a less structured neighbourhood, the confining potential has a lower curvature leading to a higher probability of the particle being mobile. Thus, they showed that in a way similar to the dislocation theory for the solids, the mobility of a particle in a supercooled liquid is related to the local arrangement in its neighbourhood.

We can speculate that this understanding has the potential to aid engineers. Brittle systems are known to have lower mobility of particles compared to ductile systems. Since the mobility of each particle is now shown to be connected to the local structure, we believe it will be possible to understand the ductile to brittle transition in terms of the change in local structure of the liquid. Going forward, it may also be possible to modify such properties by tweaking the structure.

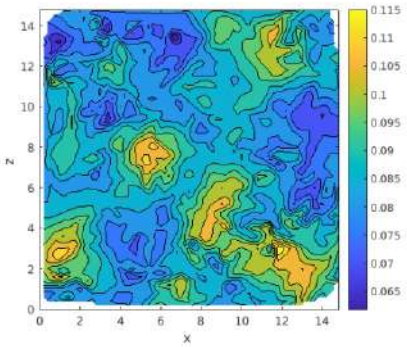


Figure 1: *Contour plot of averaged softness for a single snapshot. Here the regions in yellow are high softness regions and blue are low softness regions.*

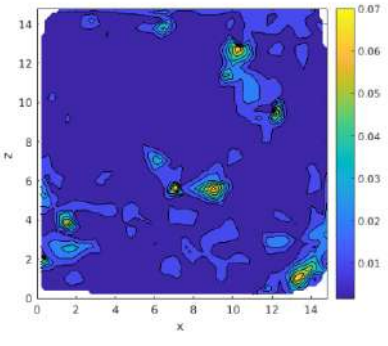


Figure 2: *Contour plot of mobility for a single snapshot. Here the regions in yellow have high mobility (rearranging regions) and regions in blue are low mobility regions.*

Citation

Nandi MK, Bhattacharyya SM. Microscopic theory of softness in supercooled liquids. Physical Review Letters. 2021 May 17;126(20):208001. See also:

Sharma M, Nandi MK, Bhattacharyya SM. Identifying structural signature of dynamical heterogeneity via the local softness parameter. Physical Review E. 2022 Apr 15;105(4):044604.

Y Soni, S Gupta, and CP Vinod,
in Molecular Catalysis

Investigating the interaction of a transition metal catalyst and its support towards tuning the conversion of CO_2 to either CO or CH_4

While the need to reduce atmospheric carbon dioxide is urgent in view of global warming, the technologies to sequester CO2 are not cost-effective yet. CO2 utilization technologies thus have a crucial role to play, by converting CO2 into other useful chemicals such as hydrocarbons. This is not an easy task either, because CO2 is a highly stable molecule. Thus, coaxing sufficient yields of higher hydrocarbons from CO2 calls for high pressure of feed gasses. But at atmospheric pressure, it is possible to convert CO2 to useful one-carbon-atom (C1) products such as carbon monoxide (CO) - an important feedstock chemical, and methane (CH4) - an important fuel. The properties of the catalyst used for these reactions as well as the interaction of the catalyst with its support material (metal - support interaction) play an important role in deciding which product will be formed, and how much CO2 will be converted into the desired product (selectivity). Metal - support interaction influences which reaction intermediates will be stabilized at particular sites, thusdeciding the selectivity switch between CO and Ch4. Dr. Vinod's research group has investigated the mechanism of tuning theconversion and selectivity of the Co_2 hydrogenation reaction promoted by the transition metal catalyst Palladium (Pd). This reaction at atmospheric pressure forms CO as the major product. However, by using a support that has more surface defects leading to more interactive site in the form of oxygen vacancies, this behaviour can be modified. In the present study, the researchers first incorporated Pd nano particles of 6-7 nm size in the hexagonal 10 nm cavities of mesoporous silica support [Santa Barbara Amorphous (SBA-15)]. They then modified it with titanium to obtain Pd/Ti-SBA-15. They screened the synthesized Pd catalysts with variable Si/ Ti molar ratios for CO_2 hydrogenation at atmospheric pressure, and compared those with TiO2 and SBA-15 supports. This was also the first time the hydrogen-ation property of Ti-modified silica was investigated.

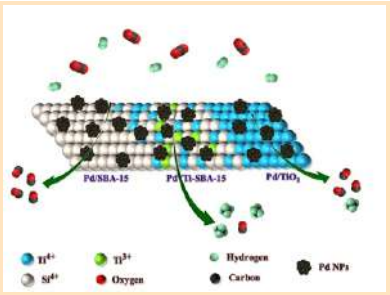


Figure 1: *The strong metal-support interface formed in the Pd/Ti-SBA-15 catalyst*

Various microscopic and spectroscopic characterizations were carried out to correlate the physicochemical properties of the modified catalyst Pd/Ti-SBA-15 with its catalytic activity, and to compare it with other modifications of the Pd catalyst (such as: Pd/SBA-15, PdTS-50, PdTS-25, PdTS-10, PdTS-1, and Pd/TiO2). These studies established that the mesoporous structure of SBA-15 was preserved even after Pd and Ti loading. Further, it was seen that at lower temperatures, the catalyst produced CO as the major product, however, with an increase in temperature the selectivity switched from CO to CH_4. The characterization provided evidence that the CO_2 conversion as well as product selectivity could be solely attributed to the strong metal-support interface formed in the Pd/Ti-SBA-15 catalyst. Further, it was shown that the catalyst synthesis procedure can affect the activity of two catalysts with similar Pd and Ti compositions by generating a strong metal-support interaction.

This work provides a platform for studying a wide range of reactions where selectivity can be easily altered. However, catalyst modification at scale is still difficult, and it would be necessary to develop simpler and faster synthesis processes for scaling up.

Citation

Soni Y, Gupta S, Vinod CP. Role of metal-support interaction for atmospheric pressure CO2 hydrogenation over Pd/(Ti)-SBA-15 catalyst: Effect of titanium composition on products selectivity. Molecular Catalysis. 2021 Jul 1;511:111732.

Members

Asish Kumar Bhattacharya

Tharun Kumar Kotammagari

Manas Kumar Santra

Patent

Patent **US11059848B2**: Artemisinic Acid Glycoconjugate Compounds, Process for Preparation and Use Thereof; granted **July 13, 2021**

A novel organic route to synthesize Artemisinic Acid Glycoconjugate compounds, with potential for enhanced anti-cancer activity

Summary

Novel compounds were synthesized starting from artemisinic acid (AA), through a simple, environment friendly, and economic process invented by Dr. Asish Kumar Bhattacharya and Dr. Tharun Kumar Kotammagari, CSIR-NCL, with Dr. Manas Kumar Santra, NCCS. These novel glycoconjugates (carbohydrate-linked AA) have a better potential to act as anti-cancer drugs compared to pure artemisinic acid.

Artemisinic acid is an important natural product of the herb *Artemisia annua*. It is a precursor to artemisinin, which was extracted from *Artemisia annua* in traditional Chinese medicine, to control fever. Artemisinin is also valuable in the modern treatment of malaria, especially as the malarial parasite plasmodium develops resistance to presently available anti-malarial drugs such as chloroquine etc. Chemical synthesis of artemisinin is difficult and costly, and therefore currently, it is extracted from *Artemisia annua*. However, quantity of artemisinic acid available in the herb is higher than artemisinin. Artemisinic acid also shows a wide range of anti-tumor and anti-bacterial activities. In view of the medicinal potential of various derivatives of artemisinic acid, their production using organic synthesis routes can be commercially attractive.

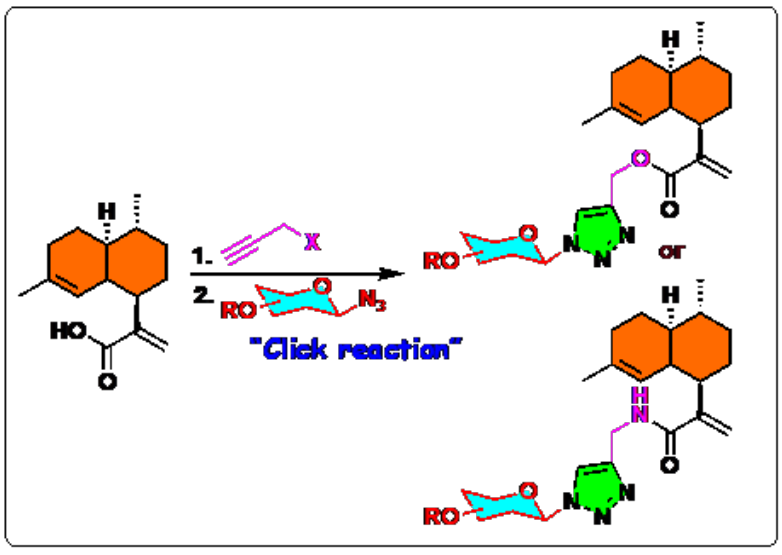


Figure 1: *12-O-artemisinic acid and 12-N-artemisinic acid glycoconjugates of artemisinic acid.*

Glycoconjugates of artemisinic acid are one such category of derivatives. They are synthesized by conjugating artemisinic acid with carbohydrate scaffolds, which help to increase the biological activity. In the present invention, the inventors developed a two-step 'click chemistry approach', which adds to artemisinic acid an oxygen or nitrogen atom in the first step, followed by a sugar in the second step. More specifically, artemisinic acid is first reacted with propargyl alcohol and propargyl amine to form acrylate and acrylamide derivatives, respectively. These undergo a 1,3-dipolar cycloaddition reaction with various sugar-azides to form the corresponding glycoconjugates. Using this process, the inventors synthesized a number of 12-*O*-artemisinic acid and 12-*N*-artemisinic acid glycoconjugates (Figure 1).

The effectiveness of the synthesized compounds was tested on breast cancer cells (cell line MCF7). Some of the novel glycoconjugates showed enhanced anti-cancer activity over that of artemisinic acid. The invention indicates that further work has the potential to develop even more effective compounds.

Members

Samir Chikkali

Dipa Mandal

Ravindra Gote

Ketan Patel

Patent

Patent **US11155654B2:** Heterogenous precatalyst for preparation of highly crystalline, disentangled, ultra high molecular weight polyethylene (UHMWPE) and a process for preparation thereof; granted **Oct 26, 2021**

Highly Crystalline, Disentangled, Ultra High Molecular Weight Polyethylene (UHMWPE) for demanding applications

Summary

A team of scientists from Polymer Science and Engineering Division of CSIR-NCL, under the leadership of Dr. Samir Chikkali, has invented a novel precatalyst to prepare UHMWPE, an extremely strong polyethylene, along with the process to prepare the precatalyst and UHMWPE using the same. This polyethylene shows improved impact and wear resistance, and finds applications in niche domains such as medical prosthetics, bullet proof jackets, helmets, and high-strength light-weight strong fibers and tapes.

Ultra High Molecular Weight Polyethylene (UHMWPE) is a polymer with molecular weight more than 2.5 million g/mol. Due to this ultra-high molecular weight, the molecular chains of UHMWPE crystallize and also entangle with each other, similar to long noodles albeit at a molecular scale. While this makes the UHMWPE several times stronger than high-density polyethylene (HDPE), the high degree of entanglement also prevents the UHMWPE from flowing (in melt state) easily. Therefore, the traditional industrial solution to this problem is the process of gel-spinning, where 5% UHMWPE is dissolved in 95% solvent to form a gel, from which fibers are spun out. Solvent recovery is a major unavoidable operation in such processing plants. Also, it takes a very long time to dissolve the UHMWPE powder in a solvent. A recent alternative to the cumbersome process of 'polymerization followed by gel-spinning' has emerged in the form of disentangled UHMWPE (dis-UHMWPE), where the polymer chains form a folded structure that avoids entanglements. Such a polymer can therefore be "melt processed" into sheets and tapes without the need of a solvent.

In the present invention, the inventors provided an alternative, by developing a precatalyst, which is converted to a catalyst during the course of the polymerization reaction. Further, they developed the process wherein ethylene monomers are polymerized in the presence of the precatalyst and a co-catalyst at temperature in the range of 0 to 60°C for a period in the range of 10 minutes to 10 hours. In this process, the active sites of the catalyst promote controlled polymerization of ethylene, such that the growing polymer chains rapidly fold and crystallize before entangling, thus forming highly crystalline dis-UHMWPE.

The invented one-pot, two-step process for the synthesis of the precatalyst involves reacting a metal alkoxide/ phenoxide with a metal halide in a suitable solvent to form a slurry, and then activating the slurry by treating with an organoaluminum halide compound

in a solvent. A metal-alkoxide based catalyst is being used for the first time to prepare dis-UHMWPE. The materials are inexpensive, readily available, and bio-compatible.

The solid catalyst can catalyze the polymerization of gaseous ethylene, without the need for a liquid solvent, unlike the homogeneous catalyst used in the present commercial process. The solid catalyst also works in liquid solvent, if required. The invented process also overcomes limitations of other catalytic systems such as multi-step and time-consuming ligand synthesis, high co-catalyst to catalyst ratio, and use of metal halides, which can cause reactor corrosion.

This project is a part of the program to develop high-value niche-grades of polyethylene with diverse functionalities. Taking the current work forward, the inventors have scaled up the process to handle it on a 3-liter scale, generating up to 300 g/batch of dis-UHMWPE powder. The reaction can be carried out in both - batch as well as continuous - modes. India currently imports more than 2000 tons UHMWPE per year. This demand, as well as the global UHMWPE fiber market is likely to grow multiple times. New applications such as battery separators will further contribute to this growing demand. Any industrial collaborations to scale up the invented process will thus lead to profitable and sustainable manufacturing that provides an Indian alternative to the imports.

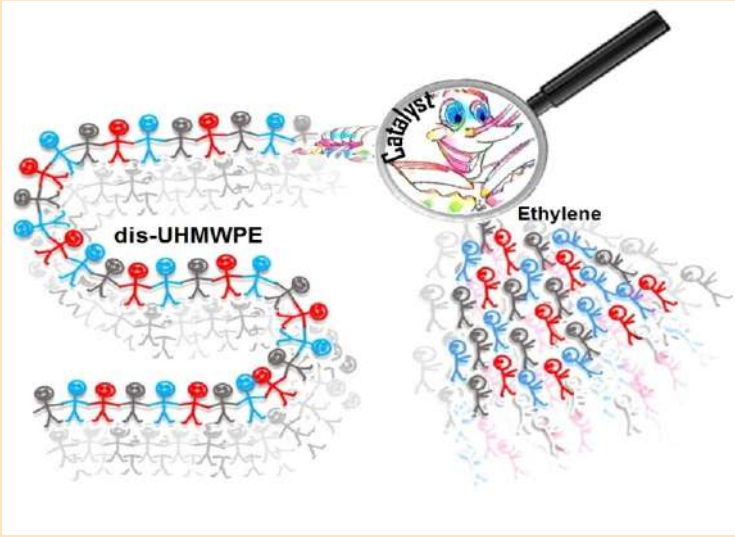


Figure 1: *Using a novel precatalyst to prepare UHMWPE*

Members

R. Nandini Devi

Leena George

Patent

Patent **US10967365B2:** Functionalized zinc oxide nanoparticles for photocatalytic water splitting; granted **April 6, 2021**

A novel photocatalyst for generating green hydrogen from water using solar energy

Summary

Dr. R. Nandini Devi and Leena George from the Catalysis Division of CSIR-NCL have invented a photocatalyst composition for enhanced water-splitting reaction using solar energy, to generate hydrogen - a clean fuel for the future. The composition comprises Zinc oxide nanoparticles conjugated with an organic component that provides additional functionality.

Zinc oxide is a light-sensitive semiconductor that has high electron mobility, high thermal conductivity, wide and direct band gap, and large exciton binding energy, all of which are important attributes for a photocatalyst. Moreover, Zinc oxide is a chemically stable and environment-friendly material. In the presence of ultra-violet light, it generates charges that catalyse water-splitting.

There are, however, some challenges to the availability of charges. When light of appropriate energy falls on a semiconductor, electrons (negatively charged particles) are excited from the valence band to the conduction band, creating a hole (positively charged particles) in the latter. In order to use these charges effectively in an electron transfer or redox reaction, it is necessary that the electrons and holes do not recombine before getting utilized for the reactions. It is especially challenging to avoid the recombination of charges in bigger particles, as the charges encounter a greater number of recombination sites before reaching the surface for utilization in any reaction.

Hydrogen production by water-splitting is one such reaction. In order to produce faster and more amounts of hydrogen, it is necessary to make more charges available by minimizing the recombination sites and through spatial charge separation in the semiconductor.

Another challenge with Zinc oxide is that it is more sensitive to the ultra-violet frequencies, which form only 4% of solar light. So, it is important that the semiconductor also responds to the visible spectrum of light in addition to the ultra-violet light.

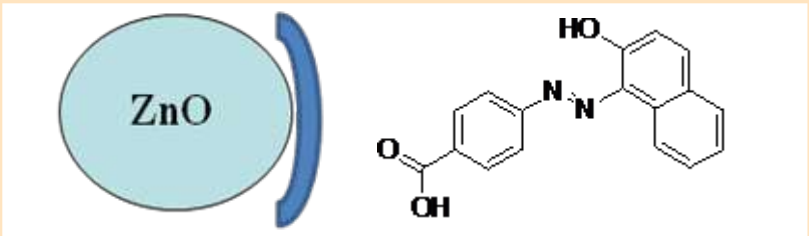


Figure 1: *ZnO Composite: Zinc oxide nanoparticle conjugated with an organic moity 4-(2-Hydroxy-naphthalen-1-ylazo)-benzoic acid*

In the current invention, the inventors addressed these two challenges by developing a photocatalyst composition comprising of Zinc oxide nanoparticles (95-98 wt%) with an added functionality of a conjugated organic component (2-5wt%), which was selected from a group consisting of oligothiophenes, azo dyes, porphyrins, hydroxyqui-nolones, and perylenes (Figure 1). The photocatalyst composition may optionally contain 1 wt % co-catalyst, selected from the group consisting of platinum, silver, nickel (II) oxide, and glycerol, acting as scavenger. This enables water-splitting in visible light, and the inventors showed hydrogen evolution of at least 2 milli moles hydrogen/hour/g of the photocatalyst composition (Figure 2).

