



International Conference on Advanced Sustainable Technologies

ICAST – 2026

(August 19–21, 2026)

BOOK OF ABSTRACTS



Department of Biotechnology and Chemical Engineering

International Conference on Advanced Sustainable Technologies
(ICAST - 2026)
(August 19-21, 2026)

Organized by

Department of Biotechnology and Chemical Engineering
Faculty of Science, Technology and Architecture (FoSTA)
Manipal University Jaipur, India

In collaboration with

Indian Chemical Council (ICC)

Sponsored by

Anusandhan National Research Foundation (ANRF)

BOOK OF ABSTRACTS

Designed by

Mr. Malay Gala
Ms. Jeevika Puri

Edited By

Dr. Sachin Kadian

PREFACE

Welcome to the **International Conference on Advances in Sustainable Technologies (ICAST 2026)**, organized by the **Department of Biotechnology and Chemical Engineering, Manipal University Jaipur**, from **19-21 August 2026**.

The rapid pace of technological advancement, coupled with pressing global challenges such as climate change, resource depletion, environmental pollution, and sustainable industrial development, demands innovative and interdisciplinary solutions. ICAST 2026 has been conceived as an international platform to bring together researchers, academicians, industry professionals, policymakers, and students to exchange knowledge, share recent scientific advancements, and foster collaborations in the broad domain of sustainable technologies.

The conference encompasses a wide spectrum of themes, including sustainable chemical and bioprocess technologies, environmental engineering, renewable energy, biotechnology, computational biology, artificial intelligence, advanced materials, healthcare innovations, circular economy, and emerging engineering solutions. Through keynote lectures, invited talks, technical sessions, poster presentations, and panel discussions, ICAST 2026 aims to stimulate meaningful dialogue and encourage interdisciplinary research that addresses contemporary scientific and societal challenges.

This Abstract Book presents the accepted abstracts that showcase the diversity, quality, and innovation of the research contributions received from universities, research institutions, industries, and organizations across India and abroad. Each submission underwent a peer-review process to ensure scientific quality, originality, and relevance to the conference themes. The abstracts compiled in this volume provide a valuable overview of current research trends and serve as a foundation for discussions, networking, and future collaborations during the conference.

We express our sincere gratitude to the University leadership for their constant encouragement and support in organizing this international event. We also acknowledge the invaluable contributions of the advisory board, keynote and invited speakers, reviewers, session chairs, organizing committee members, sponsors, faculty members, staff, and student volunteers, whose collective efforts have made ICAST 2026 possible.

We extend our heartfelt appreciation to all authors and delegates for their enthusiastic participation and valuable contributions. We hope that the conference provides an intellectually stimulating experience, fosters enduring collaborations, and inspires innovative research that contributes to sustainable development and the betterment of society.

We wish all participants a productive, enriching, and memorable ICAST 2026.

Convener
ICAST 2026

CHIEF GUEST



Shri V. Srinivas
Honourable Chief Secretary, Government of Rajasthan

MESSAGE FROM CHIEF GUEST

वी. श्रीनिवास
V. Srinivas



मुख्य सचिव
राजस्थान सरकार
Chief Secretary
Government of Rajasthan

MESSAGE

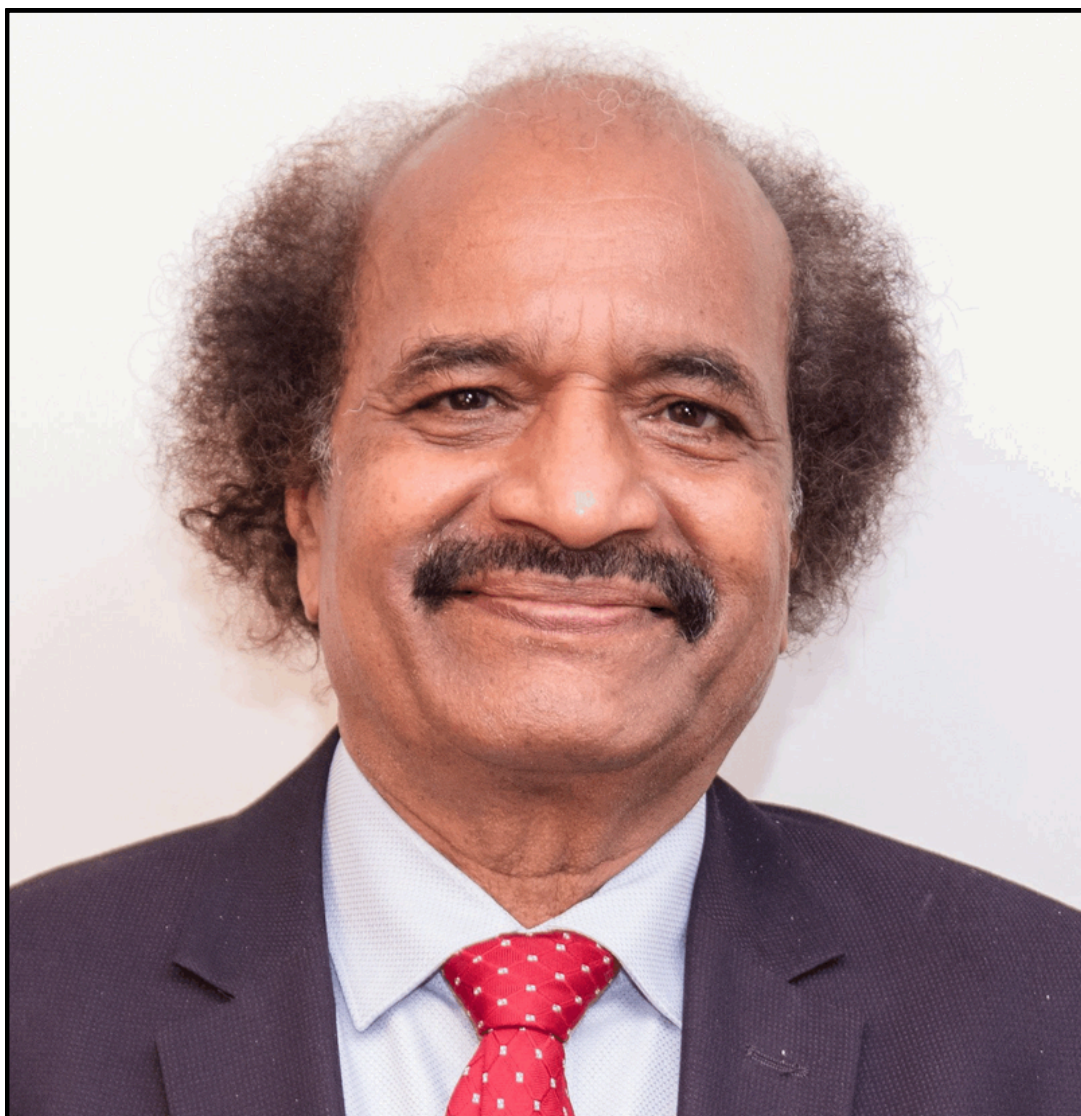
It is a matter of great pleasure that Manipal University Jaipur is hosting the International Conference on Advanced Sustainable Technologies (ICAST-2026). Themes such as green hydrogen, circular economy, renewable energy, critical minerals, and advanced materials are of particular importance to Rajasthan, a State richly endowed with solar energy potential and committed to building a cleaner and more prosperous future.

These very themes also highlight the continuing relevance of Chemical Engineering — a discipline that has always been at the heart of converting scientific knowledge into practical technologies. As a Chemical Engineering graduate, I have seen how this field plays a central role in developing clean energy systems, sustainable manufacturing processes, and innovative solutions for resource efficiency. For young students and researchers, it remains a highly rewarding career that offers the opportunity to contribute meaningfully to industry, research, and national development.