The conjugated organic moiety, for example, a dye, sensitizes Zinc oxide to the visible light spectrum. The conjugation i.e., the 'covalent' bond between the organic dye and the Zinc oxide prevents degradation of the dye. Further, the conjugated organic moiety acts as a conducting linker to assist electron conduction. It also modifies the Zinc oxide surface to reduce the defect sites. This helps to effectively absorb and transfer electrons or holes preferentially away from the surface recombination sites depending on the band positions. Moreover, the conjugated organic moiety can also link the photogenerating semiconductor nanoparticles to catalytic sites like metal nanoparticles or organometallic centres.

The cost of the invented photocatalyst is anticipated to be lower than the globally-benchmarked catalysts, since ZnO is abundantly and cheaply available on Earth. Moreover, the dye can be synthesised by simple methods. In terms of the hydrogen evolution, the demonstrated quantity is much below that from the globally-benchmarked photocatalysts. However, the invention proves the concept of assisting/enhancing water splitting activity of semiconductors. This general idea may also be applicable to enhancing the activity of other semiconductors or semiconductor composites.

India is betting big on green hydrogen (GH_2) as a renewable energy vector and a means to achieve deep decarbonisation of chemical industries such as refining, fertilizers and steel. Any technology that produces GH_2 more efficiently and from primary sources such as sunlight and water will be of interest to industry in India and globally. Photocatalysts, such as from the present invention, without the use of expensive dyes or co-catalysts, may pave the way to such GH_2 generation. The invention also has potential applications related to dye-sensitized solar cells.

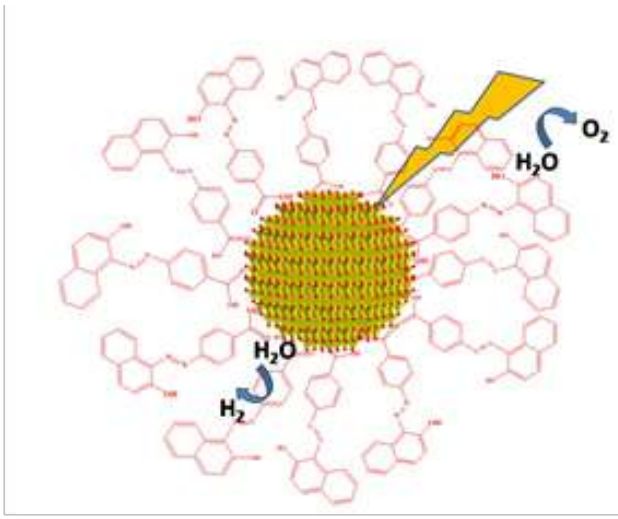


***Figure 2**: Water is split to release hydrogen and oxygen in the presence of the composition exposed to solar light.*

Members

Vidya Shrikant Gupta

Hemangi Girish Chidley

Ashish Balwant Deshpande

Ashok Prabhakar Giri

Patent

Patent **EP3310907A1:**
Molecular cloning and expression of cDNA encoding *O*-methyltransferase isolated from *Mangifera indica*; granted **November 17, 2021**

Bio-synthesis of Mesifuran, a valuable flavour compound which lends the Alphonso mango fruit its characteristic aroma and taste

Summary

A team of biochemists at CSIR-NCL, led by Dr. Vidya Gupta and Dr. Ashok Giri, have successfully invented important metabolic pathway steps in the bio-synthesis of a valuable volatile flavour compound namely, mesifuran. This is one of the major groups of compounds that lend the Alphonso mango fruit its characteristic aroma and taste during post-harvest ripening. For various reasons, other varieties of mango do not produce mesifuran and their derivatives in odour-threshold quantities, even though they may have the gene that encodes its bio-synthesis. The inventors isolated, sequenced, and characterised the gene responsible for producing the enzyme *O*-methyl transferase, which catalyses the natural process of synthesizing mesifuran. The gene was then transformed into bacteria (*Escherichia coli*), to produce *O*-methyl transferase. This enzyme, extracted from the bacterial cell, can be used in a reaction as a catalyst to produce mesifuran from a specific substrate furaneol. The inventors demonstrated that the same enzyme can also be used to bio-synthesise another useful flavour compound, namely, vanillin from the substrate protocatechuic aldehyde.

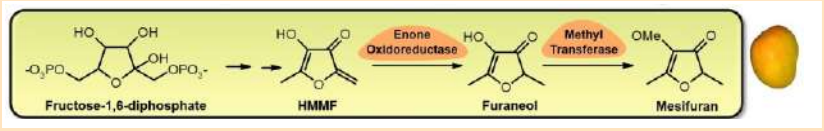


Figure 1: *Furanone biosynthesis in Alphonso mango fruit*

These volatile compounds (mesifuran, vanillin) are in high demand for flavouring food products such as ice-creams, milk shakes, soft drinks, and chocolates; and in the cosmetic and perfume industry. Compared to the chemically synthesised flavours, such bio-synthesised additives are more 'identical-to-the-natural' flavour compounds, and produce no other undesirable compounds or by-products. They also enjoy consumer preference, and thus, have a greater demand in the industry. The NCL team is further building a portfolio of inventions to engineer a complete metabolic pathway for all the related metabolites. Such a portfolio, along with its future pathway engineering in yeast as the host cell, or host cell suspension culture instead of bacteria, for the 'production' of the flavor compounds, will go a long way in the commercialization of this technology at an industrial scale.

Members

Dumbala Srinivasa Reddy

Amol Arvind Kulkarni

Vasudevan Natarajan

Mrityunjay Sharma

Patent

Patent **US11274081B2:** Process for The Synthesis of Ivacaftor; granted **March 15, 2022**

Synthesis of Ivacaftor drug using a novel process, with a potential to reduce the treatment costs and increase the availability

Summary

This invention demonstrates an improved, short, economically efficient, and environment-friendly batch and continuous flow synthesis process, for the production of the drug Ivacaftor. The invention credits to Dr. Dumbala Reddy, Dr. Amol Kulkarni, Dr. Vasudevan Natarajan, and Dr. Mrityunjay Sharma, a team from the Organic Chemistry Division and the Chemical Engineering and Process Development Division of CSIR-NCL.

Ivacaftor is a drug utilized for the treatment of Cystic Fibrosis, a condition in which muscle tissue becomes scarred and fibrous, leading to a loss of muscle flexibility and elasticity. Ivacaftor helps in muscle relaxation and hence, it is recommended in the treatment of the condition worldwide. Prevailing Ivacaftor production methods are not cost-effective and environment-friendly, and as a result, it is one of the world's most costly drugs, costing approximately 300,000 USD per patient per year.

The current processes of synthesizing Ivacaftor have limitations because the reactions require high temperatures and expensive reagents. For example, in one of the processes, the use of propyl phosphonic anhydride - a highly expensive coupling reagent - increases the manufacturing cost. The processes can only be carried out in batch mode, and require the use of high-performance liquid chromatography (HPLC) techniques for the separation of Ivacaftor and their analogues. Moreover, the product being patented, Ivacaftor cannot be manufactured at a lower cost, unless a different process is used.

In order to address these limitations, the inventors developed an alternative process starting with the substrate - ethyl ester of indole acetic acid. The first step involves oxidation of the substrate, carried out either by passing an Ozone stream (ozonolysis). This step generates ethyl 4 - oxo - 1,4 - dihydroquinoline - 3 - carboxylate. The next step is an esterification reaction, where an inorganic base such as lithium hydroxide is added to afford 4 - oxo - 1,4 - dihydroquinoline - 3 carboxylic acid. In the final step, 5 - amino - 2,4 - di - tert - butylphenol is added to the reaction along with a coupling agent to synthesize Ivacaftor (N-(2,4 - di - tert - butyl - 5 - hydroxyphenyl) -1,4 - dihydro - 4 - oxoquinoline - 3 - carboxamide).

The oxidation process using ozone (ozonolysis) is an environment-friendly alternative to the conventional use of metal-based oxidizing agents such as $NaIO_4$, which generates salt effluents that require proper disposal. However, in the batch mode, the ozonolysis reaction needs to be carried out at -78 degrees centigrade for several

hours, which is not very easy and practical. The inventors transformed the batch protocol in continuous flow mode. This enabled them to carry out the reaction at higher temperature (such as, at 0 degrees centigrade instead of -78 degrees centigrade) and thus at a faster speed.

The innovative continuous process is further optimized through a continuous layer separator for the separation of the organic and aqueous phases. Generation of impurities is avoided in the continuous flow mode, by separating the reactants and the products at the appropriate time. Moreover, the subsequent reaction steps are also carried out without any need for intervention thus accomplishing the entire synthesis of the drug molecule in a continuous flow mode. A major advantage of the continuous flow mode over the batch mode is that of 100% conversion in all the steps, selectively making the desired product while avoiding any undesired ones, thus making it a high-selectivity process with significantly high yields. Furthermore, it comprises of only one purification step, which significantly reduces the quantity of solvents to a minimum and generates less volatile organic effluents, making the process more environment-friendly. The process also reduces the reactor volume, thus reducing the costs and improving the overall economic efficiency.

The platform of continuous ozonolysis can be adapted to other similar drug manufacturing processes, by changing the substrate that is used to start the reaction.

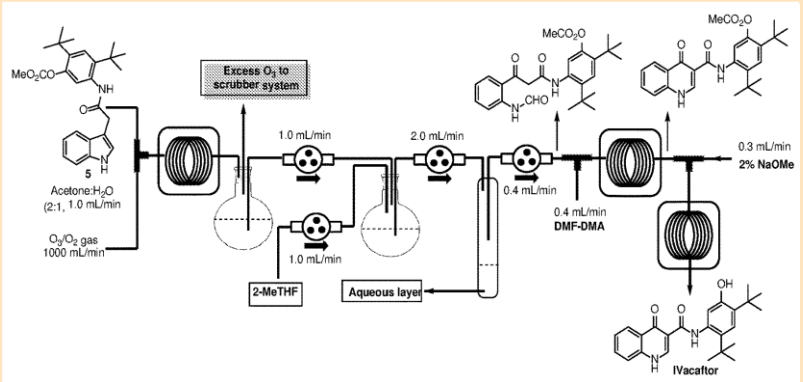


Figure 1: *Continuous Flow Synthesis of Ivacaftor*

The current improved synthesis method can produce 7.2 g of the drug Ivacaftor per day on a laboratory scale, which is sufficient to treat 50 patients per day. Adoption of this improved process has the potential for Indian or foreign pharmaceutical companies to manufacture the drug and make it available at a lower cost to address medical needs across the globe.

Members

Anuya Nisal

V. Premnath

Bhakti Khude

Patent

Patent **US11046737B2:**

Highly Crystalline Spherical Silk Fibroin Micro-Particles and a Process for Preparation Thereof; granted

June 29, 2021

A cost-effective and fast process to prepare long-lasting silk micro-particles for biomedical applications

Summary

Scientists Dr. Anuya Nisal and Dr. Premnath Venugopalan, along with students, from the Polymer Science and Engineering Division of CSIR-NCL, developed micro-particles of silk fibroin and a process to prepare these. Due to their highly crystalline and spherical structure, these micro-particles do not degrade fast, and are preferred for various biomedical applications.

The natural silk fiber from the silkworm is formed of two types of proteins, an insoluble protein called fibroin, and a glue-like protein sericin, that binds the fibroin together. Due to its mechanical strength and compatibility with human body, the silk fiber has been traditionally used for medical applications, such as stitching wounds (suturing). Modern medicine extends its use to a scaffold for internal tissue generation. For example, such a scaffold can provide a 3-dimen-tional structural backbone to re-grow the tissue inside damaged bones without getting degraded by enzymatic action over the period of re-growth. Compared to a silk thread, the Silk fibroin (SF) micro-particles offer several advantages; owing to the suitable size of the particles, their ability to fuse together to form a porous scaffold, and the strength of the scaffold thus formed.

The existing processes of preparing SF micro-particle scaffolds are tedious and time-consuming. Their lower crystallinity index implies a faster degradation, and hence these are not favored for applications that need slow-degrading scaffolds. Moreover, the particles that are not spherical tend to pack too tightly, and hence reduce the pore space necessary for cell culture.

The present invention overcomes these limitations by developing highly crystalline and spherical SF micro-particles (size 400-1000 micron). The inventors carried out a degradation experiment where the micro-particles retained more than 90% of their weight after a period of four days, thus confirming that they are not easily or quickly degraded. When packed together in a 3-D geometry, the highly spherical shape of the particles and their size in micron range enable the scaffold to show good porosity of about 46%. The high porosity and the micron-sized pores allow cells to grow inside the scaffold, as well as around it.

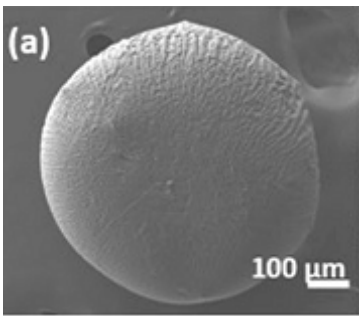


Figure 1: *Representative image of a highly crystalline and spherical SF microparticle*

The inventors developed a cost-effective and quick process to prepare the SF micro-particles. The process starts with obtaining a powder of SF. For this, 3 to 5 wt % aqueous solution of regenerated silk fibroin (RSF) is freeze-dried using a low-temperature dehydration process. The powder is then dissolved in hexafluoroisopropanol (HFIP) to obtain 5-7 wt % SF solution. Finally, the SF-HFIP solution is coagulated by adding it drop-wise at a controlled rate in a methanol bath to provide the SF micro-particles. A 3-D scaffold of desired shape and size for the targeted biomedical application can be made by suitably fusing these particles. The process is also flexible enough to incorporate different additives into the silk microparticles. These additives could include bio-ceramic based fillers, active biomolecules, and/or drugs. NCL-CSIR has licensed this techno-logy to a startup Serigen Medipro-ducts Pvt. Ltd. (previously known as BiolMed Innovations). Further research continues with silk.

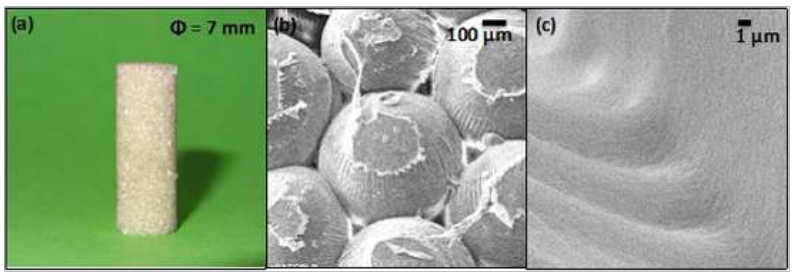


Figure 2: *(a) Representative 7mm diameter cylindrical scaffold prepared using SF microparticles; (b) SEM micrograph of scaffold showing mono-disperse SF micro-particles arranged in a hexagonal packing structure (c) Magnified image showing line of fusion between two particles. (Source: Nisal et al., 2018)*

Members

Chandrashekhar Vasant Rode

Suhas Hanmant Shinde

Patent

Patent **US11136302B2:**

Single step process for the synthesis of furan derivatives from carbohydrates; granted **Oct 5, 2021**

An efficient new process to synthesize high-demand furan derivatives

Summary

Furan is an important organic chemical that can be made from biomass. The derivatives of furan such as 2,5-di(formyl) furan (DFF) and 5-((methylthio) methyl)-2-furfural (MTMF) are in high demand as fuel additives, intermediates for pharmaceutical applications and for the synthesis of polymers, antifungal agents, drugs, etc.

The conventional processes to make these derivatives involve synthesis of hydroxymethyl furan as the first step followed by the subsequent step of conversion into the derivatives. The problems with these processes are the expensive step of distillation of 5-hydroxy-methyl furfural (5-HMF) and the use of multiple catalysts.

Scientists Dr. Chandrashekhar Rode and Suhas Shinde, from the Chemical Engineering and Process Development Division of CSIR-NCL have developed a simpler and more efficient single-step process for the synthesis of derivatives of furan from biomass feedstock. The process involves stirring of a mixture of the carbohydrate feedstock in solvent, in the presence of a catalyst, at a temperature range of 170 to 190 ° C, for 23 to 25 hours. The yield of furan derivatives is in the range of 30-60% of the feedstock. The by-products are non-hazardous, can be easily separated, and can be used as soil supplements. Sulfuric acid or Sn-Mont (Tin hydroxide nanoparticles-embedded montmorillonite) effectively catalyze the reaction. Both the catalysts, and the range of solvents used in the process, are easily amenable to scaling up for bulk production of the derivatives.

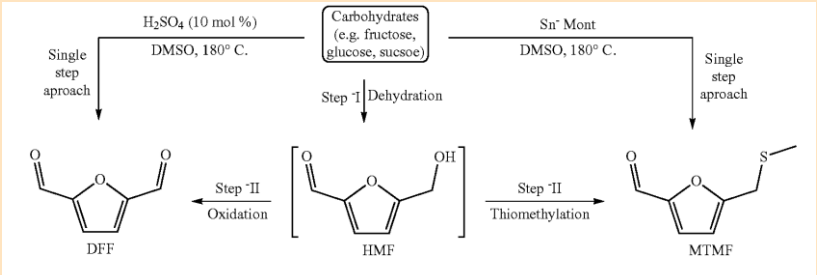


Figure 1: *Synthesis of DFF and MTMF from carbohydrates*

Compared to the existing methods, this single-pot process is cost-effective, and does not require external oxygen supply or Sulphur source. The process can be used not only for fructose as the carbohydrate source, but also for complex carbohydrates such as glucose and sucrose.

Members

Sreekumar Kurungot

Rahul Banerjee

Sekar Pandiaraj

Harshitha Barike Aiyappa

Patent

Patent **EP3047532A1:**

N-doped porous carbon electrocatalyst and process for preparation there of; granted **May 5, 2021**

An efficient, non-metal, N-doped porous carbon electrocatalyst for renewable energy

Summary

A team of scientists from the Physical and Materials Chemistry Division of CSIR-NCL, under the leadership of Dr. Sreekumar Kurungot, have invented an efficient, non-metal, N-doped porous carbon electrocatalyst for oxygen reduction reaction (ORR). They also invented a process to prepare the electrocatalyst, by doping graphitic carbon nitride (g – C3N4) as a nitrogen precursor into highly mesoporous carbon using metal-organic frameworks (MOF) as a carbon template. Such N-doped carbon composites have many potential applications in various renewable energy fields, such as, fuel cells, solar cells, supercapacitors, and so on.

Platinum and transition metal alloy-based electrocatalysts are the best-known catalysts for catalyzing the rate of oxygen reduction reaction (ORR) in polymer electrolyte membrane fuel cells (PEMFCs). However, their high cost, scarcity, and less durability in the electrochemical environment severely affect their commercia-lization. Further, given the fact that the catalytic platinum nanopar-ticles in the electrodes are anchored on a carbon substrate which contributes to a significant volume fraction, it would be useful if the carbon support could itself contribute to the catalytic oxygen reduction activity. The present invention is based on this rationale.

In this context, MOFs have tremendous potential as electro-catalysts, electrodes, or membrane materials. MOFs are crystalline solids that consist of a highly porous three-dimensional network of metal ions or clusters and rigid organic molecules to which additional functionalities can be imparted.

In the present invention, the inventors developed a carbon MOF and then replaced 5-8% carbon with nitrogen. As the nitrogen contributes a lone pair of electrons, an oxygen reduction current is obtained, thus contributing to the catalytic oxygen reduction activity. This composite performs better than pristine g - C3N4 material, which exhibits limited activity due to its low electrical conductivity and minimum surface area.

The inventors also developed the process steps to make the composite. The process comprises pyrolyzing a MOF (MOF - 2 or MOF- 5) to obtain mesoporous carbon (MOFC), which is then loaded with graphitic carbon nitride (g – C3N4) made by microwave-assisted *in situ* polymerization of melamine.

One way of loading is by adding melamine to MOFC and heating it. In this approach, the slow process of graphitic carbon MOF happens simultaneously with nitrogen release, and much of the nitrogen escapes instead of getting doped in the MOFC.

This results in only a slight improvement in the performance of the electrocatalyst. To achieve better results, the inventors first made the MOFC, and then added melamine and heated it to about 550 °C. Further heating led to nitrogen-doped MOF of carbon, the best performance being given by MOFCN900, i.e., at 900 °C heating.

This N-doped porous carbon electrocatalyst has a high specific surface area, and offers a large number of ORR active sites, and a large pore volume for facile and faster transport of gases and ions to the active sites. Further, the catalyst has a high fuel selectivity and superior durability.

This invented process opens a new pathway for the design and development of metal-free electrodes as fuel cell cathodes. The important role of N-doping to oxygen reduction reaction (ORR) can be applied to various carbon materials for the development of other metal-free efficient ORR catalysts, for fuel cell applications, and new catalytic materials for applications beyond fuel cells.

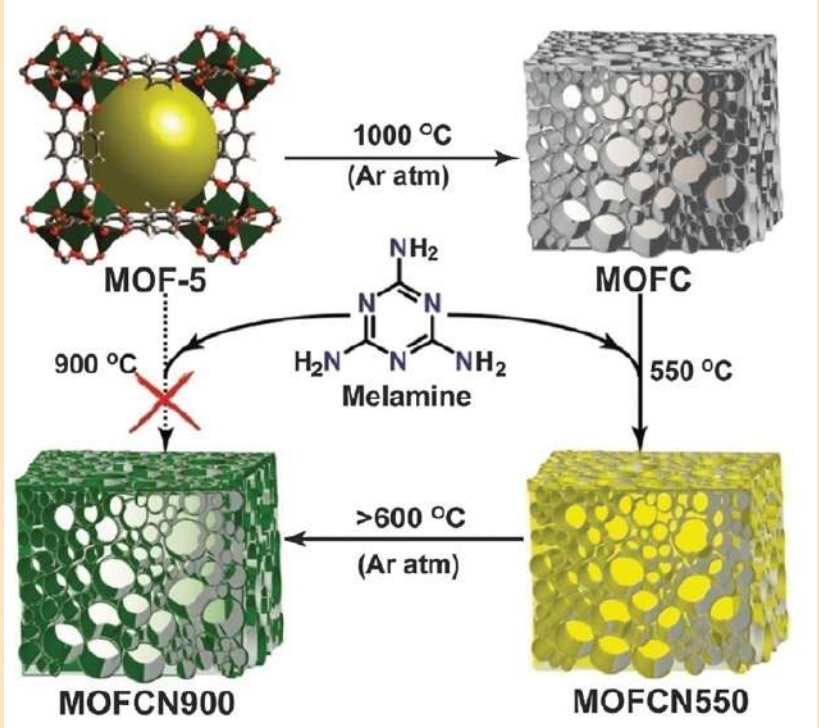


Figure 1: *Construction of N-doped porous carbon g-C3N4 upon impregnation of melamine into the pores of carbonized MOF-5 followed bycarbonization at higher temperature (4600 1C).*

Members

Santhosh Babu Sukumaran

Goudappagouda

Patent

Patent **US11040946B2:** Bromonaphthalimide compounds and phosphorescent liquid formulation thereof; granted **June 22, 2021**

A phosphorescent liquid formulation with potential for scalable and flexible lighting and display materials

Summary

Dr. Santhosh Babu Sukumaran and Dr. Goudappagouda, from Organic Chemistry Division of CSIR-NCL, have invented a phosphorescent liquid formulation of bromonaphthalimide compounds and the process to prepare these. The liquid composite can be painted on large areas, and exhibits phosphorescence in air at room temperature over extended period of time. Using the composite as an indicator, the inventors also developed a thermometer that exhibits visually detectable color change from green to orange over a wide range of temperatures from sub-ambient to ambient.

Phosphorescent substances are those chemical compounds which continue to emit light for a long duration (milliseconds to days) after being exposed to ultra-violet radiation for a short time. Phosphorescent materials (phosphors for short) store the absorbed light energy and release it sometime later, which allows them to glow in the dark, after the source of light is removed.

Organic compounds, which exhibit phosphorescence, find applications in various domains, such as display devices, bio-imaging, security labeling, anti-counterfeiting etc. Most of these metal-free organic phosphors exhibit phosphorescence at ambient temperature in crystalline state. However, if the crystalline solids are dissolved in solvents, reaction with dissolved oxygen quenches the light emission, and energy decay occurs very fast. Further, solutions of crystalline phosphors are more tedious and expensive to process, and the solvents influence their properties and performance. For this reason, future devices would benefit from having organic amorphous phosphors that exhibit phosphorescence at ambient temperatures in their own liquid physical state. In this state, their molecular packing remains intact, and hence the phosphorescence is retained.

The present invention has provided the first report of such easy-to-process liquid organic phosphorescence molecules which work at ambient temperature. The inventors also developed a process to prepare five organic phosphor compounds of bromonapthalimide mixed with fillers, additives, polymers and reinforcements. These display solvent-free liquid-state phosphorescence. Based on the fundamental understanding of the presence of weak interactions between Br-Br, and Br-O atoms in crystalline form, the inventors replicated them in the liquid form by doping the phosphor with carbonyl/ aldehyde groups, and demonstrated enhanced phosphorescence. The composites of solvent-free organic liquid mixed/doped with other materials

are paintable and can be applied over large area (10x10 cm). A limitation is the stickiness of the liquid, and further work has addressed it. In the organic-electronics era of flexible or foldable devices, this invention paves way to the formation of large-area thin films by exciplex and phosphorescent liquid hybrids. In collaboration with suitable manufacturers, it will also encourage the development of scalable lighting and display materials.

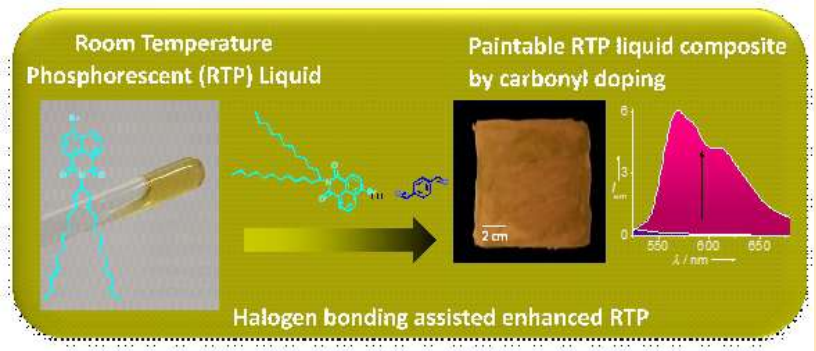


Figure 1: *Phosphorescent liquid formulation of bromonaphthalimide compounds.*

Members

Shubhangi Umbarkar

Atul Balasaheb Kulal

Amar Deshmukh

Patent

Patent **US11111207B2:**

One pot, one step process for the halogenation of aromatics using solid acid catalysts; granted

September 7, 2021

An improved process to synthesize halogenated hydrocarbons without creating pollution

Summary

Scientists at the Green and Environmental Catalysis Group, CSIR-NCL, under the leadership of Dr. Shubhangi Umbarkar, have invented an environment-friendly and speedy single-pot process for adding halogens to aromatic compounds. Halogenated hydrocarbons are extremely valuable in many industrial, pharmaceutical, and technical uses, including as starting materials for the production of dyes, synthetic resins, and insecticides. The invented one-step process involves mixing an aromatic compound in a solvent, and adding a halogenating agent to it in the presence of a small quantity of a solid acid catalyst. For example, the aminoaromatic compound 4-chloroaniline is dissolved in hexane, and iodine is added to the mixture as the halogenating agent, in the presence of silica, at 28 degrees centigrade. The process generates the iodinated aromatic compound 4-chloro-2-iodoaniline, with 94% selectivity and 4-chloro-3-iodoaniline with 6% selectivity.

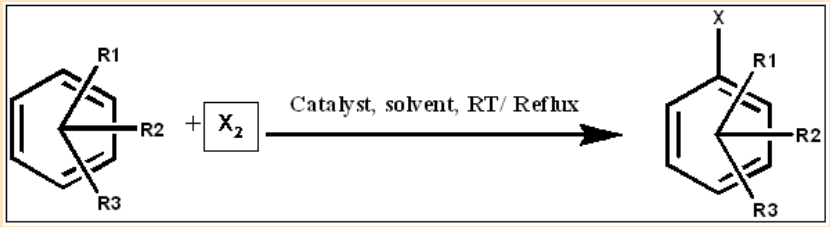


Figure 1: *Halogenation of aromatics using solid acid catalysts; where, R1 is -Alkyl, -Amines, -Carbonyl containing compounds, -Halides, -Amides, -Acids; R2 is -H, -X, -R, -NH2; and R3 is -H, -X, -R, -NH2.*

The process can be successfully used for the iodination, bromination, or chlorination of various aromatic compounds such as amino aromatics, hydroxy aromatics (phenol), aromatic aldehydes (benzaldehyde), halo-substituted aromatics, and amide-substituted aromatics. A range of solid acid catalysts can be used, such as the mixed metal oxides, silica, MoO_3/TiO_2, WO_3/TiO_2, and MoSi/Al.

The traditional non-catalytic halogenation processes require carefully controlled conditions including high temperatures and strong oxidizing agents such as mineral acids. They involve formation of wasted (salt) by-products, also generating polluting effluents. Further, the recovery of the unreacted halogenating agent is not a simple organic transformation. The regeneration of the halogenating agent for its reuse is also an multistep process which is not very clean & green.

The invented process, on the other hand, offers several advantages over this. It can be carried out under milder conditions, without any hazardous reagents, usually at room temperature. The improved conversion provides higher yield in shorter time. Moreover, there is increased selectivity towards ortho-substituted compounds. A strength of the process is that using the stoichiometry of the halogena-ting agent, the process can be controlled to yield only mono-halogenated products, when multi-halogenation is not required. Importantly, the process can be carried out in both batch as well as continuous modes, and the catalyst is easily recovered by filtration or decantation for reuse. The hydrogen halides produced in the process are not undesirable or hazardous by-products, and can be used elsewhere. The invented process emerges as clean, green, continuous-mode process that could induce the industry to replace the traditional polluting processes, when scaled-up.

Resource Centers

Catalyst Pilot Plant

Catalyst Pilot Plant (CPP) is well equipped with all the catalyst scale-up facilities such as wide range of batch reactors from 250mL to 50L capacity to perform step wise scale up from gm level to 4kg/batch level. CPP is also equipped with other wet and dry processing units required for filtration; centrifugation; drying; calcinations and extrusion of the catalyst up to 1kg level. These wide ranges of reactors are also suitable for translating batch process from Laboratory scale to Pilot Plant scale. It also houses the micro-fixed bed reactors for the performance evaluation of the catalysts in various reactions of academic and industrial importance.

CPP is also involved in various industrial as well as government projects for the development of catalyst and catalytic process in batch and continuous mode.

Major R & D activities carried out at CPP in

I) Na/Li/Ca-LSX Zeolites for High Purity Oxygen from Air

1. New-patented NaLSX zeolite (powder) synthesis recipe developed and further it was scaled up to 2.5kg/batch level.
2. Optimized granulation method for converting NaLSX powder into NaLSX granules.
3. Optimized cation exchange process for NaLSX to Li/Ca-LSX granules.

Patent filed

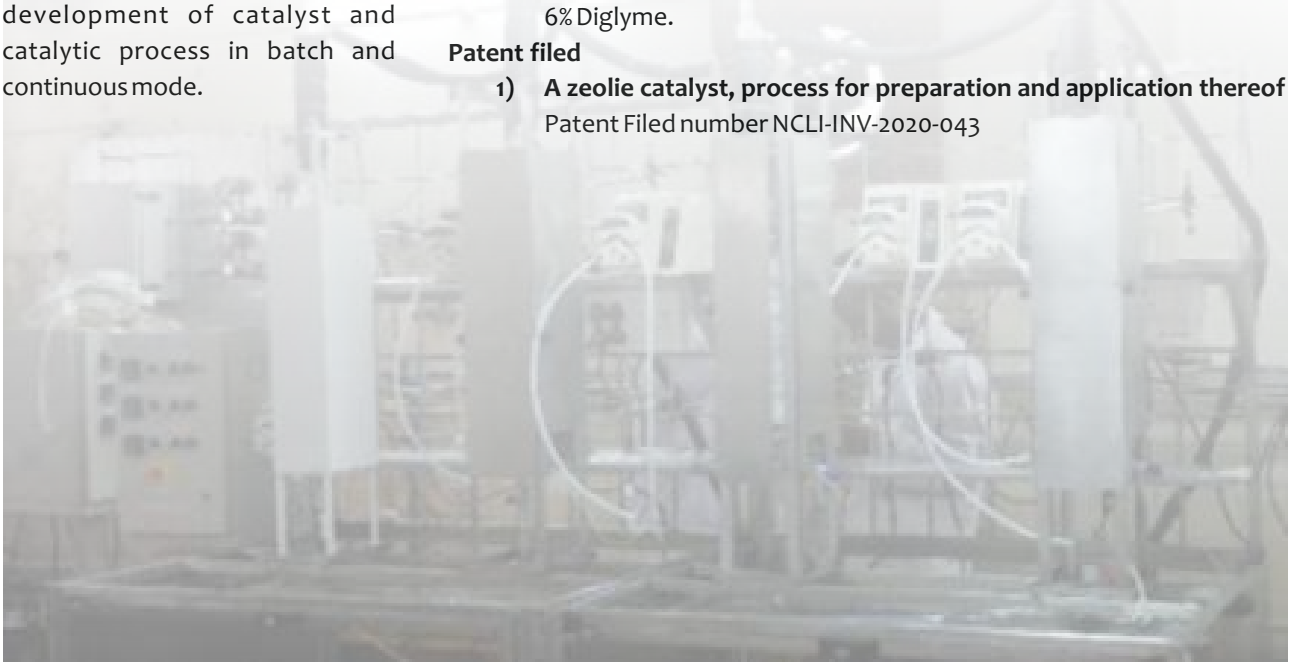
1) **A binderless Na-LSX zeolite synthesis for higher N_2 adsorption.** Indian Patent Filed No. 202211044092.
2) **Cation-exchanged zeolite X for oxygen generation or nitrogen adsorption from air**
Indian Patent Filed number NCLI-INV-2021-044.

II) H-SSZ-13 zeolite for Ethylene Glycol (EG) etherification to Dimethoxyethane (DME).

1. New-patented H-SSZ-13 zeolite developed for the synthesis of EG to Dimethoxyethane. DME is widely used as a green solvent, good etherification agent in cosmetic, pharmaceuticals, perfumes. DME is especially used in batteries and electrolytes.
2. EG to DME continuous process developed with EG conversion of 85%; 2-Methoxyethanol selectivity of 52%; DME Selectivity of 42% and 6% Diglyme.