It is in this spirit that ICAST-2026 assumes special significance. The conference will provide a valuable platform for knowledge exchange and collaboration among academia, industry, and government. I extend my best wishes to the organizers and all participants for a successful conference and look forward to the positive outcomes that will emerge from these deliberations.

(V. Srinivas)

GUEST OF HONOR



Padma Shri Prof. G. D. Yadav
Emeritus Professor of Eminence & Former Vice-Chancellor
Institute of Chemical Technology (ICT), Mumbai, India

MESSAGE FROM GUEST OF HONOR



Professor Ganapati D. Yadav

B. Chem. Eng., Ph.D. (Tech.), D.Sc. (Hon. Causa, DYPU Kolhapur), D. Eng. (Hon. Causa, NIT-A)
NAE (US), FNAI (US), FTWAS, FNA, FASc, FNASc, FNAE, FISTE, FRSC (UK), ChE, FICHE (UK), FIChE, FICS FMASc,
FIChE

Bhatnagar Fellow (CSIR) & Former National Science Chair (ANRF/DST/GOI)

Emeritus Professor of Eminence

Former Vice Chancellor & R.T. Mody Distinguished Professor
and Tata Chemicals Darbari Seth Distinguished Professor of Leadership & Innovation

INSTITUTE OF CHEMICAL TECHNOLOGY

Deemed to be University under Section 3 of UGC Act
1956

Category I Institute UGC

ICT IOE Campus Bhubaneswar, ICT Marathwada
Campus, Jalna

Elite Status & Centre of Excellence, Govt. of
Maharashtra

Message

I am pleased to convey my warm greetings and best wishes to all participants of the International Conference on Advanced Sustainable Technologies (ICAST-2026), organized by the Department of Biotechnology & Chemical Engineering, Manipal University Jaipur.

The conference brings together several contemporary and interconnected areas that are central to sustainable development, including green energy, advanced materials, environmental technologies, biotechnology, circular economy, and the application of artificial intelligence, modelling, and simulation. These fields are rapidly evolving and offer significant opportunities to address some of the most pressing challenges facing society and industry.

Sustainable technological development demands a strong foundation in science, interdisciplinary thinking, innovation, and close interaction between academic research and real-world applications. Platforms such as ICAST-2026 provide an important opportunity for researchers, academicians, students, and industry professionals to exchange ideas, share emerging knowledge, and identify new avenues for collaboration.

I commend Manipal University Jaipur and the organizing committee for bringing together this timely and relevant scientific programme. I am confident that the deliberations will be stimulating and constructive, and will contribute to advancing research, innovation, and meaningful collaborations in sustainable technologies.

I wish ICAST-2026 a great success and all participants a rewarding and intellectually enriching conference.

Ganapati D. Yadav

13th August 2026

Nathalal Parekh Marg, Matunga

T: +91-22-3361-2010 P/1111/2222

F: +91-22-3361-1020

MUMBAI-400019 INDIA

(INSA)

Vice President, Indian National Science Academy

www.ictmumbai.edu.in

Email: gd.yadav@ictmumbai.edu.in

gdyadav@gmail.com

gdyadav@yahoo.com

President, Indian Chemical Society

Honorary Professor, INCASR, Bangalore

Distinguished Adjunct Professor, IIT Guwahati

Adjunct Professor, University of Saskatchewan, Saskatoon, Canada

Distinguished Visiting Professor SOA University, Bhubaneswar

Padmashri Awardee (2016)

MESSAGE FROM PRESIDENT



Prof. (Dr.) N. N. Sharma
President

Welcome to the **International Conference on Advanced Sustainable Technologies (ICAST 2026)**, organized by the Department of Biotechnology and Chemical Engineering, Manipal University Jaipur.

As a university committed to excellence in education and research, we recognize the importance of academic forums that encourage dialogue across disciplines and foster partnerships between academia and industry. ICAST 2026 serves precisely this purpose by bringing together distinguished researchers and young scholars to discuss scientific innovations that contribute to sustainable development.

This Abstract Book reflects the quality and diversity of research contributions received from India and abroad. It is encouraging to witness the enthusiasm of researchers working on contemporary scientific and technological challenges.

I congratulate all contributing authors and thank the organizing committee, reviewers, and volunteers for their dedicated efforts. May the conference provide new insights, productive discussions, and lasting professional relationships.

Prof. (Dr.) N.N. Sharma
President
Manipal University Jaipur

MESSAGE FROM PRO-PRESIDENT



Cmd. (Dr.) Anil Rana
Pro-President

Research flourishes when knowledge is shared, ideas are challenged, and collaborations transcend disciplinary boundaries. The **International Conference on Advanced Sustainable Technologies (ICAST 2026)** embodies these ideals by bringing together experts committed to developing innovative and sustainable solutions.

This Abstract Book captures the breadth of research that will be presented during the conference. The contributions reflect scientific rigor, creativity, and a shared commitment to addressing global challenges through technological innovation.

I commend the organizing committee, reviewers, editorial team, and all contributors for maintaining high academic standards throughout the conference planning and publication process. Their collective efforts have resulted in a valuable scholarly resource.

I hope that the deliberations during ICAST 2026 encourage new collaborations, inspire future research, and strengthen our shared pursuit of excellence in science and engineering.

Cmd. (Dr.) Anil Rana
Pro President
Manipal University Jaipur

MESSAGE FROM REGISTRAR



Prof. (Dr.) Amit Soni
Registrar

The **International Conference on Advances in Sustainable Technologies (ICAST 2026)** represents another significant milestone in Manipal University Jaipur's commitment to academic excellence, research integrity, and global engagement.

This Abstract Book serves as a record of the innovative ideas and research contributions that will be presented during the conference. It highlights the diversity of scientific inquiry and demonstrates how collaborative research can address pressing technological and environmental challenges.

The successful organization of an international conference requires the coordinated efforts of faculty members, researchers, reviewers, staff, student volunteers, and numerous supporting teams. I sincerely appreciate their dedication and professionalism in making this event possible.

I congratulate all authors and wish every participant an engaging conference filled with insightful discussions and rewarding academic interactions.

Prof. (Dr.) Amit Soni
Registrar
Manipal University Jaipur

MESSAGE FROM PROVOST



Prof. (Dr.) Nitu Bhatnagar
Provost

It gives me immense pleasure to welcome all participants to the **International Conference on Advances in Sustainable Technologies (ICAST 2026)**, organized by Manipal University Jaipur. The conference reflects our continued commitment to fostering academic excellence, research innovation, interdisciplinary collaboration, and meaningful global engagement.

The ICAST 2026 Abstract Book brings together a diverse range of research contributions that showcase emerging ideas, innovative approaches, and technological advancements in the field of sustainable development. The exchange of knowledge and perspectives through such academic platforms is vital for addressing the complex technological, environmental, and societal challenges of our time.

I sincerely appreciate the dedicated efforts of the organizing committee, faculty members, researchers, reviewers, staff, student volunteers, and all supporting teams whose collective contributions have made this conference possible. Their commitment and professionalism are commendable.

I congratulate all the authors for their valuable research contributions and extend my best wishes to all the delegates and participants. I hope ICAST 2026 provides an enriching platform for insightful discussions, knowledge sharing, new collaborations, and meaningful academic interactions.

I wish the conference great success and all participants a rewarding and memorable experience.

Prof. (Dr.) Nitu Bhatnagar
Provost
Manipal University Jaipur

MESSAGE FROM CONFERENCE CHAIR



Prof. (Dr.) Kuldip Singh Sangwan
Dean, FoSTA

I extend a warm welcome to all delegates participating in the **International Conference on Advances in Sustainable Technologies (ICAST 2026)**, organized by the Department of Biotechnology and Chemical Engineering.

In an era characterized by rapid technological advancements and evolving global challenges, the pursuit of sustainable solutions requires innovative thinking and interdisciplinary collaboration. ICAST 2026 has been envisioned as a dynamic platform that brings together scientists, engineers, academicians, researchers, and industry professionals to exchange knowledge, present pioneering research, and explore practical approaches toward building a sustainable future.