Patent filed

1) **A zeolie catalyst, process for preparation and application thereof**
Patent Filed number NCLI-INV-2020-043



Intellectual Property Group

The intellectual property group (IPG) at CSIR-NCL is a service group that aims to help scientist and students to strategize, protect, secure, valorize and extract value from intellectual property emerging out of their work while also championing the cause of inventions, inventors and the spirit of invention within CSIR-NCL. First time IPG changed the technical services hiring through online bidding process from this year. During the year number of inventions increased to 85 in 2022 than previous years. Polymer science and engineering, hybrid than previous years. Polymer science and engineering, hybrid and organic materials subject received the highest 22% and 17% inventions respectively. This year IPG filed 52 patents in India, 32 patents filed in foreign countries and number of PCT filings are 19. As well as this year 53 patents granted in India.

IPG manages the portfolio of 1200 patent documents in various countries and provides annual renewal recommendations and their management process within CSIR-NCL. IPG collaborated with Indian patents office's National Intellectual Property awareness Mission (NIPAM). This year IPG partnered with Cell for IPR Promotion and Management (CIPAM) to promote IPR awareness in country and conducted online sessions to train researchers. IPG also partnered with IISER, Pune to organize series of one day workshop for PhD students to train them in science communication. It manages the ownership assignment, MoUs and agreements and also conducts awareness, teaching and scouting programs like IP clinic, drug polymorphism and pharmaceutical Co crystals etc.

National Collection of Industrial Microorganisms

NCIM Resource Centre is dedicated to the isolation, identification, collection, preservation, and distribution of authentic microbial strains to industries and academia for R&D purpose. It is also one of the unit generating significant bio based economy in recent times utilizing microbiology and biotechnological interventions to preserve Indian microbial wealth and diversity.

It has generated the cash flow of Rs. 440 lakhs through supply of 9200 microbial strains. Around 15 microbial strains were lyophilized for their long-term preservation. Nearly 25 new microbial strains were received for deposition. New services of sequencing and phenotypic identification were initiated and about 450 in-house samples and around 590 commercial samples were authenticated.

Standardized certificate of analysis (COA) and authentication report of microbial cultures is being given along with every supply.Latest catalog of microbial strains were made available in the form of hard copy and online version. Updated deposit forms, and sequencing and miscellaneous forms as per global standards are available on online services. NCIM services are also listed on AnalytiCSIR portal.

Digital Information Resource Center

Digital Information Resource Center (DIRC) is continuously in the process of visualizing, anticipating and defining ICT needs of the laboratory and setting up its infrastructure to improve the operational efficiency, convenience, speed & security. The center takes care of planning, installation, operation as well as maintenance of necessary hardware, software as well as human ware of all the IT assets. DIRC also maintains online applications like EMIS, PIR, MIS, and Indent Management etc. Some of the highlighting activities in the year 2021-22 are as follows:

The center maintained two data centers consisting of more than hundred servers/storage and network devices as well as essential non-IT infrastructure consisting of high end UPS, PAC, VESDA, surveillance, fire detection, access control systems, etc. located at DIRC–managed maintenance of more than thousand desktop/ laptop PCs, printers and other computer peripherals in the lab. It maintained DATA CENTER, located at the newly constructed 'Convergence' building, while ensuring its 24x7 availability for the computational scientists in the laboratory. DIRC maintained latest version 'Quick Heal' antivirus software, in order to provide virus-free network environment in the lab and provided/altered 50+ new LAN ports at various locations in the lab/guest house.

DIRC managed the balancing and scheduling of dedicated Internet leased lines from two service providers, ensuring 24x7 Internet requirements/applications of the lab. It takes care of surveillance system consisting of more than sixty IP based Indoor/Outdoor cameras in the lab, guest house and hostel. The center looked after web based 'Access Control & Time Management' system, while maintaining more than twenty biometric readers, installed at various locations in the lab and managed 100+ Wi-Fi devices installed at various locations to provide Internet in the areas such as divisional conf. rooms, corridors, PAML Building, guest house, hostels, etc.

Knowledge Resource Center

The KRC/Library of CSIR-NCL, Pune holds 54839 books, 3000 e-books, 80494 bound volumes, 2500 Theses, 4400 Reports, around 2500 lab books. During the year more than 15 books, 45 theses, 54 bound volumes and 17 Hindi books were added in the library collection.

KRC/Library subscribes to several e-resources for the users of CSIR-NCL. To provide state-of- the-art services to the users, KRC/Library arranges author workshops, training programs for the effective utilization of databases and e-resources subscribed by the library.

Through CSIR-NKRC consortia, users get access to range of e-journals & e-databases from different leading international publishers. During the year, users were able to access more than 750 e-journals from leading foreign publishers such as ACS, AIP, APS, IEEE, Royal Society of Chemistry, IOP-Science, Science Magazine, Springer/Springer-Nature, Thieme , Wiley, Oxford University Press, Taylor & Francis, ASTM standards.

Various popular print journals (Indian & International) were also subscribed.

The library also subscribe to several specialized databases such as iThenticate plagiarism software, Grammarly Software, Web of Science Database, Sci-Finder Database, Orbit Intelligence Questel Database and Derwent Innovations Database. The access to these databases is provided through username/password or through IP.

Library provides Inter Library Loan facilities to users for the documents which are not available in CSIR-NCL library. Due to COVID-19, large number of research requests 1239 journal articles, 47 Indian/ International standards, 14 theses, 58 e-books, 16 reports and 49 patents were handled by the library staff. Library has also provided translation service for various foreign language patents and articles such as German, Russian, French, Japanese, Chinese to English language.

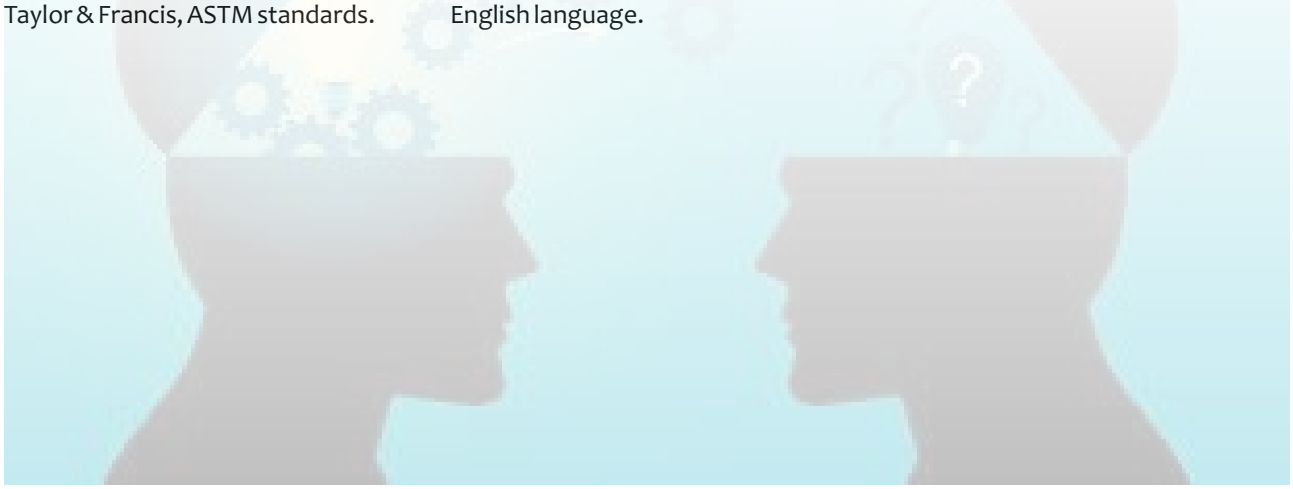
CSIR-NCL Publications Database: During the year around 404 publications were added to the database. Databas currently holds more than 8444 publications. (http://library.ncl.res.in/publications-by-year).

IR@NCL: CSIR-NCL thesis repository is available on Internet through link https://dspace.ncl.res.in.

It is mandatory for students to upload soft copy of their thesis on IR@NCL. The repository presently contains total 2441 records.

New Initiative:

KRC/Library initiated IRINS (Indian Research Information Network System) facility with help from INFLIBNET Centre. The new instance running on https://ncl.irins.org, provides support for scientists to showcase the scholarly communication activities. As of date, there are 116 faculty profiles available on the IRINS platform.



Technology Management Group

Technology Management Group at CSIR-NCL is a central facility to deal with Industry, Contracts, Projects, Licensing, Training and policies. It provides great support to techno-commercial assessment, patent strategies, market intelligence and technological marketing & events. This year NCL-TMG interacted with 250+ clients (Industries, ministries, NGO's, Startups etc.) and signed 120+ agreements including five licensing deals. During the year, TMG executed different agreements that is Non -disclosure/ confidentiality agreements, Material transfer Agreements, MOU's, Sponsored Research Agreements, Technical Services Agreements, Consultancy Agreements, Option Agreements, PhD Fellowship Agreements, Umbrella Agreements, Agreement for CSR engagement and Joint invention disclosure Agreements. TMG Conducted 15 Techno-Commercial assessments, 11 technology Innovation digests once in a month to summarize the market and research trends in the seven theme areas which identified by CSIR- NCL. During this year TMG have produced eight new marketing flyers, redesigned over 20 marketing documents and represented NCL in events like Shining Maharashtra program, March 2022 organized under an awareness program at Phaltan, Maharashtra. TMG actively organized two one day workshops, one two day workshop, and one Three hour workshop for students, principle scientists and for newly joined scientists.

S&T Support Services

CSIR-Jigyasa

CSIR-NCL has been leading the CSIR Jigyasa virtual laboratory (CJVM) since the past three years. The CJVM was conceptualised to include school students from all corners on a single online platform. The platform is built to provide free remote access to students to enjoy playing with science.

The collaboration of CSIR-NCL with IIT Bombay has been fruitful in building the CJVM platform. This platform was opened by Union Minister of State Dr. Jitendra Singh on 22nd November, 2021 in presence of DG CSIR, Head HRDG and others.

The CSIR Jigyasa Vigyan Mohatsav 2022, a joint national level competition, to mark the Azadi Ka Amrit Mohatsav was organised together with CSIR laboratories and headquarter. More than 30,000 students from all over the country and a handful from abroad registered. CSIR-NCL being the lead was involved in all committees and sub committees that were set up to evaluate the students in various categories of themes such as the Health, Energy, Climate Change, Artificial Intelligence, Disaster Mitigation, Agro technology and Water Conservation. The students were evaluated based on their way of conceptualising the scientific themes using creative. They were given with eight choices for creative that included Video, Animation, and Science Fiction, App development, Infographics and Comics. The 75 winners were awarded by Union Minister of State Dr. Jitendra Singh on 25th February, 2022. Four bootcamps were organised and conducted under Jigyasa Vigyan Mahotsav in online mode during April 2021-March 2022.

Jigyasa popular talks and training workshops:

Event	No. of participants
National Level Teachers Training jointly organised with RSC & CSIR-Jigyasa (7–26, February 2022)	450
CSIR-Jigyasa National Science Day Celebration in online mode & Popular Talk on "Converting waste to value" (28 February 2022)	450
Episode on "Microbes and Food" (28 March 2022)	550
Vigyan Jyoti Program Lecture Series "The effect of Force: Equilibrium and Motion" (25 May 2021)	250
CSIR-NCL 7th IISF Curtain Raiser Event "Computer Modelling: Lab in your laptop" (27 November 2021)	250
Participation and Popularisation of CSIR Jigyasa Virtual Lab at IISF Goa (10-13, December 2021)	>1500

Engineering Services Unit

'Engineering Services Unit' comprises Air Conditioning, Carpentry, Civil, Electrical, Glass Blowing Mechanical, and telecommunication sections. ESU plays a significant role in laboratory functioning.

The Civil Engineering section is responsible for buildings construction, foundations for plant erections, road revamping, colony maintenance, drainage cleaning system, etc. The unit also runs and maintains a water treatment plant for providing drinking water to the laboratory. It also runs a garbage management plant to properly dispose of waste while producing a good amount of manure.

The Electrical Engineering section is responsible for providing electrical power supply received to the laboratory, Colony, Guest House, Hostels, Dispensary, etc., from MSEDCL. The unit also takes care of the entire laboratory, colony, allied facilities lighting, and roadside lights. It also maintains electrical substations, distribution systems, solar power systems, diesel generators, telecommunication, etc. The Mechanical Engineering section looks after the procurement, installation, and routine maintenance of water pumps, compressors, vacu-um pumps, gas-piping systems, fume hoods, etc. The central workshop facility is used for various machinery work related to turning, fitting, welding, fabrication, carpentry, etc. This section also manages outsourcing of the Liquid Nitrogen plant for the laboratory requirements. The 'Refrigeration and air conditioning' section takes care of procurement, installation, and repairing of all sorts of comfort and precision ACs. The carpentry department takes care of laboratory furniture procurement as well as repairs. Glass blowing sections undergone the fabrication of various glassware articles required for scientific purposes such as repairs of general purpose as well as special glassware, submitted by scientists and students. Telecommunication section provides internal as well as external telephone facility to all the scientists, staff and in most of the wet labs. It manages preventive and breakdown maintenance of the telephone exchange.

Installation of Walk-In Fumehoods for the PP-IV: A skid was devised by the CEPD division for the use of various reaction set-ups on it. This task was given to ESU for designing a Walk-In Fumehood. Based on the size of this skid, ESU optimized the design of the fumehood and installed three Walk-In Fumehoods. This is the first installation of the Walk-in Hood in CSIR-NCL and is tested as per the ASHRAE standards for its performance. In addition to this during the Pandemic conditions, an uninterrupted supply of liquid Nitrogen was managed in consultation with the supplier for the laboratory experimental work.

निधि की उपयोगिता	(₹ लाख में)
सीएसआईआर अनुदान राशि	
परियोजनाएँ	671.461
नेटवर्क (सी/एफ सहित)	17721.474
गैर-नेटवक	0.000
NMITLI परियोजनाएँ	0.000
ईएमआर एवं वैज्ञानिक पूल	165.367
प्रयोगशाला आरक्षित निधि	1449.577
बाहरी वित्तपोषित परियोजनाएँ	453.157
विविध जमा राशि	0.000
बाहरी निकायों की ओर से भुगतान	0.000
प्रायोजित सम्मेलनों/संगोष्ठियों हेतु अमानतकुल	
कुल	**20461.036**

प्रयोगशाला आरक्षित निधि का अर्जन	(₹ लाख में)
वर्ष के दौरान अतिरिक्त निधि (सीएसआईआर के अलावा) के निवेश पर अर्जित ब्याज के माध्यम से प्रयोगशाला आरक्षित निधि का अर्जन	201.799
अन्य लेखाशीर्षों से	267.552
Total	**469.351**

31.3.2022 को अतिरिक्त निधि का निवेश (₹ लाख में)	**7499.999**

आपत्ति-पुस्तिका मदों का निपटारा	
वर्ष के दौरान किए गए समायोजन	
निजी	550.690
यात्राा भत्ता /छुट्टी यात्रा रियायत	26.080
स्थानीय	2.560
कुल	**579.330**
कुल मदें	93

निम्न लिखित प्रकार के वाउचर तैयार किए गए	
भुगतान	10113
प्राप्त राशि	3030
टी.ई.	153
कुल	**13296**

Funds Utilization	(₹ in lakh)
CSIR Grant	
Projects	671.461
Network (including C/F)	17721.474
Non – network	0.000
NMITLI Projects	0.000
EMR & Scientist Pool	165.367
Laboratory Reserve	1449.577
Externally Funded Projects	453.157
Misc. Deposits	0.000
Payment on behalf of outside bodies	0.000
Deposits for Sponsored conf. / seminars	
Total	**20461.036**

Generation of Lab Reserve	(₹ in lakh)
Through earning of interest on investment of surplus funds (other than CSIR) during the year	201.799
From other heads	267.552
Total	**469.351**

Investment of surplus funds as on 31.3.2022 (₹ in lakh)	7499.999

Clearance of OB items	
Adj. made during the year	(₹ in lakh)
Private	550.690
TA/LTC	26.080
Local	2.560
Total	**579.330**
No. of items	93

Following types of vouchers were generated	
Payment	10113
Receipt	3030
TE	153
Total	**13296**

उपलब्धियां

मद	संख्या		मूल्य (₹ करोड में)	
	2020-21	2021-22	2020-21	2021-22
कुल प्राप्त एवं निष्पादित मांगपत्र	923	3627	21.45	32.42
कुल दिए गए ऑर्डर (आयातित)	44	27	1.72	5.99
कुल दिए गए ऑर्डर (स्वदेशी : ऑनलाइन आरसी ऑर्डर सहित)	1236	3600	18.78	26.63
सीनीय और जेम खरीद; ऑनलाइन आरसी ऑर्डर सहित)	1165 & 204	2069 & 332	1.46 & 0.20	3.46 & 0.40
वित्तीय वर्ष के दौरान समायोजित बकाया शेष	36		15.99	
वित्तीय वर्ष के दौरान सीमा शुल्क से छूट प्राप्त राशि का उपयोग	8		1.12	
आरसी ऑर्डर	376	532	1.25	1.71

Accomplishments

Item	Numbers		Value (₹ In Crores)	
	2020-21	2021-22	2020-21	2021-22
Total indents received and Processed	923	3627	21.45	32.42
Total order placed (imported)	44	27	1.72	5.99
Total orders placed (indigenous including on line RC orders)	1236	3600	18.78	26.63
Local purchases & Gem purchases	1165 & 204	2069 & 332	1.46 & 0.20	3.46 & 0.40
O.Bs adjusted during the financial year	36		15.99	
Utilization of Custom Duty Exemption	8		1.12	
RC orders	376	532	1.25	1.71

Lab Safety Management

CSIR-NCL's Laboratory Safety Committee has been instrumental in comprehensive lab safety management and has initiated new activities that will lead to better overall safety of the laboratory. The safety committee works under the leadership of Director, Dr. Ashish Lele and is stewarded by Dr. Harshawardhan Pol (Chair) and Dr. Samir Chikkali (Co-Chair) in implementation of various safety protocols in the laboratory. Various activities undertaken in safety management include quarterly lab safety review meetings, divisional safety audits (conducted by divisional safety committee), fire safety training (in-house & through outside experts), waste chemical (both solid & liquid) disposal, waste solvent disposal, lab clean-ups, etc. The current lab safety cmte (in FY 2021-2022) has undertaken several new initiatives under safety management such as: i) providing hands-on fire safety training to all staff and students (about 950 number) through an external authorized fire safety training firm ii) construction of new waste chemical shed, iii) starting waste solvent collection activity in new waste solvent shed iv) distribution of new safety glasses and solvent gloves to all research groups in all divisions, v) procurement of new fire safety blankets, full-faceRespirators, safety helmets for use by staff/students in lab vi) replacement of damaged/obsolete fire hydrant fittings vii) implementing regular fire hydrant checks, ix) Identifying emergency assembly areas and marking them with signages, etc. The lab safety cmte has been also instrumental in performing regulatory activities under the MPCB's consent to operate (CtO) that include periodic air/water/sound quality checks and hazardous and non-hazardous waste disposal for the entire campus. Finally, the lab safety cmte has initiated a process for hiring services of an experienced safety consultant. The appointment of the safety consultant will be beneficial in further strengthening lab safety through preparation of lab safety manuals, lab rankings based on risk assessment, and safety related asset replacement plan.

In-house fire safety training

Publication and Science Communication Unit

Publication and Science Communication unit is instrumental in communicating the information between the laboratory and its stakeholders. It communicates the impact making work from laboratory in the form of R&D features, prepares and issues press releases and also coordinates the videos for its stakeholders. The department compiles the annual reports, brochures and uses digital media platforms like Facebook, Twitter, YouTube, Web applications. It plays critical role to manages programs organized through auditorium and lecture hall and webinars. It also manages the external and internal websites. The unit with active role of scientists participates in exhibitions across India and conducts interviews with scientists on the request of media reporters.

PSC coordinated / participated in following exhibitions during the year

- Shining Maharastra, Phaltan, Maharastra (25-27 March, 2022)
- India International Science Festival, Panaji, Goa (10 – 13 December, 2022)

Skill Development Program

Skill development and specific domain knowledge are fundamental to the growth of research, science, technology and in turn, drive the manufacturing & services sectors.CSIR- NCL has embarked on implementing CSIR's Skill Integrative initiative and started its first skill development course. The major objective of this program is to give students the opportunity to develop the skills they'll need to prosper "both in their career and beyond". It aims to create opportunities, space and scope for the development of the talents of the youth and to expand more of those sectors which have already been put under skill development for the last so many years and also to identify new areas for skill development.

During the last financial year (2021-2022) CSIR-NCL has conducted seven skill develo-pment programs and trained 113 candidates and generated the ECF of ~5.13 Lakh. Some of the Skill Development programs like Certificate Course on Science Communication and Practice, Patents for Students, Researchers & Entrepreneurs and Targeted Proteomics were conducted online.

Photographs of the candidates during the training/certificate distribution

X-ray Crystallography

Polymer Characterisation by DSC, TGA, FTIR and GPC Spectrophotometer

Following Skill Development programs were conducted at CSIR-NCL during the year

Course Name & Duration

- X-ray Crystallography (18-29 October 2021)
- Certificate Course on Science Communication and Practice (22-26 November 2021)
- Patents for Students, Researchers & Entrepreneurs (20-21 January 2022)
- Polymer Characterisation by DSC, TGA, FTIR and GPC Spectrophotometer (7-17 March 2022)
- Targeted Proteomics (10-12 March 2022)
- Synthetic Organic Chemistry (10 March - 10 May 2022)
- Controlled Release of Active Molecules (21-25 March 2022)

Human Resource Management

The Human Resource Management (HRM) department coordinates the process of a short term Training Program for postgraduate students. These students are inducted throughout the year.

Due to the pandemic and for safety reasons CSIR-NCL had restricted short term training students from visiting the laboratory. Limited number of students were permitted during November and December 2021. From January 2022 only a total of 10 students were permitted in each division. The total number of students during the FY 2021-22 were 51 out of which 15 were undergraduate and 36 were post graduate students.

CSIR-Jigyasa

Annexures

Title	Inventor(s)	Country/ Patents No.
Synthesis Of Alkyl Carbamates From Alkyl Alcohol And Urea In A Tubular Reactor	Vivek V. Ranade; Ashutosh Anant Kelkar; Vilas Hari Rane; Anil Kisan Kinage; Dhananjay Ravindra Mote; Savita Kiran Shingote; Lalita Sanjib Roy	JP: 6864629
Water Splitting Activity Of Organic Conducting Ligand Functionalized Semiconductor Nanoparticles	R Nandini Devi; Leena George	US: 10967365
N-doped Porous Carbon Derived From Graphitic C_3N_4-MOF Composite As An Efficient Non-platinum Electrocatalyst	Sreekumar Kurungot	DE: 3047532 GB: 3047532 EP: 3047532
A Nucleotide Sequence Of 9-Lipoxygenasegene From Mango	Vidya S Gupta	EP: 3436573 FR: 3436573 DE: 3436573
Preparation Of Disentangled Ultra High Molecular Weight Polyethylene Catalyzed By Carboxy/Sulfoxy-Imine Ligated Early Transition Metal Complexes In Presence Of A Cocatalyst	Samir H Chikkali	JP: 6882206
Novel Process For The Synthesis Of Hunanamycin A	D Srinivasa Reddy	US: 11002524
Hydrogenolyis Of Biomass Derivatives Over Ruthenium Supported On Nitrogen Doped Mesoporous Carbon	Satyanarayana V V Chilukuri	US: 11000831
Bioactive Oil Based Polyesteramide Nanofibers For Wounds Healing	G V N Rathna	GB: 3131536 EP: 3131536 DE: 3131536
Blend Membranes Based On Pbi And Polyionic Liquids	U K Kharul; Sreekumar Kurungot; Anita Sanwarmal Rewar; Harshal Dilip Chaudhari	CA: 2937444
Discovering Room Temperature Multiferroicity In Fe_3Se_4	Pankaj Poddar	US: 11014813

Title	Inventor(s)	Country/ Patents No.
Pyridinium-Oxazole Dyad Salts With Tunable Emission Wavelengths	Aslam C Shaikh; Nitin T Patil	US: 11021490
Method To Enhance Ferroelectric Crystal Phases And Dielectric Properties Of Pvdf	Kadhiravan Shanmuganathan	US: 11034829
Phosphorescence Assisted Tunable Emission From Alkylated Bromonaphthalimides	Santhosh Babu Sukumaran	US: 11040946
Molecular Complexes For Effective Inhibition Of Tau Aggregation	Subashchandrabose Chinnathambi; Ekambaram Balaraman	US: 11040994
Surfactant Combination Applied Through Aqueous Dispersion That Allows Effective Staining Of Hydrophobic Surfaces	Guruswamy Kumaraswamy	DE: 3484963 FR: 3484963 EP: 3484963 ES: 3484963
Highly Crystalline Spherical Silk Fibroin Particles	Anuya Nisal; Bhakti Khude; Premnath V	US: 11046737
Microcapsules Modified With Nano Materials For Desired Release Pattern / Rate And Preparation Thereof	Parshuram Gajanan Shukla	US: 11059015
Method For The Synthesis Of Artemisinic Acid Glycoconjugates As Novel Anti-Cancer Agents	Asish K Bhattacharya	US: 11059848
Synthesis Of Up-Converting Nano-Rods And Application Towards Security Tags	J Nithyanadhan; A Ananthan	US: 11078415
Low Temperature Demulsifier	Sanjay Pandurang Kamble	US: 11084987
Elastic Macroporous Scaffolds With Tunable Pore Size From Covalent Self-Assembly Of Nano And Microparticles	Guruswamy Kumaraswamy; Raja Rajamanickam; Sayam Sengupta	US: 11083820
Solomonamides Analogues And Synthesis Thereof	Dumabala Srinivasa Reddy; Kashinath Kormirishetty; Vasudevan Natrajan	CH: 2925771 EP: 2925771 DE: 2925771 GB: 2925771

Title	Inventor(s)	Country/ Patents No.
Process For The Preparation Of Self-Assembled Metalloporphyrin 2d-Sheets For Efficient Photo- And Electro- Catalytic Splitting Of Water	Santhosh Babu Sukumaran	US: 11098156
Novel Analogues Of Benzenecarbothioccyclopenta[C]Pyrrole-1,3-Dioneand Synthesis Thereof	Dumbala Srinivasa Reddy ; Satish Chandra Philkhana ; Gorakhnath Rajaram Jachak ; Vidya Bhausaheb Gunjal	CH: 3201193 GB: 3201193 EP: 3201193
Iodination Of Aromatics Using Solid Acid Catalysts	Shubhangi B Umbarkar; Amarsinh Deshmukh; Atul B Kulal	US: 11111207
Process For Dissolution Of Melanin And Products Thereof	Kadhiravan Shanmuganathan; Abhijit Shete; Nikhil Pimpalkar	US: 11109589
Regeneration And Recovery Of Catalysts (Rare Earth Metal Salts) Used In Process Of Manufacturing Dialkyl Carbonates From Alkyl Carbamate And Alkyl Alcohol	Vivek V Ranade	US: 11110449
Single Step Process For 2,5-Di(Formyl)Furan And 5-((Methylthio)Methyl)-2-Furfural Directly From Carbohydrates	Chandrashekhar Rode	US: 11136302
Heterogeneous Catalyst System For Producing Disentangled Ultra High Molecular Weight Polyethylene	Samir H Chikkali	US: 11155654
ABPBI Copolymer Membranes For HT-PEMFC Application / ABPBI Copolymers	U K Kharul; Kurungot Sreekumar; Harshal Dilip Chaudhari; Vinaya Bhagwat Ghodake	CA: 2922667
A Nucleotide Sequence Of O-Methyl Transferase Gene From Alphonso Mango	Vidya S Gupta	CH: 3310907 EP: 3310907 DE: 3310907
Polyolefin Composition That Can Be 3d Printed Using Fused Deposition Modeling (Fdm) Technology Without Warpage	Guruswamy Kumaraswamy	JP: 6975855
Synthesis Of Functionalized Carbon Microspheres And Their Catalyst Activity In C-C And C-N Bond Formation Reactions	Shubhangi B Umbarkar; Ankush V Biradar; Mohan K Dongare	NL: 3013743B1 EP: 3013743B1

Title	Inventor(s)	Country/ Patents No.
Process For The Preparation Of L-Lactide Of High Chemical Yield Optical Purity	Bhaskar Bhairavnath Idage; Sivaram Swaminathan	BR: BR1120120213458
Regeneration And Recovery Of Catalysts (Rare Earth Metal Salts) Used In Process Of Manufacturing Dialkyl Carbonates From Alkyl Carbamate And Alkyl Alcohol	Vivek V Ranade	CN: XL201680026395.X
Synthesis Of N-Methyl Phenyl Carbamate From Aniline And Dimethyl Carbonate Using Ceznzr Ternary Mix Metal Oxide As A Catalyst	Ashutosh A Kelkar; Vivek V Ranade; Nayana T Nivangune	EP: 3630717
Novel Process For Self Reinforcement Of Silk Fibroin Coatings And Products Thereof	Anuya Nisal	FR: 3600463 NL: 3600463 EP: 3600463 CH: 3600463 GB: 3600463
Isomerizing Hydroformylation Of Plant Oils To Feedstock Chemicals And Monomers	Samir H Chikkali	US: 11267833
Novel One Pot Continuous Process For Synthesis Quinolines And Its Derivatives	D Srinivasa Reddy; Amol Kulkarni	US: 11274081
Simple Strategy For The Preparation Of PbI Based Membrane Electrode Assembly (MEA) With Improved Fuel Cell Performance And Stability	Sreekumar Kurungot; Rajith Illathvalappil; Siddheshwar Navanath Bhange; Sreekuttan Maraveedu Unni	CA: 2933168
Use Of Proton Conducting Fnpa Metallogel As Solid Electrolyte For Realizable Dry And Intermediate Temperature H_2-O_2 Fuel Cell Operation	Sreekumar Kurungot; Rahul Banerjee; Harshitha Barike Aiyappa; Subhadeep Saha; Pritish Wadge	US: 11283095
New Reagent For Specific Detection Of Cysteine In Physiological Condition As Well As By Using Modified Silica Coated Test Strip	Amitava Das; Anila H A; Upendar Reddy Gandra; Firoj Ali	EP: 3283461

Title	Inventor(s)	Patent No.
Eco-Friendly Route For Synthesis Of Diphenylmethane	Sanjay Pandurang Kamble; A Sudalai	363996
Process For Preparing Biodegradable Lubricant Base Oils	Darbha Srinivas; Mehejabeen Kotwal	364027
Cystine Mediated Reduction Allows Tunable Synthesis Of Different Size Of Fluorescent Au Quantum Clusters	Pankaj Poddar; Puneet Khandelwal; Dheeraj Kumar Singh	364630
Isomerizing Hydroformylation Of Plant Oils To Feedstock Chemicals And Monomers	Samir H Chikkali	364950
Pcda-Phbv Electrospun Adherent Mats On Paper As Authentication Feature	Sachin Dubey;Jyoti Jog; V Premnath; Usman Khan	366177
Novel Nickel Catalyst Systems For C–H Bond Alkylation And Arylation Of Arenes And Heteroarenes	Benudhar Punji	366437
Magic(Modular, Agile, Intensified & Continuous) Reactors: HVF (Helical Coil, Vortex Diode & Flow Disrupter)	Vivek Vinayak Ranade; Amol Arvind Kulkarni	366511
Process Of Production Of 6-Amino Penicillanic Acid From Phenoxymethyl Penicillin (PenV) Using Highly Active Recombinant Penicillin V Acylase	Avinash V S ; Pundle A V; Sureshkumar R	367762
Novel Chemically Isolated Graphene Nano Spheres And Its Production From Graphene Through Self Organizing And Thereof	K Selvaraj; Rajendra Prasad Meena; Krishan Kumar Dhaka; Meghana Aneesh	368745
Insertion Copolymerization Of Functional Olefins Catalyzed Pd-Phosphinesulfonate Acetonitrile Complex	Samir H Chikkali; Sahaji Rajaram Gaikwad	369128
Synthesis Of Dimethyl Carbonate (DMC) From Methanol And Methyl Carbamate/Urea Using Samarium Nitrates (Metal Nitrate Of Rare Earth Elements) As Catalysts	Vivek V Ranade; Ashutosh Anant Kelkar; Vilas Hari Rane;Anil Kisan Kinage; Savita Kiran Shingote; Lalita Sanjib Roy	369632
Molecular Complexes For Effective Inhibition Of Tau Aggregation	Subashchandrabose Chinnathambi; Ekambaram Balaraman	370238
CuPt Alloy With Mixed Dispersion On Nitrogen Doped Grapheme As A Highly Efficient And Durable Electrocatalyst For Alkaline Fuel Cell Application	Sreekumar Kurungot	370555

Title	Inventor(s)	Patent No.
Water Splitting Activity Of Organic Conducting Ligand Functionalized Semiconductor Nanoparticles	R Nandini Devi; Leena George	370722
Active And Durable Catalyst For Synthesis Gas Generation	C V V Satyanarayana	371485
Iodination Of Aromatics Using Solid Acid Catalysts	Shubhangi B Umbarkar; Amarsinh Deshmukh; Atul B Kulal	371573
Self Standing Crystalline, Porous Covalent Organic Membranes For Molecular Separation	Rahul Banerjee; Ulhas Kanhaiyalal Kharul; Sharath Kandambeth; Bishnu Prasad Biswal; Harshal Dilip Chaudhari; Suvendu Karak	371570
Microcapsules Modified With Nano Materials For Desired Release Pattern / Rate And Preparation Thereof	Parshuram Gajanan Shukla	371908
Synthesis Of N-Methyl Phenyl Carbamate From Aniline And Dimethyl Carbonate Using CeZnZr Ternary Mix Metal Oxide As A Catalyst	Ashutosh A Kelkar; Vivek V Ranade; Nayana T Nivangune	372085
Process For The Synthesis Of Chlorizidine A And Its Analogues For Their Anticancer And Antimalarial Properties	Santosh Baburao Mhaske	372562
Synthesis Of Dimethyl Carbonate From Ethylene Carbonate And Methanol Using Ternary Hydrotalcite As A Catalyst	Ashutosh A Kelkar; Vivek V Ranade	372929
Novel One Pot Continuous Process For Synthesis Quinolines And Its Derivatives	D Srinivasa Reddy; Amol Kulkarni	374290
Novel Copper (II) Coordination Complex For Multi-Action Naked Eye Calorimetric Anion Sensor	V G Puranik ; Rajesh G Gonnade; Rupesh Liladhar Gawade	375024
Asymmetric Synthesis Of Spiro-3-Amino-Oxindoles Via Vinylogous Mannich Reaction To Isatin Derived N-Tert Butanesulfinyl Ketimines	Ravi P Singh; Udaya Bhaskara Rao Vippili; Amol Pandharinath Jadhav	375550
Synthesis Of Polymer Supported Lewis Acid: Recyclable Catalyst	Nayaku Nivrati Chavan; Sachin Tanaji Mane; S Ponrathnam	377935
Process For The Preparation Of Self-Assembled Metalloporphyrin 2D-Sheets For Efficient Photo- And Electro- Catalytic Splitting Of Water	Santhosh Babu Sukumaran	378060