The research contributions presented in this conference reflect the breadth, diversity, and excellence of scholarly work being undertaken across various disciplines. These studies not only advance scientific understanding but also inspire meaningful dialogue to promote innovative solutions to contemporary challenges.

I am confident that ICAST 2026 will provide a rewarding platform for intellectual engagement, professional networking, and the exchange of transformative ideas.

I wish all participants a productive, enriching, and memorable conference experience.

Prof. (Dr.) Kuldip Singh Sangwan
Dean, FoSTA
Manipal University Jaipur

MESSAGE FROM CONFERENCE CHAIR



Prof. (Dr.) Ravi Kant Gupta
Associate Dean, SoE

It is my pleasure to welcome you to ICAST 2026, a multidisciplinary conference designed to foster innovation through collaboration organized by Department of Biotechnology and Chemical Engineering on August 19-21, 2026.

The enthusiastic response received from researchers across institutions and countries demonstrates the growing importance of sustainable technologies in addressing global scientific and engineering challenges. The research presented in this Abstract Book spans diverse domains while sharing a common objective—developing solutions that create a more sustainable future.

I express my sincere gratitude to the authors for their valuable submissions, the reviewers for their rigorous evaluations, and the advisory and technical committees for their continuous guidance. I also acknowledge the support of the University leadership, faculty members, staff, sponsors, and student volunteers.

I am confident that the deliberations during the conference will inspire new ideas, strengthen interdisciplinary collaborations, and open avenues for impactful research and technological innovations. May ICAST 2026 serve as a catalyst for knowledge creation and partnerships that translate research into meaningful and lasting societal impact.

Welcome to ICAST 2026!

Prof. (Dr.) Ravi Kant Gupta
Associate Dean, SoE
Manipal University Jaipur

MESSAGE FROM HEAD



Dr. Manisha Sharma
HoD, DBCE

It gives me immense pleasure to welcome all distinguished guests, eminent speakers, researchers, academicians, industry professionals, and participants to the **International Conference on Advanced Sustainable Technologies (ICAST 2026)**, organized by the Department of Biotechnology and Chemical Engineering, Manipal University Jaipur.

The theme of ICAST 2026 reflects the urgent need to develop innovative, sustainable, and technologically advanced solutions to address the complex challenges encountered by industry, society and environment. The convergence of biotechnology, chemical engineering, advanced materials, artificial intelligence, energy, and environmental technologies provides tremendous opportunities to accelerate the transition towards a sustainable and resilient future.

The abstract book represents the intellectual contributions of researchers and professionals participating in this conference. Each contribution reflects the efforts of researchers to advance knowledge, develop innovative technologies, and translate scientific ideas into meaningful solutions. I am confident that the conference will provide a vibrant platform for meaningful discussions, knowledge exchange, and collaborations among academia, industry, and research organizations.

I sincerely thank all dignitaries, speakers, authors, reviewers, delegates, and participants for their valuable contributions. I also appreciate the dedicated efforts of the organizing committee, faculty, staff, student volunteers, and supporting teams for making ICAST 2026 possible.

I hope ICAST 2026 provides an enriching platform for knowledge sharing, innovation, networking, and collaboration, and that the ideas emerging from this conference contribute towards building a more sustainable and technologically empowered future.

I extend my best wishes for a highly successful and intellectually stimulating ICAST 2026.

Dr. Manisha Sharma
Head, Department of Biotechnology and Chemical Engineering
Manipal University Jaipur

MESSAGE FROM ICC-ACADEMIA CHAIR



Mr. Dinesh Chopra
Chairman, ICC-Industry Academia

It gives me immense pleasure to note that the Indian Chemical Council (ICC) is associated with the **International Conference on Advanced Sustainable Technologies (ICAST-2026)**, organized by the Department of Biotechnology and Chemical Engineering, Manipal University Jaipur.

The chemical industry today is undergoing a significant transformation. Sustainability is no longer a choice but a necessity. Issues such as climate change, resource scarcity, and the need for cleaner production methods have placed green technologies at the centre of industrial strategy. In this context, themes like green hydrogen, circular economy, sustainable aviation fuels, critical minerals, energy storage, and advanced materials are of great relevance to both industry and academia.

ICAST-2026 offers a timely and valuable platform for researchers, industry professionals, and policymakers to come together and exchange ideas. Such interactions are essential for converting laboratory-scale innovations into commercially viable and scalable solutions. Strong industry-academia collaboration has always been a priority for the Indian Chemical Council, and this conference is an excellent example of that shared vision.

I am confident that the discussions and deliberations during ICAST-2026 will generate meaningful insights and foster new partnerships that will contribute to the growth of a more sustainable chemical sector in India. On behalf of the Indian Chemical Council, **I extend my warm greetings and best wishes to the organizers, speakers, and all participants for a highly successful and impactful conference.**

Mr. Dinesh Chopra
Chairman, ICC-Industry Academia Committee



ABOUT THE UNIVERSITY

Manipal University Jaipur (MUJ), established in 2011, is a constituent university of the Manipal Education and Medical Group (MEMG), a pioneer in the field of education and healthcare with a legacy spanning several decades. Located in the vibrant city of Jaipur, MUJ is committed to providing quality education, fostering innovation, and creating an ecosystem that nurtures research, entrepreneurship, and holistic development.

The University offers a diverse range of undergraduate, postgraduate, and doctoral programmes across disciplines including engineering, technology, sciences, management, architecture, design, humanities, and law. With a strong emphasis on interdisciplinary learning, MUJ encourages students and faculty to explore emerging areas and address contemporary challenges through innovative approaches.

Research and innovation form an integral part of the University's academic vision. MUJ promotes high-quality research through well-equipped laboratories, advanced research facilities, externally funded projects, interdisciplinary collaborations, and strong engagement with industry and academic institutions. The University provides an enabling environment for faculty and students to pursue impactful research and translate scientific knowledge into practical solutions.

Sustainability, technological advancement, and societal impact are central to the University's vision. MUJ actively promotes research and initiatives aligned with the United Nations Sustainable Development Goals (SDGs) and encourages the development of technologies that contribute to a sustainable and resilient future.

With its modern infrastructure, dedicated faculty, vibrant student community, and commitment to excellence, Manipal University Jaipur continues to evolve as a centre of knowledge, innovation, and transformation. The University remains committed to preparing globally competent professionals and researchers who can contribute meaningfully to society and address the challenges of a rapidly changing world.

ABOUT THE DEPARTMENT

Department of Biotechnology and Chemical Engineering

VISION

Be a vibrant department of global standards fostering quality education in the field of Biotechnology and Chemical Engineering by inculcating professional and ethical practices to serve society.

MISSION

Provide fundamental and applied knowledge of computational, biological, and chemical process engineering and infuse professional skills as desired in industry. Fostering leadership and entrepreneurship skills among the students to provide global innovations for environmental and societal upliftment. Undertake interdisciplinary, transdisciplinary, and applied research with academia, industry, and research organizations.

ABOUT

Established in 2014, following the inception of Manipal University Jaipur in 2011, the Department of Chemical Engineering was founded with a vision to promote excellence in engineering education, research, and innovation. Since its inception, the Department has been supported by highly qualified faculty members with extensive academic, research, and industrial experience, fostering an environment of critical thinking, interdisciplinary learning, and innovation.

Building on its strong academic foundation, the Department expanded its academic portfolio in 2023 to include Biotechnology and Computer Science and Bioscience programmes and was subsequently renamed as the Department of Biotechnology and Chemical Engineering. In 2026, the Department further strengthened its academic offerings with the introduction of the M.Tech. programme in Computational Biology, reflecting its commitment to emerging interdisciplinary fields integrating life sciences with computational and data-driven technologies.

The Department offers undergraduate, postgraduate, and doctoral programmes in Chemical Engineering, Biotechnology, and Computational Biology. With a strong emphasis on interdisciplinary learning, its academic programmes integrate engineering principles, biological sciences, and computational technologies to prepare students for careers in academia, research, and industry.