Title	Inventor(s)	Patent No.
Synthesis Of Polyoxalates From Renewable Resource, And A Process For Preparing Films Thereof	Samir H Chikkali	378518
Mineral Supported 2D Carbon Based Non-Metallic Bifunctional Nanocatalyst For Sustained Oxygen Electrochemistry	K Selvaraj	378641
Synthesized A New Pyrene Tetraboronic Acid For A Use Of Glucose Sensing	Santhosh Babu Sukumaran	378733
Polyolefin Composition That Can Be 3D Printed Using Fused Deposition Modeling (FDM) Technology Without Warpage	Guruswamy Kumaraswamy	378994
Non Noble Metal Based Diesel Oxidation Catalyst	Shubhangi B Umbarkar; Mohan K Dongare;Pavan M More; Ankush V Biradar	379475
Curcumin Conjugated Silver Nanoclusters As An Anti-Aggregation Agent	Subashchandrabose Chinnathambi; Pankaj Poddar	379652
Solar Hydrogen Production From Artificial Leaf Made From Chalcogenide-Au-TiO2	Chinnakonda S Gopinath	379838
Synthesis Of Spherical And Fluorescent Nanostructures Using Sophorolpids	Asmita Ashutosh Prabhune; Pradeep Kumar Singh; Ruchira Arup Mukherji; S. B. Ogale	380263
Solvent-Less Synthesis Of Organic-Solvent Dispersible Metal Nanoparticles	B L V Prasad	380616
Transition-Metal-Free Catalytic Conversion Of Amides To Esters	Ekambaram Balaraman	381666
A Method For The Synthesis Of Norepinephrine Alkaloids And Its Analogs As Antimalarial Agents	Asish K Bhattacharya; Eswarkumar Aratikatla; Kumkum Srivastava; Ashan Manhas	381965
A New Process For The Preparation Of Aromatic Ketones From Arenes	Arumugam Sudalai; Sanjay P Kamble	382272
Fe(III) Complex Of Biuret-Amide Based Macrocyclic Ligand As Peroxidase Enzyme Mimic	Sayam Sengupta; Chakadola Panda; Munmun Ghosh	382545
Selective Aerobic Oxidation Of Hydrocarbons Using Metal Free Catalysts	C V V Satyanarayana ; Narasimharao Kanna; Lakshmiprasad Gurrala	383004

Title	Inventor(s)	Patent No.
Synthesis Of 2,2,3,3-Tetrahydro-3,3,3,3-Tetramethyl-1,1-Spirobi[1H-Indene]-5,5,6,6-Tetramine, Method Of Polymerization And Use	C V Avadhani	383756
New Reagent For Specific Detection Of Cysteine In Physiological Condition As Well As By Using Modified Silica Coated Test Strip	Amitava Das; Anila H A; Upendar Reddy Gandra; Firoj Ali;	383752
Reinforced Cellulose Papers With Enhanced Tear Strength	V Premnath; Kadhiravan Shanmuganathan	384074
Solomonamides Analogues And Synthesis There of	Dumabala Srinivasa Reddy; Kashinath Kormirishetty; Vasudevan Natrajan	384278
Scalable And Tunable Synthesis Of Visible To Near Ir Absorbing And Emitting Library Of Metal Sulfides QDs	B L V Prasad	384312
Ketoesters: A Facile Access To Γ-Spiroketal-Γ-Lactones Bismuth(III)-Catalyzed Cascade Annulation Of Alkynols With	Kontham Ravindar	384547
Porous Crystalline Covalent Organic Framework-Materials With Remarkable Chemical Stability For Methane Storage	Rahul Banerjee	384671
A Novel Process For The Synthesis Of Bio-Lubricant Using Homogenous And Heterogeneous Catalyst	Sanjay Pandurang Kamble	384768
Compounds With 3/5/6 Tricyclic Ring System	Srinivasa Reddy; Kishor Laxman Handore	385084
Improved Perovskite Catalysts For Synthesis Gas Production With Variable Hydrogen To Co Ratios	Satyanarayana Chilukuri	385504
Porous Silk Fibroin Scaffold	Anuya Nisal; V Premnath	387170
Simple Strategy For The Preparation Of PBI Based Membrane Electrode Assembly (MEA) With Improved Fuel Cell Performance And Stability	Sreekumar Kurungot; Rajith Illathvalappil; Siddheshwar Navanath Bhange; Sreekuttan Maraveedu Unni	388996
Electrochemical On-Chip DNA Sensor For Pancreatic Sensor	Preeti Nigam Joshi	389909
Transformed *Withania Somnifera* Plants With Improved Secondary Metabolite Content	B M Khan; Neha Gupta; Parth Sanjaykumar Patel; Poonam Sharma; Shuchishweta Vinay Kendurkar	390995

Indian

Title	Inventor(s)	Patent No.
A Process For Direct Production Of 2-Methyl Tetra Hydro Furan From Furfural	Chandrashekhar V Rode	393603
Process For Synthesis Of Hyperbranched Polycarbonate	Ashootosh V Ambade	393660
Silk Sericine And Sophorolipids: A Novel Cost Effective Formulation For Wound Healing	Asmita A Prabhune; Snehal More; Sachin Agawane	393814

Academy of Scientific & Innovative Research: 71

Author	Title	Guide(s)
Abdul Motaleb	Organocatalyzed synthesis of regio- and stereoselective heterocycles via functionalization of (unsusbtituted) N–heteroaromatics and carbocyclization of propargyl ethers	Pradip Maity
Abhijit Bera	Scalable synthesis of dispersible semiconducting metal chalcogenides nanocrystals and their application	B.L.V. Prasad & Arup Kumar Rath
Ajay Bansode	Synthesis of biologically important molecules and development of synthetic methodologies involving oxidation reactions *via* visible-light and transition metal-free conditions	Gurunath Suryavanshi & Shafeek A. R. Mulla
Amarnath Singam	Studies on development of polymeric nano-systems for delivery of anti-cancer bioactive molecules	G. V. N. Rathna
Ambaji Pawar	Synthetic studies towards biotin, oxybiotin, α-lipoic acid and scalable synthesis of 3-ethyl-4-methyl- 1,5-dihyro-2*H*-pyrrole-2-one and development of synthetic methodologies.	Subhash Chavan
Amol Ichake	Bio-Derived Monomers for Step-Growth Polymers Based on Lignin-Derived Aromatic Chemicals and Cashew Nut Shell Liquid (CNSL)	P. P. Wadgaonkar & Henri Cramail
Anagh Mukherjee	Computational Studies on the Effect of Charge and Electric Fields on Systems of Chemical and Biological Interest	Kumar Vanka & Sayam Sengupta
Anupam Biswas	Synthetic control in low dimensional 'Pb' and 'Pb-free' perovskites for rationalizing the origin of their luminescence properties	Durba Sengupta & Janardan Kundu
Anupam Tripathi	An approach toward the total synthesis of biologically active molecules (D2 receptor agonist quinagolide and antidiabetic drug sitagliptin) & synthesis of heterocyclic building block and novel triazole methodology	Subhash Chavan
Anurag Chahande	The Optical Properties Of Noble Metal Nanoclusters & Application In Bioimaging and Security	R. Nandini Devi
Ashish Sharma	Designing the hole transport layer for the development of perovskite and quantum dot solar cells	Arup Kumar Rath
Ashwini Deshpande	Apolar oligomers: Synthesis and their self-association through physical / 3D interactions	P. P. Wadgaonkar, C. V. Avdhani, & Cloudio

Author	Title	Guide(s)
Atish Wagh	IsoDNA/isoRNA oligomers of the thrombin binding aptamer and 2'-thiopropyl and abasic ethanediol substitutions therein	Moneesha Fernandes
Bapurao D. Rupanawar	Enantioselective synthesis of glucosylceramide inhibitor by aminolytic kinetic resolution and development of synthetic methodologies for C-C, C-O bond formation reactions involving acid and hypervalent iodine reagents	Gurunath Suryavanshi & Shafeek A. R. Mulla
Betsy K J	Exploring the chemical modifications in periodic mesoporous silica materials for heterogeneous catalytic applications	C. P. Vinod
Debranjan Mandal	Role of surface passivation and doping on the development of quantum dot solar cells	Arup K. Rath
Dhananjay Doke	Synthesis of lactate and its valorization to value added chemicals	Shubhangi Umbarkar
Digambar Kambale	π -Activation triggered cascade annulation reactions of alkynols: Application in construction of ketallactones related to bioactive natural products	Ravindar Kontham
Divya Karade	Chemoinformatics based investigation of plant metabolites for their medicinal and crop protection values	M. Karthikeyan & Narendra Kadoo
Emmanuel Joseph	Design and development of biocompatible silk fibroin coatings for breast implant applications	Anuya Nisal
Govind Porwal	Insights on the synthesis of fine chemicals and its upscaling on heterogeneous catalysts	Vinod C. Prabhakaran
Gunvant Deshmukh	Hydrogen bond comprising small molecules and polymers for the self-assembly and electronic device	K. Krishnamoorthy
Harsha Chilukuri	Alkyl proline and oxytocin derivatives towards development of anti-diabetics and design of potential antifolates derived from guanine	Moneesha Fernandes
Jayesh Shimpi	Understanding the Digestive Ripening Process through Metal, Metal Alloys Nanocrystal Preparation and their Applications	B. L. V. Prasad
Jyoti Rawat	Towards improving cell culture processes for biotherapeutic production: Novel tools and strategies	Mugdha Gadgil
Mahendra Pawar	Growth of two dimensional (2d) materials and its	T. G. Ajithkumar & Dattatray J.

Author	Title	Guide(s)
	applications in nanoelectronic devices	Late
Mahesh Pisal	Synthesis and biological evaluation of thienopyrimidinone-containing compounds as antitubercular and anticancer agents, novel dicyanoanilines as cell imaging agents and studies towards the total synthesis of quinagolide	Subhash Chavan
Mahesh Shinde	Gold-catalysed cycloisomerization of alkynols: Studies toward the total synthesis of mersicarpine and C35–C53 fragment of symbiospirols A/B/C	C. V. Ramana
Maya Mane	Studies in newer methodologies and materials/ material modifications for environmental, pollution control applications specifically for water treatment and desulfurization	V. M. Bhandari
Meena Ghosh	Configuring post-lithium aqueous rechargeable zinc batteries using optimized electrolytes and electrode materials	K. Sreekumar
Megha Dinkar Deokar	Controlled Synthesis of Polymers and Copolymers Derived From Lactic Acid-Structure, Property and Function	B. Garnaik
Monika Malik	Study of the effect of phase and morphology on the optical properties of lanthanide ion-doped phosphors and their applications	Pankaj Poddar
Muzammil Khan	Gas-liquid-liquid-solid hydrogenation systems	Sunil Joshi & V. V. Ranade
Naresh Killi	Design and synthesis of new polymeric carriers as drug delivery systems	G. V. N. Rathna
Nirshad Alam	Removable Functional Group Strategy for Regio- and Stereoselective Molecular Rearrangements and Related Reactions	Pradip Maity
Nitainikhil Sarkar	Preparation of chiral *myo*-inositol derivatives and their conversion to natural product/analogs	S. Shashidhar & Rajesh Gonnade
Niteen Patil	Synthetic studies towards quinagolide, 3-ethyl-4-methyl-1,5-dihydro-2*H*-pyrrol-2-one and continuous flow synthesis of Miltefosine	Subhash Chavan
Paresh Athawale	Total synthesis guided structural revision of peribysin family natural products and development of novel method for enone transposition	D. Srinivasa Reddy

Author	Title	Guide(s)
Pawan Dhote	Internal nitro-/azidoalkyne redox processes in heterocyclic synthesis and metal free mcmurry type coupling	C. V. Ramana
Piyali Ganguli	Identification of immuno-regulatory modules and optimal treatment strategies for eliciting effector functions against different diseases	Ram Rup Sarkar
Prabu K.	Selective catalytic oxidation over metal oxides for the valorization of biomass derived feedstocks and Propane	T. Raja
Prachi Walke	Molecular investigation of glycated insulin induced insulin resistance and hyperglycemia induced beta cell dysfunction	Mahesh Kulkarni
Pratikshkumar Patel	Design and Development of Non-woven Nanofibers as Drug Delivery System	G. V. N. Rathna
Priyanka Bhongale	An investigation into alkylation of hydroxybenzenes to industrial useful chemicals	Sunil Joshi & Nilesh Mali
Prophesar Kamdi	Study of pressure driven flow of Laponite suspension through a cylindrical tube	Ashish V. Orpe & Guruswamy Kumarswamy
Rashid P P	Design and synthesis of novel class of multi-purpose fluorescent α-amino acids and an efficient route for the synthesis of NOS inhibitors	G. J. Sanjayan
Roopa Parate	Bioconversion of biomass derived C3 and C6 molecules to value added products	C. V. Rode & Mahesh Dharne
Ruchi Dixit	Understanding nucleophilic attack chemistry in main group compounds with density functional theory	Kumar Vanka
Rupa Bhowmick	Deciphering the complexities in oncogenesis: An integrative approach to understand its adaptive phenotypes	Ram Rup Sarkar
Rupali G. Kalshetti	Early and late stage C-H activation protocols for bioactive molecules and direct conversion of stilbenes to diaryl-α-hydroxyacetaldehydes	C. V. Ramana
Sagar Thorat	Stereoselective total synthesis of yaoshanenolides, pleurospiroketals, and construction of furopyranones through [3+2]-annulation of alkynols and α-ketoesters	Ravindar Kontham
Sanjukta Pahar	Donor-acceptor stabilization of compounds with	Sakya S. Sen

Author	Title	Guide(s)
	low coordinate group 13 and 14 elements	
Santosh Lavhale	Functional characterization of 4-Coumarate-CoA ligases involved in phenylpropanoid biosynthesis from *Ocimum kilimandscharicum*	A. P. Giri
Santosh Shelar	Cyclic anhydrides and imides to indole based novel natural and unnatural products	Narshinha P. Argade
Sayantan Paul	Approaches towards the synthesis of C-13 arylated artemisinin from artemisinic acid *via* C(sp2)–H and C(sp3)–H functionalization; Hydroxyl assisted transition metal free C(sp2)–H functionalization and biodynamics from *Artocarpus heterophyllus* and *Aspergillus niger*	Asish K. Bhattacharya
Shamala Mane	Chitosan from zygomycetous fungus, *Benjaminiella poitrasii*: Scale up for biomass production and biophysical characterization of biopolymer	Bhushan Chaudhari & Mukund Deshpande
Shrikant Karegaonkar	Chemical and *De novo* Transcriptomic Analysis of medicinal plants, *Amomum aculeatum* Roxb. And *Couroupita guianensis* Aubl.	H. V. Thulsiram
Shrikant Nikam	Synthesis of various classes of chiral polymers and their application in enantioselective separation	Asha S. K.
Sibadatta Senapati	A chiral pool approach for the total synthesis of *bis*-THF C15 acetogenins - notoryne, laurefurenynes A/B, laurendecumenyne B and a chloroenyne from *Laurencia majuscula*, and Synthesis of C14 to C29 fragment of eribulin	C. V. Ramana
Sneha Singh	Structural studies on sesquisabinene synthase 1: Enzyme involved in terpene biosynthesis pathway	Kiran Kulkarni & H. V. Thulsiram
Sonia Agrawal	Characterization of nitrite induced viable but non-cultivable *Mycobacterium tuberculosis* bacilli	Dhiman Sarkar
Subhrashis Banerjee	Computational Insights into Proton and Hydride Transfer Chemistry	Kumar Vanka
Suman Devi	Luminescent nanomaterials and their applications	M. Niraj Luwang
Sunil B Aute	Synthesis, characterization and photophysical studies of dyes molecule for dye sensitized solar applications	Amitava Das
Sushil Sakpal	Spectroscopic investigation of molecular probes	Sayan Bagchi

Author	Title	Guide(s)
Sutanu Nandi	Development of machine learning strategies and integrated web platform for the prediction of essential genes	Ram Rup Sarkar
Tamal Das	Insights into messy chemistry related to cosmology and origin of life obtained by employing state-ofthe-art computational methods	Kumar Vanka
Tapas Haldar	Spectroscopic determination of electrostatic and hydrogen bonding interactions in chemical and biological systems	Sayan Bagchi
Tejashri B Hingamire	Studies on novel inhibitors, target validation and resistance mechanism in apicomplexan parasites	Dhanasekaran Shanmugam
Ujjwal Kumar Nandi	Connecting real glasses to mean-field models: A study of structure, dynamics and thermodynamics	Sarika Maitra Bhattacharyya
Uma Jadhav	Analysis of the molecular response of thompson seedless grapes to GA3 treatment	Narendra Kadoo

Indian Customers

- Tatva Chintan Pharmachem P. Ltd.
- Tata Chemicals Ltd.
- Astec Life Sciences Limited
- Aarti Industries Ltd
- Gujarat Fluorochemicals Ltd.
- Atul Limited
- Savannah Surfactants Ltd.
- Reliance Life Sciences P. Ltd.
- Godrej Consumer Products Ltd.
- LUPIN Ltd.
- Praj Industries Ltd.
- Unilever Industries Pvt. Ltd.
- BASF Ltd.
- Sigma Aldrich Chemicals P. Ltd.
- Vinati Organics Limited
- Shell Technology Centre
- Renault Nissan Tech & Business Centre India P Ltd

Foreign Customers

- Qatar Shell Research & Tech. Center (QSRTC)
- University of Jeddah
- Australian High Commission