Faculty members are actively engaged in research in areas including environmental remediation, sustainable technologies, renewable energy, biochar, bioprocess engineering, computational biology, biomaterials, process systems engineering, and artificial intelligence. The Department has secured research funding from prestigious agencies, including ANRF, SERB, DST, ICMR, and industry partners, and actively collaborates with leading academic institutions and research organizations.

Committed to excellence in teaching, research, and innovation, the Department continues to develop future-ready engineers, technologists, and researchers dedicated to advancing sustainable technologies for the benefit of society.

ABOUT ICAST 2026

The International Conference on Advanced Sustainable Technologies (ICAST- 2026), scheduled for 19–21 August 2026 at Manipal University Jaipur, is a premier interdisciplinary platform dedicated to addressing global sustainability challenges through cutting-edge research and innovation. Organized by the Department of Biotechnology & Chemical Engineering, MUJ, ICAST-2026 brings together researchers, academicians, students, and industry professionals to explore transformative solutions in green hydrogen, sustainable aviation fuels, critical minerals and responsible mining, advanced energy storage and recycling, environmental remediation, circular economy, life cycle assessment (LCA), AI & machine learning applications, digital technologies, novel materials science, modeling, simulation, and process control. The conference will feature keynote addresses, oral and poster presentations, panel discussions, and industry exhibitions. Selected high-quality papers will be considered for publication in a Scopus-indexed journals after rigorous peer review. ICAST-2026 aims to foster meaningful collaborations and inspire actionable ideas for a more sustainable and technologically advanced future.

Chief Patron Lt. Gen. (Dr.) M. D. Venkatesh, Chairperson, MUJ	Patron Dr. N.N. Sharma President, MUJ
Co-Patron Cmd. (Dr.) Anil Rana, Pro-President, MUJ Dr. Nitu Bhatnagar, Provost, MUJ	Co-Patron Dr. Amit Soni Registrar, MUJ
Conference Chair Dr. Kuldip Singh Sangwan, Dean, FoSTA, MUJ Dr. Ravi Kant Gupta, Associate Dean, SoE, MUJ	Conference Co-Chair Dr. Manisha Sharma, HoD, DBCE, MUJ
Convener Dr. Anees Y. Khan Dr. Abhay Dinker	Co-Convener Dr. Asaithambi P. Dr. Ankit Srivastava

ORGANIZING COMMITTEE

Organizing Committee

Chief Patron

Lt. Gen. (Dr.) M. D. Venkatesh, Chairperson, MUJ

Patron

Dr. N.N Sharma, President, MUJ

Co Patrons

Cmd. (Dr.) Anil Rana, Pro president, MUJ

Dr. Amit Soni, Registrar, MUJ

Dr. Nitu Bhatnagar, Provost, MUJ

Conference Chair

Dr. Kuldip Singh Sangwan, Dean FoSTA, MUJ

Dr. Ravi Kant Gupta, Associate Dean, SoE, MUJ

Conference Co-chair

Dr. Manisha Sharma

Conveners

Dr. Anees Y. Khan

Dr. Abhay Dinker

Co-Conveners

Dr. Asaithambi P.

Dr. Ankit Srivastava

Organizing Secretaries

Dr. Harsh Pandey

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Dr. Diksha Srivastava

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Dr. Nikhil Kumar

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Dr. Shikha Suman

Dr. Pallavi Mishra

Dr. Prathap Somu

Dr. Sachin Kadian

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Dr. Bharath Rajaguru, MAHE

Prof. SP Chaurasia, MNIT Jaipur

Prof. AB Gupta, MNIT Jaipur

Prof. Madhu Agarwal, MNIT Jaipur

EMINENT SPEAKERS

Plenary Speakers

Padma Shri Prof. G. D. Yadav

National Science Chair (ANRF), Emeritus Professor of Eminence & Former Vice-Chancellor, Institute of Chemical Technology (ICT), Mumbai

Keynote Speakers

Dr. Chiranjeevi Thota General Manager, BPCL, R&D Centre, Greater Noida

Mr. Chirag Patel, General Manager, PI Industries, Ahmedabad

Dr. Prasad Ramachandran, Sr. Project Manager CBR Sustainability Partners, Germany

Mr. Dinesh Chopra, Chairman ICC-Industry Academia committee, Mumbai

Mr. Vasant T. Jagtap Patil, Vice President – Process & Tech. Sales, Xytel India Pvt. Ltd, Pune

Prof. S. Vasudevan. Emeritus Scientist, CSIR-Central Electrochemical Research Institute, Karaikudi

Invited Speakers

Dr. Garima Kaushik, Associate Professor, Central University of Rajasthan

Dr. Kamendra Awasthi, Associate Professor, MNIT Jaipur

Dr. Vivek Anand, Associate Professor, MNIT Jaipur

Dr. Vinay Amte, Research & Technology, Reliance Industries Limited, Navi Mumbai

Dr. Nidhi Pareek, Assistant Professor, Central University of Rajasthan

Dr. Chandra M Rao Vendra, Senior Lecturer, University of Hertfordshire, UK

Dr. T Pandiyarajan, Associate Professor, IIITD, Kurnool

Prof. Jagpreet Singh, Assistant Director - Research & Incubation Centre, Rayat Bahra University, Mohali

Dr. Sulalit Bandopadhyay, Associate Professor, NTNU, Norway

Mr. Jeekesh Arora, Director, Inch Enviro Technologies Pvt. Ltd., Jaipur

Dr. Dorota Bartkowiak, Innovation Manager, ISC3 Innovation Hub, Germany

Dr. Aakash Sharma, Research Scientist, KAUST, Saudi Arabia

CONFERENCE SCHEDULE

ICAST 2026: INAUGURAL SCHEDULE (19th August)

S. No	Time Duration	Activity/Remark	Venue
1	9:30 am Onwards	Registrations Open	Outside Smt. Sharada Pai Auditorium
2	10:20-10:25 am	Opening Remarks and Formal stage program	Smt. Sharada Pai Auditorium
3	10:25-10:30 am	Lighting of Lamp	Smt. Sharada Pai Auditorium
4	10:30-10:35 am	Address by Conference Chair	Smt. Sharada Pai Auditorium
5	10:35-10:40 am	Felicitation	Smt. Sharada Pai Auditorium
6	10:40-10:45 am	Release of Abstract Book	Smt. Sharada Pai Auditorium
7	10:45-10:55 am	Presidential Address	Smt. Sharada Pai Auditorium
8	10:55-11:15 am	Address by Chief Guest Shri V. Srinivas	Smt. Sharada Pai Auditorium
9	11:15-11:35 am	Address by Guest of Honour	Smt. Sharada Pai Auditorium
10	11:35-11:40 am	Vote of Thanks	Smt. Sharada Pai Auditorium
11	11:40-11:50 am	Group Photograph	Smt. Sharada Pai Auditorium

CONFERENCE SCHEDULE

ICAST 2026: Day 1 August 19, 2026)

Day 1 – 19th August 2026 (Wednesday) – Conference

Time (IST)	Event / Speaker
	Session 1 : Convener Invites Session Chair -Introduction by Session Chair
12:00 pm-12:45pm	Plenary Talk Prof. G.D. Yadav President of Indian Chemical Society and former VC, ICT Mumbai
12:45 pm-1:15pm	Keynote Talk 1 Innovation and Policy Synergies for Sustainable Technologies: ICC's Vision for a Greener Chemical Future Mr. Dinesh Chopra Chairman ICC-Industry Academia committee
1:15pm – 2:00 pm	Lunch Break
Venue: TSB Seminar Hall, Floor:2, Dome Building	
2:00 pm	Session 2: Convener Invites Session Chair -Introduction by Session Chair
2:00 pm-2:30pm	Keynote Talk 2 Can We Make Blue Skies Green ?: Decarbonizing aviation with eSAF Dr. R Prasad Balegedde Ramachandran (Online) Sr. Project Manager CBR Sustainability Partners, Germany
2:30 pm-2:50 pm	Invited Talk 1 Emerging Contaminants and SDGs: a special context to Plastics in daily life Dr. Garima Kaushik Central University of Rajasthan

CONFERENCE SCHEDULE

ICAST 2026: Day 1 August 19, 2026)

Day 1 – 19th August 2026 (Wednesday) – Conference Sessions

Time (IST)	Event / Speaker
2:50 pm-3:10 pm	Invited Talk 2 Sustainable Innovation Through Sustainable Chemistry: Key Characteristics, Critical Thinking, and Early Assessment Dr. Dorota Bartkowiak (Online) International Sustainable Chemistry Collaborative Centre (ISC3)
3:10 pm-3:30 pm	Invited Talk 3 Bio-Derived Quantum Materials: A Sustainable Approach to Renewable Energy Applications Dr. T Pandiyarajan <i>IIITD, Kurnool</i>
3:30 pm-3:40 pm	Contributory talk: Abstract ID: 043
3:40 pm-3:50 pm	Contributory talk: Abstract ID: 047
3:50 pm-4:00 pm	Contributory talk: Abstract ID: 038
4:00 pm-4:10 pm	Contributory talk: Abstract ID: 041
4:10 pm-4:30 pm	TEA Break
4:30 pm-4:40 pm	Contributory talk: Abstract ID: 008
4:40 pm-4:50 pm	Contributory talk: Abstract ID: 051
4:50 pm-5:00 pm	Contributory talk: Abstract ID: 037
5: 00 PM	END of DAY 1

CONFERENCE SCHEDULE

ICAST 2026: Day 2 August 20, 2026)

Day 2 – 20th August 2026 (Thursday) – Conference Sessions

Time (IST)	Event / Speaker
10:00 am	Convener invites session chair
10:00 am – 10:30 am	Keynote Talk: 3 Sustainable technologies and life cycle management in pharmaceutical and chemical industries Dr. Chirag Patel <i>General Manager, PI Industries</i>
10:30 am-11:00 am	TEA Break
11:00 am	Convener invites session chair
11:00 am-11:30 am	Keynote Talk 4 (Online) Green Hydrogen by Electrolysis: Basic Insights and Future Perspectives Prof. S. Vasudevan <i>CSIR-Central Electrochemical Research Institute, Karaikudi</i>
11:30 am-11:50 am	Invited Talk 4 Developing Sustainable Aviation Fuel Through Advanced Hydro processing Technologies: From Research to Refinery Implementation Vinay Amte <i>Research and Technology - Refining, Reliance Industrie</i>
11:50 am-12:10 pm	Invited Talk 5 (online) Advancing Safe and Sustainable Energy Systems through Physics-Based Computational Modelling: Applications in Hydrogen Technologies. Dr Chandra M Rao Vendra <i>University of Hertfordshire</i>
11:50 am-12:10 pm	Invited Talk 6 Agro-Waste to Functional Materials: Enabling Circular Economy and Sustainable Resource Recovery Prof. Jagpreet Singh (online) <i>Rayat Bahra University, Mohali, Punjab, India</i>

CONFERENCE SCHEDULE

ICAST 2026: Day 2 August 20, 2026)

Day 2 – 20th August 2026 (Thursday) – Conference Sessions

Time (IST)	Event / Speaker
12:30 pm-12:40pm	Contributory talk: Abstract ID: 003 and 009
12:40 pm-12:50 pm	Contributory talk: Abstract ID: 052 and 013
12:50 pm-1:00 pm	Contributory talk: Abstract ID: 066 and 067
1:00pm–2:00pm	Lunch
2:00 pm	Convener invites session chair
2:00 pm-2:30 pm	Keynote Talk: 5 Advances in Sustainable Technologies Mr. Vasant T. Jagtap Patil <i>Vice President – Process & Tech. Sales, Xytel India Pvt. Ltd</i>
2:30 pm-2:50 pm	Invited Talk 7 Employing Chemical Engineering to Recycle Batteries for a Sustainable Value Chain Dr. Sulalit Bandopadhyay (Online) <i>NTNU, Norway</i>
2:50 pm-3:10 pm	Invited Talk 8 PFAS in Refrigerant Aerosols: Detection, Precaution, and Global Student-Led Monitoring Frame Dr. Jeekesh Arora <i>Inch Enviro Tech Pvt. Ltd.</i>
3:10 pm-3:30 pm	Invited Talk 9 Flexible Conducting Polymer Nanocomposite Sensors for Room-Temperature Ammonia Detection Dr. Kamendra Awasthi <i>MNIT Jaipur</i>

CONFERENCE SCHEDULE

ICAST 2026: Day 2 August 20, 2026)

Day 2 – 20th August 2026 (Thursday) – Conference Sessions

Time (IST)	Event / Speaker
3:30 pm-3:50 pm	Invited Talk 10 Biomass-derived carbon bioelectrode from coconut husk for energy storage applications Dr. Vivekanand <i>MNIT Jaipur</i>
3:50 pm-4:10 pm	Invited talk 11 Harnessing Mycochitinases for the Biocatalytic Transformation of Coastal Residual Biomass into Value-Added Bioactives Dr. Nidhi Pareek <i>Central University of Rajasthan</i>
4:10 pm-4:30 pm	TEA
4:30 pm-4:40 pm	Contributory talk: Abstract ID: 050
4:40 pm-4:50 pm	Contributory talk: Abstract ID: 073
4:50 pm-5:00 pm	Contributory talk: Abstract ID: 043
5:00 pm-5:10 pm	Contributory talk: Abstract ID: 039
5:10 pm-5:20 pm	Contributory talk: Abstract ID: 015
5:20 pm-5:30 pm	Contributory talk: Abstract ID: 077
	End of Day 2

CONFERENCE SCHEDULE

ICAST 2026: Day 3 August 21, 2026)

Day 3 – 21st August 2026 (Friday) – Conference Sessions

Time (IST)	Event / Speaker
10:00 am	Convener invites session chair
10:00 -10:30 am	Keynote Talk 6 Energy Transition in the Oil and Gas Sector: Strategies for Sustainable Future Dr. Chiranjeevi Thota <i>BPCL RSD</i>
10:30-10:50 am	Invited Talk 12 (Online) From Viscose to Lyocell: Enabling Sustainable Regenerated Cellulose Fibers Dr. Aakash Sharma <i>KAUST, Saudi Arabia</i>
10:50-11:00 am	Contributory talk: Abstract ID: 036
11:00-11:10 am	Contributory talk: Abstract ID: 071
11:10-11:20 am	Contributory talk: Abstract ID:040
11:20-11:30 am	Contributory talk: Abstract ID: 014
11:30-11:40 am	Contributory talk: Abstract ID: 062
11:40-11:50 am	Contributory talk: Abstract ID: 064
11:50-12:00 pm	Contributory talk: Abstract ID: 086
12:00 pm -12:10 pm	Contributory talk: Abstract ID: 087
12:10 pm -12:20 pm	Contributory talk: Abstract ID: 058

CONFERENCE SCHEDULE

ICAST 2026: Day 3 August 21, 2026)

Day 3 – 21st August 2026 (Friday) – Conference Sessions

Time (IST)	Event / Speaker
12:20 pm -12:30 pm	Contributory talk: Abstract ID: 092
(TBD)	Valedictory Ceremony and Prize distribution
	Conference Ends!