Publicly Funded

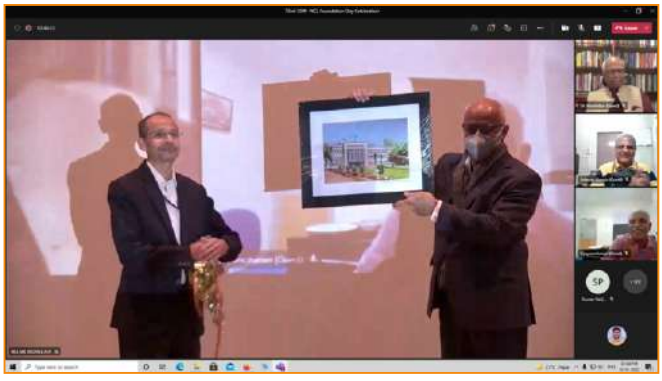
- GAIL (India) Limited

Awards

Name	Awards
Dr. Sarika Bhattacharya	4th Charusita Chakravarty Memorial Lecture Award
	SERB-POWER Fellowship 2021
Dr. Asha S. K.	SERB-POWER Fellowship 2022
Dr. Premnath Venugopalan	Distinguished Alumnus Award 2022 by the Indian Institute of Technology Bombay
Dr. Syed Dastager	An Associate Editor of Microbiotechnology, a section within Frontiers in Microbiology, Frontiers in Bioengineering and Biotechnology and Frontiers in Environmental Science
	An Associate Editor of the Journal 'Microbiological Research'
Dr. Nandanwar Sachin Uttamrao	Elected as a Young Associate of the Maharashtra Academy of Sciences
Dr. C. S. Gopinath	A Member of the Editorial Board of Indian Journal of Chemistry (IJC)
Dr. Sakya Singha Sen	SwarnaJayanti Fellowship
Dr. Kumar Vanka	Dr. A. P. J. Abdul Kalam HPC Award 2021
Dr. Amol Kulkarni	A Fellow of the Indian National Academy of Engineering (INAE), New Delhi
Dr. Putla Sudarsanam	A member of the Editorial Board of the Journal Catalysis Communications
	Australian Alumni Award from the Australian Government
Dr. Rakesh Joshi	CSIR Young Scientist Award 2021
Dr. C. P. Vinod	A Review Editor joining the Editorial Board of Catalytic Reactions and Chemistry from the Journal Frontiers in Chemistry
Dr. Ram Rup Sarkar	Editorial Board Member as a Review Editor of Multiscale Mechanistic Modeling, a specialty section of the Journal Frontiers in Systems Biology

Date	Event
May 11, 2021	Celebration of National Technology Day: A special discussion meeting on the topic "Hydrogen Economy in India" with Sh. Ravi Pandit, Co-founder, and Chairman of KPIT Technologies Ltd.
August 13, 2021	Talk on " Ethics and Academic Integrity in Research" by Prof. Uday Maitra, Indian Institute of Science, Bengaluru and Ombudsman, Chemical Cluster Laboratories, CSIR
August 26, 2021	One day workshop on 'Essentials of Tech Transfer' for R&D Managers in Universities and Govt. funded Institutions, organized by CSIR-NCL and AGNii-Invest India
September 15, 2021	Celebration of National Engineers Day: 75th R. A. Mashelkar Endowment Lecture in Polymer Science and Engineering by Dr. Ajit Sapre, Reliance Industries Ltd. India
September 27, 2021	Celebration of 80th Foundation Day of CSIR: Professor Raghunathan Rengasamy, Dean Global Engagement and the Marti Mannariah Gurunath Institute Chair Professor at IIT Madras delivered a lecture on 'Artificial Intelligence (AI) in Science and Engineering.'
October 27, 2021	76th R. A. Mashelkar Endowment Lecture in Polymer Science and Engineering by Prof. George Church, Harvard Medical School & MIT, Boston, USA
November 9-10, 2021	A lecture series to celebrate the 2021 Nobel Prize in Medicine/Physiology, Physics and Chemistry.
November 29, 2021	A lecture series on 'Circular Economy of Plastics' by Dr. Vijay Habbu, Adjunct Professor, ICT Mumbai
November 29-30, 2021	3rd NCL-RF Annual Student's Conference 2021
December 07, 2021	Prof. J.W McBain Memorial lecture by Prof. Daan Frenkel, Emeritus Professor, University of Cambridge, UK, on "Entropy and (dis)information."
December 17, 2021	Professor K. Venkataraman Memorial Lecture by Prof. Deevi Basavaiah, Institution of Eminence Research Chair Professor in Chemistry, School of Chemistry, University of Hyderabad
January 3, 2022	72nd Foundation Day of CSIR-NCL: Shri. Subroto Bagchi Chairman, Odisha Skill Development Authority, Government of Odisha, delivered the CSIR-NCL Foundation Day Lecture on a topic "NCL at 100: Building Memories for the Future."
February 23, 2022	A lecture by Dr. Raghunath Mashelkar, Eminent Scientist in the "Vigyan Sarvatra Pujyate" Science week Festival Lecture Series
February 28, 2022	National Science Day Celebration: A Lecture by Professor Ambuj D. Sagar, Vipula and Mahesh Chaturvedi Professor of Policy Studies & Head, School of Public Policy, Indian Institute of Technology Delhi
March 8, 2022	Celebration of International Women's Day 2022

Sh. Ravi Pandit, Co-founder, and Chairman of KPIT Technologies Ltd. Pune, delivered the National Technology Day lecture on "Hydrogen Economy in India." Dr. Ajit Sapre, Group President R&T, Reliance Industries Limited, India, delivered the 75th R.A. Mashelkar Endowment Lecture on "Technology developments for sustainability in India: One perspec-tive" to commemorate the National Engineers Day 2021. Prof. Raghu Rengasamy, Chair Professor, Department of Chemical Engineering, IIT Madras, Chennai, delivered the CSIR Foundation Day Lecture on "Artificial Intelligence (AI) in Science and Engineering. "The oration on the 72nd Foundation Day of CSIR-NCL was given by Shri Subroto Bagchi, Chairman, Odisha Skill Development Authority, on "NCL at 100: Building Memories of the Future." Dr. Raghunath Mashelkar, Eminent Scientist and Science Leader, spoke on "CSIR-NCL: Yesterday, Today, and Tomorrow" in a Science Week Festival Lecture Series called Vigyan Sarvatra Pujyate." Prof. Ambuj D. Sagar, Vipula and Mahesh Chaturvedi Professor of Policy Studies & Head, School of Public Policy, Indian Institute of Technology Delhi delivered the National Science Day Lecture on "The clean-energy transition: Challenges and opportunities." An invited lecture was delivered by Dr. Vijay Habbu, Adjunct Professor, ICT Mumbai on the topic "Circular economy of plastic".



सीएसआईआर-एनसीएल में हिन्दी पखवाडा समारोह का आयोजन

एनसीएल में दिनांक १४-२८ सितंबर, २०२१ के दौरान हिन्दी पखवाडा समारोह आयोजित किया गया। हिन्दी पखवाडे के अंतर्गत राजभाषा हिन्दी के प्रयोग को बढावा देने की दृष्टि से विभिन्न हिन्दी प्रतियोगिताएं तथा गतिविधियां आयोजित की गई। इस बार कोरोना संक्रमण के कारण अधिकतर प्रतियोगिताएं ऑनलाइन मोड पर की गई। कुछ प्रतियोगिताओं का आयोजन पूरी सावधानी बरतते हुए ऑफलाइन मोड पर भी किया गया।

इस दौरान निम्नांकित गतिविधियां आयोजित की गई

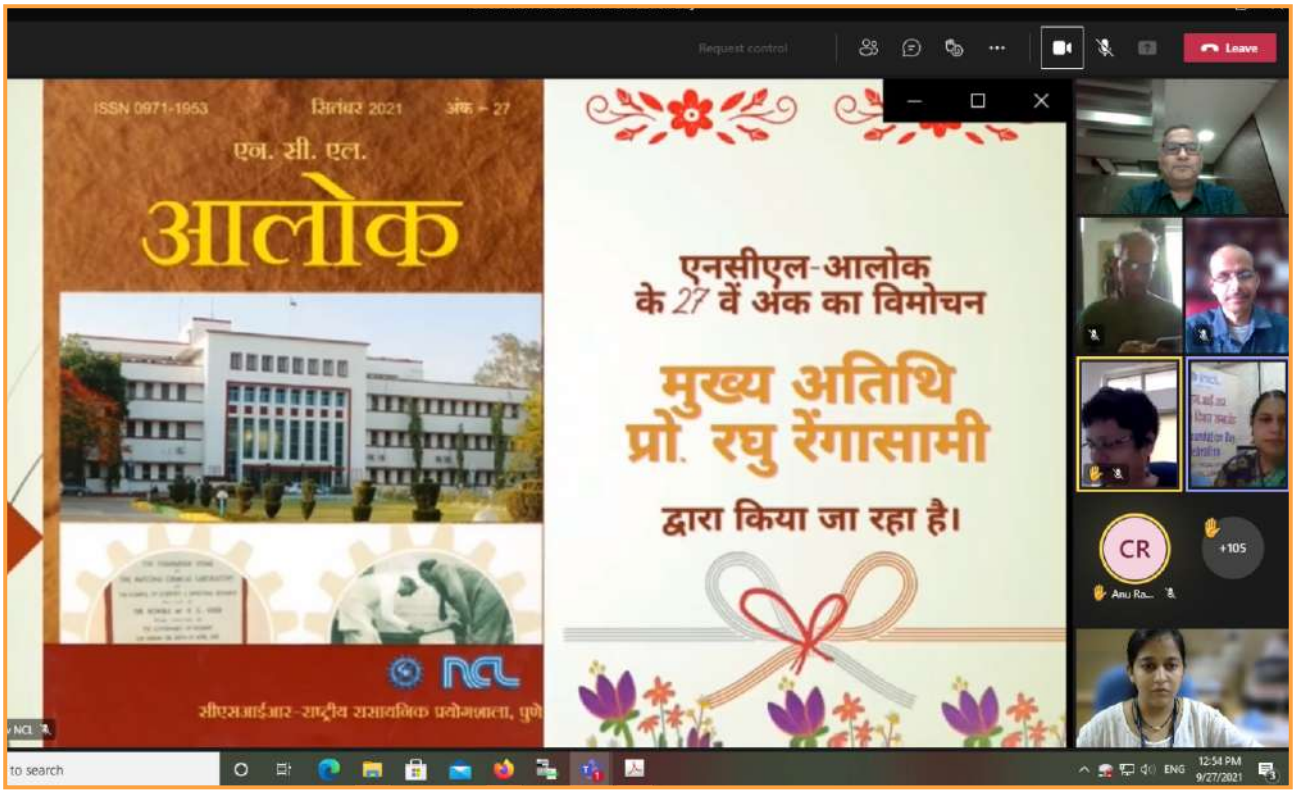
- दिनांक १४ सितंबर, २०२१ को नगर स्तर पर हिन्दी निबंध प्रतियोगिता का आयोजन-पुणे नगर के केंद्रीय संस्थानों में कार्यरत अधिकारियों/कर्मचारियों के लिए यह आयोजन किया गया, जिसे अच्छा प्रतिसाद प्राप्त हुआ। प्रविष्टियां ई-मेल द्वारा आमंत्रित की गई थी।

- दिनांक १६ सितंबर, २०२१ को ऑनलाइन हिन्दी ई-कार्यशाला का आयोजन इस कार्यक्रम में प्रमुख वक्ता श्री प्रदीप शर्मा (सेवानिवृत्त वरिष्ठ अनुसंधान अधिकारी- संसदीय राजभाषा समिति एवं प्रसिद्ध लेखक तथा मोटीवेशनल गुरु) ने 'लक्ष्य की प्राप्ति एवं उसका निर्धारण' विषय पर अत्यंत प्रभावी ऑनलाईन व्याख्यान प्रस्तुत किया। कार्यक्रम के आरंभ में एनसीएल के प्रशासनिक अधिकारी श्री कौशल कुमार ने मुख्य अतिथि का स्वागत किया तथा प्रस्ताविक वक्तव्य दिया। श्री कौशल कुमार ने राजभाषा हिन्दी का महत्व तथा पखवाडा आयोजन के विभिन्न उद्देश्यों की जानकारी भी प्रदान की। आभार प्रदर्शन एनसीएल के वरिष्ठ तकनीकी अधिकारी श्री एस.एस. देव द्वारा किया गया। कार्यक्रम का संचालन डॉ. (श्रीमती) स्वाति चढ्ढा द्वारा किया गया। इस ऑनलाइन कार्यशाला में संपूर्ण भारत से विभिन्न प्रतिभागियों ने भाग लिया।

  - दिनांक १७ सितंबर, २०२१ को हिन्दी शुद्धलेखन प्रतियोगिता
  - दिनांक २० सितंबर, २०२१ को सामान्य ज्ञान प्रतियोगिता
  - दिनांक २१ सितंबर, २०२१ को हिन्दी निबंध लेखन प्रतियोगिता
  - दिनांक २२ सितंबर, २०२१ को शब्द ज्ञान प्रतियोगिता

- 'एनसीएल-आलोक' छ:माही पत्रिका का लोकार्पण– दिनांक २७ सितंबर, २०२१ को सीएसआईआर -स्थापना दिवस समारोह के ऑनलाइन कार्यक्रम आयोजन के अंतर्गत 'एनसीएल-आलोक' पत्रिका का लोकार्पण कार्यक्रम के मुख्य अतिथि प्रो. रघु रंगास्वामी (अध्यक्ष – रासायनिक अभियांत्रिकी विभाग, आईआईटी मद्रास, चैन्नई) तथा एनसीएल के निदेशक डॉ. आशीष लेले द्वारा किया गया।

  इस संपूर्ण आयोजन में हिन्दी पखवाडा समिति के अध्यक्ष डॉ. एस.एस. जोशी तथा सदस्य श्री कौशल कुमार, श्री एस. एस. देव, श्री पांडुरंग कोसराबे तथा डॉ. (श्रीमती) स्वाति चढ्ढा ने महत्वपूर्ण भूमिका निभाई।



सीएसआईआर-एनसीएल की राजभाषा कार्यान्वयन संबंधी रिपोर्ट

भारत सरकार की राजभाषा नीति तथा राजभाषा संबंधी नियमों का अनुसरण करने की दृष्टि से सीएसआईआर- राष्ट्रीय रासायनिक प्रयोगशाला (एनसीएल), पुणे में प्रत्येक स्तर पर गहन प्रयास किए जाते हैं। सीएसआईआर-एनसीएल एक वैज्ञानिक प्रयोगशाला है, जहां अधिकांश कार्य वैज्ञानिक तथा तकनीकी स्वरूप का होता है तथा शेष प्रशासनिक कार्य अधिकांशत: हिन्दी भाषा में किया जाता है। इस प्रयोगशाला में किए जा रहे राजभाषा कार्यान्वयन संबंधी उल्लेखनीय प्रयास निम्नानुसार हैं।

- प्रत्येक तिमाही में एनसीएल की राजभाषा कार्यान्वयन समिति की तिमाही बैठक नियमित रूप से निदेशक महोदय की अध्यक्षता में आयोजित की जाती है एवं इन बैठकों में प्रयोगशाला में राजभाषा हिन्दी के प्रगामी प्रयोग तथा राजभाषा कार्यान्वयन संबंधी प्रयासों की समीक्षा की जाती है। इन बैठकों में प्रयोगशाला के प्रत्येक प्रभाग /अनुभाग प्रमुख सदस्य के रूप में उपस्थित रहते हैं।
- प्रत्येक छ: महीने में हिन्दी गृहपत्रिका ''एनसीएल- आलोक'' का प्रकाशन नियमित रूप से किया जाता है। गृहपत्रिका प्रकाशन का मूल उद्देश्य हिन्दी भाषा में लिखे गए वैज्ञानिक लेखों का प्रचार-प्रसार तथा कर्मचारियों की हिन्दी में लेखन और अभिव्यक्ति क्षमता को प्रोत्साहित करना है।
- एनसीएल में प्रतिवर्ष हिन्दी पखवाडा समारोह का भव्य आयोजन किया जाता है। इस अवसर पर स्टाफ के लिए विभिन्न हिन्दी प्रतियोगिताओं तथा कार्यक्रमों का आयोजन किया जाता है। हिन्दी पखवाडा के आरंभ में हिन्दी दिवस के अवसर पर प्रतिवर्ष प्रयोगशाला की अर्धवार्षिक गृहपत्रिका ''एनसीएल-आलोक'' का विमोचन भी किया जाता है।
- एनसीएल के स्टाफ को हिन्दी कार्य करने में आ रही समस्याओं का निदान करने तथा हिन्दी में कार्य करने हेतु प्रोत्साहित करने की दृष्टि से प्रत्येक तिमाही में नियमित रूप से हिन्दी कार्यशाला का आयोजन किया जाता है। इन कार्यशालाओं में स्टाफ को भारत सरकार की राजभाषा नीति की जानकारी देने के साथ-साथ अपना दैनंदिन सरकारी कार्य हिन्दी में करने तथा कंप्यूटर पर यूनिकोड प्रणाली के माध्यम से हिन्दी में काम करने का प्रशिक्षण दिया जाता है।
- एनसीएल में प्रतिवर्ष हिन्दी वैज्ञानिक संगोष्ठी का आयोजन किया जाता है, ताकि विज्ञान के क्षेत्र में राजभाषा हिन्दी की संपदा बढ सकें। संगोष्ठी के अवसर पर स्मारिका भी प्रकाशित की जाती है।
- हिन्दी कक्ष द्वारा प्रतिदिन हिन्दी सुविचार तथा अँग्रेजी शब्द के अर्थ का प्रेषण मेल द्वारा सभी कर्मचारियों को किया जाता है, ताकि कर्मचारियों में हिन्दी भाषा के प्रति रुचि उत्पन्न हो सकें।
- राजभाषा अधिनियम की धारा 3(3) के अंतर्गत जारी होने वाले सभी दस्तावेज द्विभाषी जारी किए जाते हैं।