Circular and Smart Carbon Management: From Carbon Emissions to Carbon Valorisation for the Energy Transition

Ganapati D. Yadav

Bhatnagar Fellow (CSIR), National Science Chair (ANRF) Emeritus Professor of Eminence, Former Vice Chancellor Institute of Chemical Technology, Mumbai

The world is at a critical inflection point in its energy and carbon journey. Geopolitical conflicts, disruptions in energy supply chains, climate change and rapidly increasing energy demand have exposed the vulnerability of conventional fossil-fuel-based systems. At the same time, global energy-related CO₂ emissions reached a record 38.4 billion tonnes in 2025, demonstrating that the transition to clean energy, although accelerating, is not yet sufficient to achieve climate goals. For India, the challenge is particularly complex: approximately 88% of crude-oil requirements are imported, while domestic coal production exceeded 1,047 Mt in 2024–25 and coal and lignite continued to provide about 73% of utility electricity generation. India must therefore simultaneously pursue energy security, economic growth, decarbonisation and carbon management.

This lecture proposes a paradigm shift from carbon disposal to carbon circularity, and from passive carbon management to circular and smart carbon management. Carbon dioxide should increasingly be regarded not merely as an emission, but as a carbon resource that can be captured, concentrated, converted, recycled and, where necessary, permanently stored. The emerging circular carbon economy can connect fossil carbon, renewable carbon, biomass carbon, waste carbon and captured CO₂ through integrated pathways for producing fuels, chemicals, materials and hydrogen.

The lecture will explore an integrated portfolio of technologies including carbon capture, utilisation and storage (CCUS), CO₂-to-fuels and chemicals, C1 chemistry, green hydrogen, methanol, dimethyl ether, formic acid, carbon mineralisation, biomass valorisation, waste-to-energy, catalytic hydrogenolysis, electrochemical and thermochemical conversion, and carbon-negative technologies. Particular attention will be given to the development of CO₂ refineries, in which captured carbon becomes a feedstock for value-added products rather than a waste stream.

India's large coal, biomass and agricultural-residue resources offer additional opportunities for smart carbon management. Advanced catalytic and thermochemical technologies can transform coal and biomass into hydrogen, chemicals, fuels and carbon materials, while integrating carbon capture and renewable energy to progressively reduce their carbon intensity. Such pathways can provide a pragmatic bridge between India's present energy system and its future low-carbon economy.

The ultimate objective is to move beyond the traditional hierarchy of reduce–reuse–recycle towards capture–convert–cycle–create–remove, transforming carbon from an environmental liability into an industrial resource. The lecture will argue that the pathway from carbon-intensive growth to net zero and ultimately net-negative emissions will depend not on a single technology, but on the intelligent integration of chemistry, catalysis, biotechnology, renewable energy, hydrogen, carbon engineering and artificial intelligence. Circular and smart carbon management through the use of green H₂ can therefore become a defining technological paradigm of the 21st century turning the carbon challenge into an opportunity for sustainable industry, energy security, innovation and economic value creation.



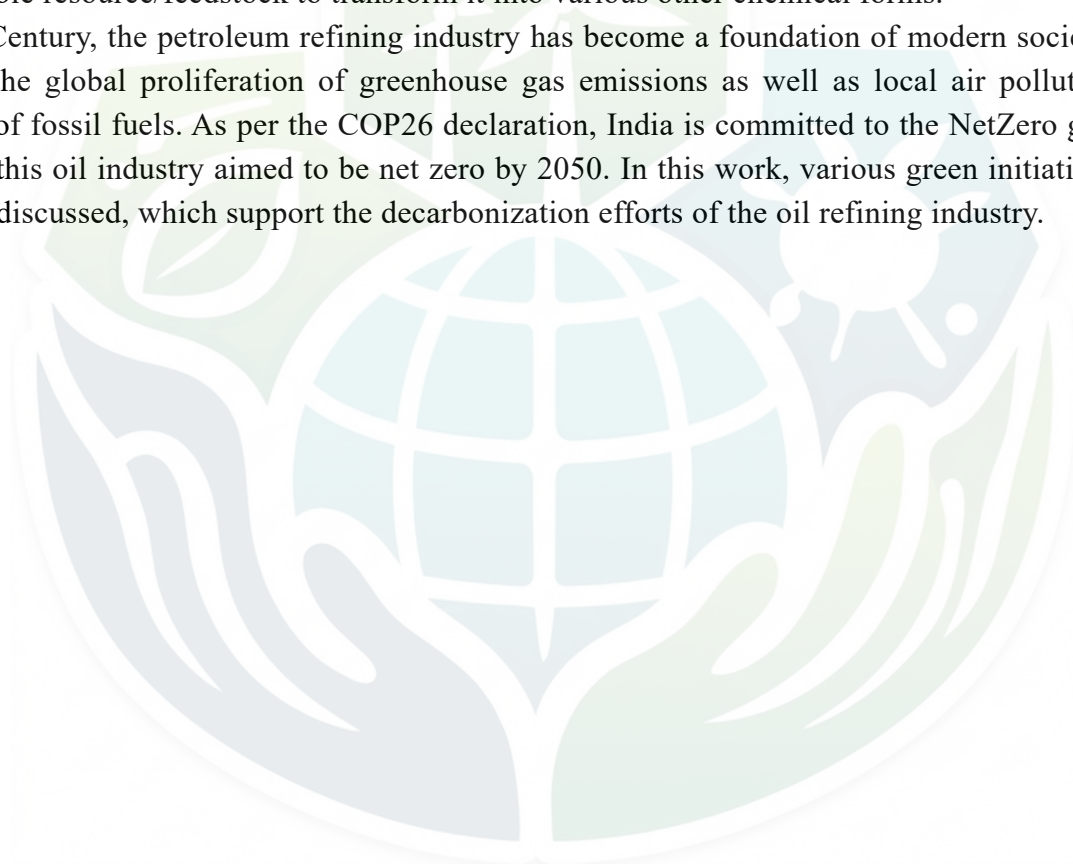
Energy Transition in the Oil and Gas Sector: Strategies for Sustainable Future

Chiranjeevi Thota

Corporate R & D Centre, Bharat Petroleum Corporation Ltd., Greater Noida, U.P. 201 301, Tel: 0120-2354127, chiranjeevit@bharatpetroleum.in

The ever-increasing reliance on existing fossil fuels has not only put us to the threshold limit of exhausting non-renewable energies but also caused serious problems in the environment by accumulating significant amounts of greenhouse gas CO₂. A recent study mentioned that about 48-52 Gt of CO₂ will be released into the atmosphere by 2035.. The chemical transformation of carbon dioxide into useful products becomes increasingly important as CO₂ levels in the atmosphere continue to rise because of human activities. It emphasizes the necessity of innovations for capturing and utilizing CO₂ to decrease its net emissions or adopting CO₂ reduction technologies. Instead of looking at CO₂ emissions as a threat, it can be viewed as a highly valuable resource/feedstock to transform it into various other chemical forms.

In the 19th Century, the petroleum refining industry has become a foundation of modern society, but it has also led to the global proliferation of greenhouse gas emissions as well as local air pollution from the combustion of fossil fuels. As per the COP26 declaration, India is committed to the NetZero goal by 2070. In line with this oil industry aimed to be net zero by 2050. In this work, various green initiatives of the oil industry are discussed, which support the decarbonization efforts of the oil refining industry.



Sustainable Technologies and Life Cycle Management in Pharmaceutical and Chemical Industries

Chiragkumar Patel

General Manager-Technology Transfer and Basic Engineering, PI Industries Ltd.

The pharmaceutical and chemical industries are undergoing a significant transformation driven by the need for sustainability, cost efficiency, and regulatory compliance. Sustainable technologies, coupled with Life Cycle Management (LCM), provide a comprehensive framework to minimize environmental impact while enhancing economic performance. This study presents a critical analysis of the gap between academic research and industrial practices in the context of current trends in these industries.

Academic research predominantly focuses on the development of green chemistry principles, advanced modeling techniques, and life cycle assessment (LCA) methodologies. However, industrial adoption remains limited due to challenges such as high implementation costs, scalability issues, regulatory barriers, and lack of standardized sustainability metrics. This gap highlights the need for stronger collaboration, effective technology transfer, and policy support.

The role of modeling and simulation, including digital twins and AI-driven tools, is emphasized as a key enabler for optimizing processes, reducing resource consumption, and accelerating scale-up. Life Cycle Assessment serves as a critical tool to evaluate environmental impacts across all stages, from raw material extraction to disposal, while LCM integrates these insights into strategic decision-making.

Furthermore, the study explores cost reduction strategies within LCM, such as solvent recovery, process intensification, and energy optimization, demonstrating that sustainability initiatives can directly contribute to reduced operating costs and improved profitability.

Looking ahead, the demand for sustainable solutions in pharmaceutical and chemical industries is expected to grow, driven by advancements in biopharmaceuticals, green chemicals, and digital technologies. The transition toward a circular economy and net-zero emissions will further shape the future landscape.

In conclusion, bridging the gap between academia and industry, supported by innovation, digitalization, and policy frameworks, is essential for achieving sustainable development in these sectors.

Can We Make Blue Skies Green?: Decarbonizing aviation with eSAF

Dr. R Prasad Balegedde Ramachandran

Sr. Project Manager CBR Sustainability Partners, Germany

Global aviation accounts for roughly 2.5% of CO₂ emissions, with non-CO₂ effects such as contrail formation and NO_x pushing its true climate impact closer to 3.5% of human-caused warming. As demand growth in emerging markets like India outpaces that in mature aviation sectors, the sector faces mounting pressure to decarbonize beyond current biofuel-based approaches. This keynote presents electro-Sustainable Aviation Fuel (eSAF) — synthesized from captured CO₂, green hydrogen, and renewable electricity via Reverse Water-Gas Shift and Fischer-Tropsch synthesis — as a scalable, feedstock-unconstrained alternative capable of exceeding 90% lifecycle emissions reduction while remaining chemically compatible with existing aircraft. Surveying deployments by various technology providers, alongside techno-economic modelling of a representative 100 ktpa facility, the talk weighs eSAF's technical readiness against the cost, capital, and CO₂-sourcing barriers still limiting commercial scale-up. Particular attention is given to India's positioning — its renewable resource base, hydrogen mission, and regulatory mandates — as a potential first-mover opportunity, closing with concrete research directions for students entering the field of aviation decarbonization.



Innovation and Policy Synergies for Sustainable Technologies: ICC's Vision for a Greener Chemical Future

Mr. Dinesh Chopra

Chairman ICC - Industry Academia Committee

Highlights & Key Themes:

1. About the Indian Chemical Council (ICC):

- Founded in 1938 by Acharya P.C. Ray and Rajmitra B.D. Amin and headquartered in Mumbai with offices in Delhi, Chennai, Vadodara, Kolkata.
- Serves as the national apex body for the \$300B+ Indian Chemical Industry, covering pharmaceuticals, petrochemicals, specialty chemicals, agrochemicals, plastics, and more.

2. Global & Economic Dynamics:

- Macroeconomics: The Indian chemical market is ~\$300 billion and aims to reach \$1 trillion, as part of India's broader push toward a \$5 trillion economy.
- Industrial Evolution: Industrial transitions occurred from Industry 1.0 (Mechanisation) through 4.0 (Digitalisation/AI) to Industry 5.0 (Personalisation & Human-Machine Harmony).
- Global Ecosystem Comparison:
- West: Historical innovation powerhouse since 18th Century, now shifting low-tech manufacturing with lower basic R&D spend.
- China: Aggressive growth via government funding in late 19th Century, built massive production capacity scaling and dominant patent generation with strong Industry Academia Partnership by bringing labs/pilot plants to production sites.
- India: Heavily MSME-driven with high domestic consumption, low prices, but low Industry Academia partnerships for new innovation to commercialization.

3. Climate Imperatives & Global Policies:

- Rising Temperatures: Highlights the urgent need for decarbonization due to global thermal acceleration (approaching +1.5°C threshold between 2030-35).
- EU Climate Policy Impact: Targets under EU ETS (-62% emissions by 2030) and the Carbon Border Adjustment Mechanism (CBAM) mandate strict embedded-carbon monitoring for global trade.
- Clean Tech Drivers: Rapid adoption of green solar energy, advanced energy storage (Li-ion costs decreasing significantly), and zero-emission Hydrogen Fuel Cell vehicles.

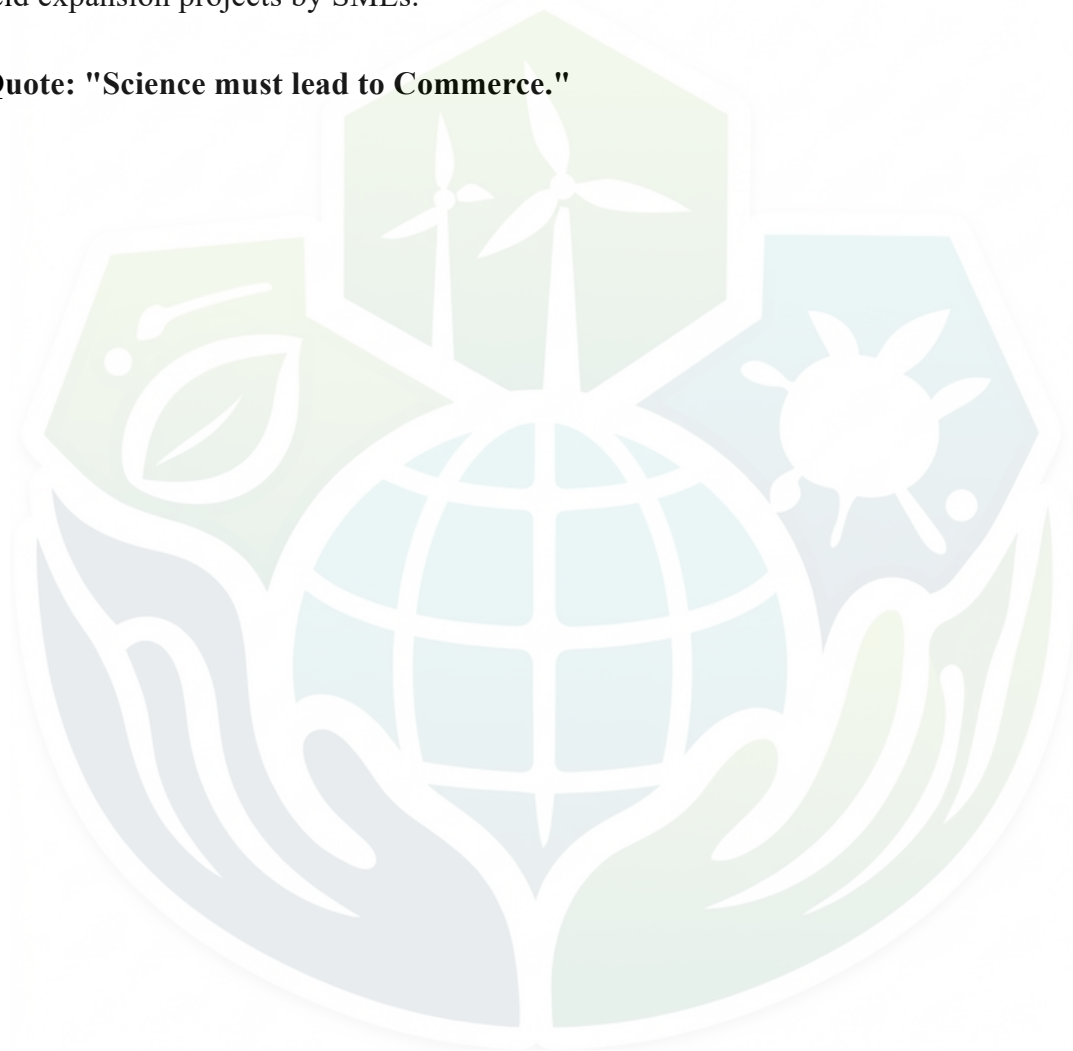
4. ICC Action Strategy & Green Chemistry Vision:

- 12 Principles of Green Chemistry: Stresses on proactive waste prevention, maximum atom economy, renewable feedstocks, and selective green catalysis.
- Responsible Care (RC) Program: The gold-standard initiative in India with 100 logo holders following strict third-party audits for Environmental, Health, Safety, and Security (EHS&S).
- Shift in Industry Mindset: Moving away from simple regulatory compliance toward proactive global integration, bio-manufacturing, and green decarbonization pathways.