सीएसआईआर-एनसीएल की राजभाषा कार्यान्वयन संबंधी रिपोर्ट

- इस प्रयोगशाला में राजभाषा विभाग द्वारा जारी वार्षिक कार्यक्रम में निर्धारित किए गए लक्ष्यों की प्राप्ति की ओर विशेष ध्यान दिया जाता है।
- केंद्र सरकार, राजभाषा नियम 1976 (संघ के सरकारी प्रयोजनों के लिए प्रयोग) के नियम 10 (4) के अंतर्गत इस प्रयोगशाला को ऐसे कार्यालयों के रूप में , जिसके 80 : से अधिक कर्मचारी वृंद ने हिन्दी का कार्यसाधक ज्ञान प्राप्त कर लिया है, राजपत्र में अधिसूचित किया गया है।
- प्रयोगशाला के 98 प्रतिशत कर्मचारियों को हिन्दी, हिन्दी टंकण एवं आशुलिपि का प्रशिक्षण दिया जा चुका है।
- प्रशासन अनुभाग के कुछ अधिकारियों /कर्मचारियों तथा वैज्ञानिक स्टाफ को कंप्यूटर पर हिन्दी में कार्य करने हेतु प्रशिक्षित किया गया है तथा शेष स्टाफ को प्रशिक्षित करने की प्रक्रिया जारी है।
- सभी मानक प्रपत्र,फार्म तथा आवेदन पत्र इत्यादि द्विभाषी रूप में तैयार किए गए हैं।
- वैबसाइट को द्विभाषी रूप में प्रदर्शित किया गया है।
- सभी कम्प्यूटरों में द्विभाषी रूप से कार्य करने की सुविधा उपलब्ध है।
- सभी साइनबोर्ड, नाम-पट्टों तथा रबर की मोहरों को द्विभाषी बनाया गया है।
- प्रशिक्षण कार्यक्रमों में मिली-जुली भाषा का उपयोग किया जाता है।
- एनसीएल के निदेशक एवं हिन्दी अधिकारी नगर राजभाषा कार्यान्वयन समिति की बैठकों में नियमित रूप से भाग लेते हैं।
- एनसीएल की शीर्ष स्तर की प्रबंध परिषद की बैठकों की कार्यसूची द्विभाषी रूप में तैयार की जाती है और इन बैठकों में हिन्दी में भी चर्चा की जाती है।
- पुस्तकालय हेतु प्रतिवर्ष हिन्दी पुस्तकें खरीदी जाती हैं।
- एनसीएल में आयोजित होने वाले समारोहों, व्याख्यानों एवं संगोष्ठियों की रिपोर्ट हिन्दी एवं अँग्रेजी दोनों भाषाओं में सीएसआईआर-समाचार में प्रकाशनार्थ राष्ट्रीय विज्ञान संचार एवं सूचना स्त्रोत संस्थान (निसकेयर),नई दिल्ली को नियमित रूप से भेजी जाती है।
- सीएसआईआर मुख्यालय की मौलिक (विज्ञान) पुस्तक लेखन योजना, वैज्ञानिक कार्यों में हिन्दी पुरस्कार योजना तथा विज्ञान चिंतन लेखमाला आदि योजनाएँ इस प्रयोगशाला में लागू हैं।
- इसके अतिरिक्त प्रयोगशाला में आयोजित होने वाले विभिन्न वैज्ञानिक कार्यक्रमों तथा अन्य समारोहों का संचालन भी हिन्दी माध्यम से किया जाता है।

सीएसआईआर-एनसीएल की राजभाषा कार्यान्वयन संबंधी रिपोर्ट

- इस प्रयोगशाला के वैज्ञानिक देश के विभिन्न संस्थानों में राजभाषा के माध्यम से आयोजित होने वाली संगोष्ठियों तथा विज्ञान सम्मेलनों में भाग लेकर हिन्दी भाषा में अपना शोध पत्र प्रस्तुत करते हैं।
- प्रयोगशाला से जारी होने वाली सभी निविदा सूचनाएँ तथा विज्ञापन इत्यादि द्विभाषी रूप में प्रकाशित किए जाते हैं प्राप्त हिन्दी पत्रों के उत्तर अनिवार्य रूप से हिन्दी में ही दिये जाते हैं।
- विज्ञान शिक्षा के प्रति रुचि उत्पन्न करने तथा राजभाषा के माध्यम से विज्ञान के प्रचार-प्रसार के उद्देश्य से एनसीएल के वैज्ञानिकों द्वारा विभिन्न विद्यालयों तथा महाविद्यालयों के विद्यार्थियों के लिए विज्ञान संबंधी व्याख्यान हिन्दी में देते है।
- एनसीएल के स्टाफ को हिन्दी में कार्य करने हेतु प्रोत्साहित करने की दृष्टि से यहाँ विभिन्न राजभाषा प्रोत्साहन योजनाएँ लागू हैं।
- क तथा ख क्षेत्रों को जाने वाले अधिकांश पत्रों के लिफाफों पर पते हिन्दी भाषा में लिखे जाते हैं।
- राजभाषा विभाग के वार्षिक कार्यक्रम तथा राजभाषा संबंधी निर्देशों से सभी विभाग/प्रभाग प्रमुखों को अवगत कराया जाता है।
- हिन्दी काम-काज को बढावा देने तथा राजभाषा नीति के अनुपालन हेतु 9 अनुभागों को हिन्दी में कार्य करने के लिए निर्दिष्ट किया गया है।

संयुक्त राजभाषा वैज्ञानिक राष्ट्रीय संगोष्ठी

पुणे स्थित तीन वैज्ञानिक संस्थान सीएसआईआर-राष्ट्रीय रासायनिक प्रयोगशाला (एनसीएल), राष्ट्रीय कोशिका विज्ञान केंद्र (एनसीसीएस), तथा आघारकर अनुसंधान संस्थान (एआरआई) द्वारा सम्मिलित रूप से संयुक्त राजभाषा वैज्ञानिक राष्ट्रीय संगोष्ठी का आयोजन सीएसआईआर-राष्ट्रीय रासायनिक प्रयोगशाला (एनसीएल), पुणे में दिनांक २९ अप्रैल, २०२२ को किया गया। इस संगोष्ठी का विषय महामारी के दौर में विज्ञान और प्रौद्योगिकी संस्थानों की भूमिका था। इस मौके पर पदाधिकारियों द्वारा संगोष्ठी की सारांश पुस्तिका का तथा सीएसआईआर-राष्ट्रीय रासायनिक प्रयोगशाला की छ:माही हिन्दी पत्रिका 'एनसीएल आलोक' का भी विमोचन किया गया। इस संगोष्ठी में सम्पूर्ण भारत के केन्द्रीय संस्थानों से वैज्ञानिक, शोध छात्र तथा प्रशासनिक प्रमुख/हिन्दी अधिकारी उपस्थित थे। उद्घाटन कार्यक्रम में मुख्य अतिथि के रूप में डीआरडीओ (इसीई, पुणे) के निदेशक (प्रोजेक्ट मानिटरिंग) डॉ. हिमांशु शेखर, एनसीएल के निदेशक डॉ. आशीष लेले, एआरआई के निदेशक डॉ. प्रशांत ढाकेफलकर, एवं एनसीसीएस के निदेशक डॉ. अरविंद साहू उपस्थित थे। उद्घाटन सत्र का संचालन तथा आभार प्रदर्शन एनसीएल की हिन्दी अधिकारी डॉ. (श्रीमती) स्वाति चढ्ढा द्वारा किया गया। संगोष्ठी में पुणे के केंद्रीय संस्थानों से तथा सीएसआईआर की लखनऊ, चैन्नई, हैदराबाद एवं गोवा स्थित प्रयोगशालाओं से प्रतिभागियों ने प्रतिभाग लिया । कुल १४० प्रतिभागियों ने हिस्सा लिया। इस संगोष्ठी में तीन वैज्ञानिक सत्र आयेजित किए गए, जिनमें १६ शोध पत्रों की प्रस्तुति वैज्ञानिकों और शोध छात्रों द्वारा दी गई।

कार्यक्रम के प्रारंभ में एनसीएल के संगोष्ठी संयोजक डॉ. नरेन्द्र कडू ने स्वागत भाषण प्रस्तुत किया। उन्होंने सभी को इस कार्यक्रम के उद्देश्य से अवगत कराया। तत्पश्चात एनसीएल के निदेशक डॉ. आशीष लेले ने अपने संबोधन में सभी को बधाई दी और कहा कि इस प्रकार का आयोजन निश्चित रूप से सभी के लिए अत्यंत लाभकारी होगा। इसके द्वारा हम एक दूसरे की कार्य प्रणाली और विचारों से परिचित होते है और संयुक्त रूप से इसी विषय पर नए तरीके से विचार करने का मौका मिलता है। साथ ही हमें वैज्ञानिक शोध के नए-नए आयामों को जानने का एवं उन पर विचार विमर्श करने का मौका मिलता है। तकनीक और विज्ञान से क्षेत्र में हिंदी का प्रयोग अत्यंत कम होता है। विश्व भाषा के रूप में विकसित होने के लिए हिंदी भाषा में विज्ञान सम्बन्धी साहित्य होना जरुरी है। अधिकांश वैज्ञानिक शोधकार्य अंग्रेजी भाषा में ही होने के कारण जन साधारण तक उसकी जानकारी नहीं पहुँच पाती है, इस कार्यक्रम के माध्यम से हम वैज्ञानिक कार्यों को राजभाषा हिंदी में करने का संदेश दे रहे है।

एनसीसीएस के निदेशक डॉ. अरविन्द साहू ने अपने अभिभाषण में महामारी के दौरान वैज्ञानिकों के बढे हुए महत्व को रेखांकित किया । महामारी के दौरान विज्ञान और प्रौद्योगिकी संस्थानों ने एकजुट होकर निस्वार्थ रूप से सभी ने अपना-अपना योगदान दिया। उन्होंने संस्थानों में किए जा रहे अनुसंधान के प्रचार और

संयुक्त राजभाषा वैज्ञानिक राष्ट्रीय संगोष्ठी

प्रसार के लिए सही जानकारी साझा करने के लिए सभी को प्रोत्साहित किया।

एआरआई के निदेशक डॉ. प्रशांत ढाकेफलकर ने वैज्ञानिक जानकारी का प्रसार हिंदी और क्षेत्रीय भाषा में करने के लिए अपनी शैली में सभी को प्रेरित किया। उन्होंने बताया कि सीएसआईआर में किसानों के लिए धान की नई प्रजातियों के विकास के बाद बीज लेने के लिए बहुतांश किसानों ने हिंदी भाषा में ही संपर्क किया।

इस संगोष्ठी के उद्घाटन समारोह के मुख्य अतिथि के रूप में डीआरडीओ (इसीई, पुणे) के निदेशक (प्रोजेक्ट मानिटरिंग) डॉ. हिमांशु शेखर उपस्थित थे। उन्होंने अपने उद्बोधन में बताया कि महामारी के दौर में विज्ञान और तकनीकी का विकास सुसंगत रूप से हुआ और उसकी दिशा में परिवर्तन हुआ है। कोरोना एक सामाजिक बिमारी है और इसमें हर व्यक्ति को ठोस कदम लेना चाहिए तभी उसका इलाज संभव हो सकता है। महामारी में वैज्ञानिक संस्थानों ने बहुत महत्वपूर्ण योगदान दिया है। उन्होंने बताया कि अच्छे शोधकर्ता को अपना शोध अपनी क्षेत्रीय भाषा में भी छापने की जिम्मेदारी लेनी चाहिए, ताकि क्षेत्रीय लोग भी उस शोध से लाभान्वित हो और समाज का कोई भी व्यक्ति उससे वंचित न रहे। हमें समाज को साथ में लेकर चलना होगा। समाज के सुधार के लिए जो भी काम आप कर रहे है, उस काम की जानकारी समाज तक पहुँचाने की जिम्मेदारी भी आप की है।

इस सम्मेलन में निम्नांकित विषयों पर चर्चा की गई।

१. कोविड से संबंधित विभिन्न निदान/अनुसंधान एवं उपचारात्मक एवं बचाव की पद्धतियां
२. कोविड के दौरान पर्यावरण संरक्षण
३. अस्पतालों/ केयर सेंटर में प्रयुक्त विभिन्न प्रौद्योगिकियां/ तकनीकें
४. कोविड के दौरान अन्य रोगों का प्रभाव

तकनीकी सत्रों का संचालन श्री रामेश्वर नेमा और श्रीमती मंजुषा तिवारी ने किया। तकनीकी सत्रों की अध्यक्षता तीनों संस्थाओं के वरिष्ठ वैज्ञानिकों -डॉ. राजेश गोन्नाडे, डॉ. गिरधारी लाल, डॉ. हर्षवर्धन पोळ, डॉ.ज्यूतिका राजवाडे, डॉ. संजय सिंह, डॉ. परेश ढेपे द्वारा की गई।

इस संगोष्ठी के आयोजन में डॉ. नरेंद्र कडू, डॉ. गिरधारी लाल, डॉ. एस. के.सिंह, श्री गुरूदत्त वाघ ने महत्वपूर्ण भूमिका निभाई। संगोष्ठी के समन्वयक के रूप में डॉ. (श्रीमती) स्वाति चढ्ढा, श्रीमती स्मिता खडकीकर तथा श्रीमती मंजुषा तिवारी ने कार्य किया। तीनों संस्थानों के निदेशकों ने भी संगोष्ठी आयोजित करने के लिए प्रोत्साहित और सहयोग किया।

NCL mechanism aims to convert PPE waste to recycled raw items

EXPRESS NEWS SERVICE
PUNE, SEPTEMBER 23

प्रेरक शास्त्रज्ञ

पुण्याच्या राष्ट्रीय रासायनिक प्रयोगशाळेच्या (एनसीएल) संचालकपदी डॉ. आशिष लेले यांच्या निवडीने, एका तळमळीच्या शास्त्रज्ञाचा उचित गौरव झाला आहे. वैज्ञानिक आणि औद्योगिक संशोधन परिषदेच्या (सीएसआयआर) राष्ट्रीय प्रयोगशाळांच्या साखळीतील आघाडीवरील संशोधन संस्था असलेल्या 'एनसीएल'ला, संचालक-शास्त्रज्ञांची उज्ज्वल परंपरा आहे. डॉ. लेले यांची आजवरची कामगिरी त्या परंपरेला शोभणारी आणि नवोदितांसाठी प्रेरणादायी आहे. देशातील संशोधन क्षेत्रात प्रतिष्ठेच्या समजल्या जाणाऱ्या बहुतेक पुरस्कारांचे मानकरी असलेले डॉ. लेले हे अव्वल दर्जाचे संशोधक आहेत. सुमारे तीन दशके संशोधन क्षेत्रात कार्यरत असलेले लेले यांचे पदवी शिक्षण मुंबई विद्यापीठातील रासायनिक तंत्रज्ञान विभागातून झाले. रासायनिक अभियांत्रिकीच्या पदवीनंतर, त्यांनी १९९३मध्ये अमेरिकेतील डेलावर विद्यापीठातून पीएचडी मिळविली. त्यानंतर ते एनसीएलमध्ये दाखल झाले. शास्त्रज्ञ म्हणून जिथून काम सुरू केले, त्याच

डॉ. आशिष लेले

Mosquito repelling molecule discovery

Results of this study have been published in the journal ACS Omega. HT PHOTO

tified molecule needs to undergo several studies, including long-term safety assessment, before it reaches the market. "The discussions are on with some leading companies to take forward this insect repellent molecule for further studies towards commercialisation. Twenty-five silicon-containing piperidines were synthesised, and the influence of silicon incorporation on insect repellency was investigated. One of the compounds showed better protection time than the gold-

विद्यार्थ्यांसाठी 'व्हर्च्युअल लॅब'

एनसीएल-आयआयटीचा करार

टा. प्रतिनिधी, पुणे

Dr Ashish Lele takes charge as CSIR-NCL director

Pune: Dr Ashish Lele assumed charge as the director of CSIR - National Chemical Laboratory (NCL) on Thursday. He specialises in chemical and reactor engineering. Lele began his professional career as a scientist with NCL in 1993 and later served in various capacities, including as the chief scientist, till 2018.

He quit NCL in 2018 to take up the role of senior vice president

Webmail | Site Map | Feedback

Enter Search Term Web People A- | A | A+ English

Council of Scientific & Industrial Research

National Chemical Laboratory

Home About NCL Research Academic Programme Partnership with Industry Join Us Resource Contact Us NCL Quick Links

ABOUT CSIR- NCL

CSIR-National Chemical Laboratory, Pune is a research, development and consulting organisation with a focus on chemistry and chemical engineering.

सबका साथ
सबका विकास
सबका विश्वास
सबका प्रयास

आजादी का अमृत महोत्सव

Azadi Ka Amrit Mahotsav: Celebrating 75 Years of India's Independence

"The purpose of this laboratory is to advance knowledge and to apply chemical science for the good of the people"

Research

Academic Programme

Partnership with Industry

Join Us

Featured News : CSIR "Integrated Skill Initiative" program

Director

(Council of Scientific & Industrial Research)

Tel: +91-20-2590 2600 Fax: +91-20-2590 2601

Email: director@ncl.res.in

www.ncl.res.in