5. ICC Industry-Academia Committee (IAC) Initiatives:

- Skill Development: Initiatives in chemical hubs like Dahej (in partnership with ITIs, industry leaders, and RCPSDC).
- Inclusion & CSR: "WeChemie" project aimed at skilling underprivileged women and offering internships.
- Policy Collaboration: Active engagement with government bodies (DST, DCPC, NITI Aayog) on R&D funds (₹1.0 Lakh Cr fund), web portals, and schemes like the ₹3,030 Cr Bhavya Rasayan scheme for chemical parks.
- Environmental Recommendations: Advocating to permit 100% off-site green belt options for brownfield expansion projects by SMEs.

Takeaway Quote: "Science must lead to Commerce."

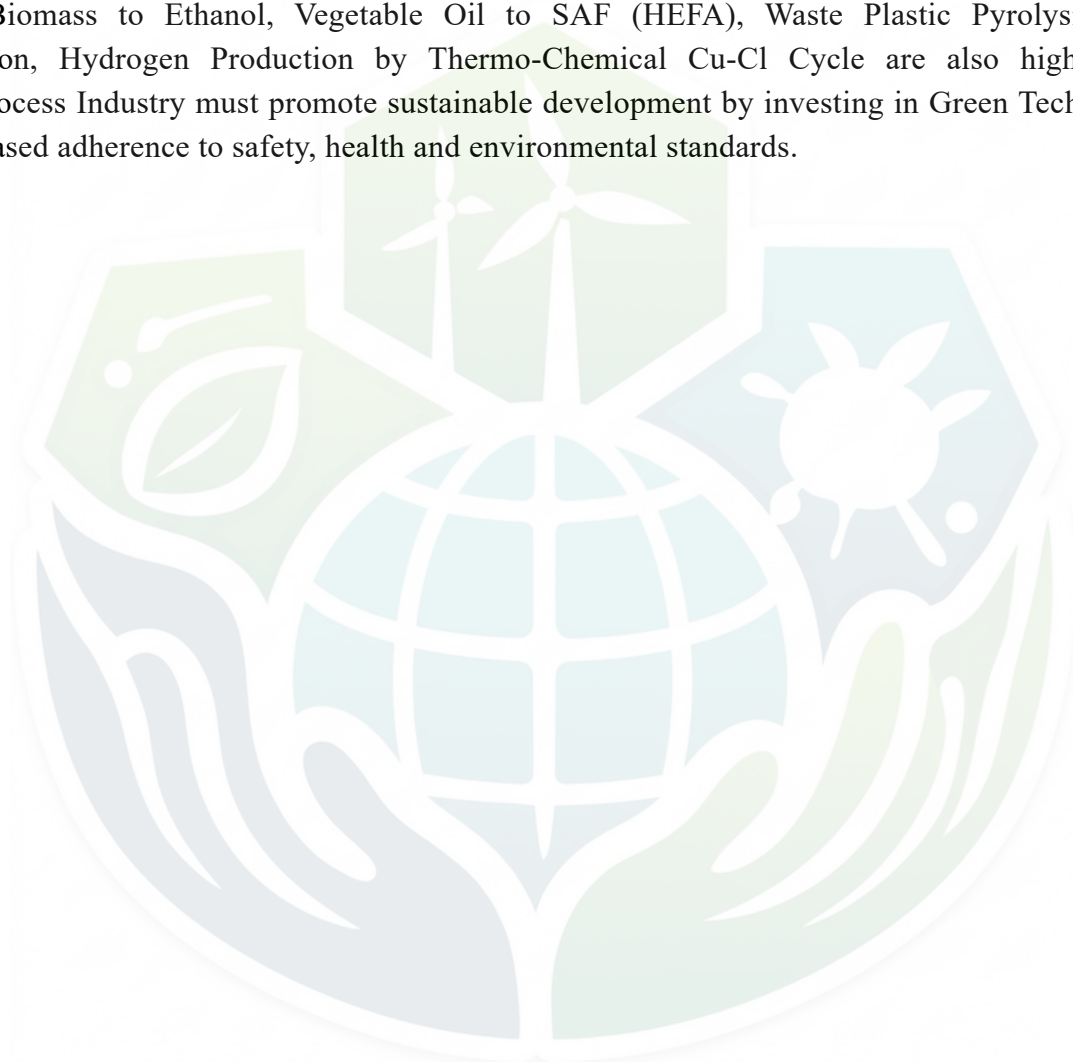


Advances In Sustainable Technologies

Mr. Vasant T. Jagtap Patil

Vice President – Process & Tech. Sales, Xytel India Pvt. Ltd

The comprehensive review is presented on the significant progress made in Green Technology innovations across various sectors. The advancements in sustainable technologies have demonstrated substantial potential for reducing greenhouse gas emissions and also in promoting resource efficiency. Recent work on various pilot plant such as Hydrothermal Liquefaction (HTL), Sustainable Aviation Fuel (SAF), CO₂ to Methanol, Biomass to Ethanol, Vegetable Oil to SAF (HEFA), Waste Plastic Pyrolysis, PET De-Polymerisation, Hydrogen Production by Thermo-Chemical Cu-Cl Cycle are also highlighted. The Chemical Process Industry must promote sustainable development by investing in Green Technologies and ensure increased adherence to safety, health and environmental standards.



Green Hydrogen by Electrolysis: Basic Insights and Future Perspectives

Prof. S. Vasudevan

*Electrochemical Process Engineering Division, CSIR-Central Electrochemical Research Institute,
Karaikudi-630003, India*

Green hydrogen is pivotal to the clean energy transition, offering a sustainable, zero-emission alternative to fossil fuels in hard-to-abate sectors like steel, fertilizers, refineries, chemicals, and heavy transport. It enables renewable energy storage, low-carbon chemical production, and significant greenhouse gas reductions, forming a key pillar of the net-zero economy.

Produced via water electrolysis using renewable electricity, green hydrogen relies on two main mature technologies such as alkaline electrolyzers (AEL) that are cost-effective and well-established, followed by proton exchange membrane (PEM) electrolyzers favoured for their fast response, compact design, and high-purity output suited to variable renewables. Currently, electrolysis accounts for only 4–5% of global hydrogen production due to high electricity and material costs. However, prices are set to fall rapidly through standardization, mass production, and scale. Rising demand for clean hydrogen and its storage potential will drive massive growth in renewable electrolysis, while non-renewable variants support near-term niche applications like small fuelling stations. In low-carbon futures, electrolyzers could bridge electricity grid needs with transport and industrial fuel demands, displacing large volumes of fossil-based non-electric energy and unlocking a vast new global market.

This talk covers recent advances in electrochemical hydrogen generation, focusing on novel materials for improved efficiency, durability, and affordability. It also presents key hydrogen technologies from CSIR-Central Electrochemical Research Institute (CSIR-CECRI), including large scale 25 Nm³/h PEM generators, next-generation electrolyzer R&D direct seawater electrolysis, advanced PEM materials, alkaline anion exchange membranes (AAMEs), and innovations supporting India's green hydrogen goals.

Keywords: Green hydrogen, PEM electrolyzer, alkaline electrolyzer, electrocatalyst



Emerging Contaminants and SDGs: a special context to Plastics in daily life

Preksha Palsania, Garima Kaushik

Department of Environmental Science, School of Earth Sciences, Central University of Rajasthan,

BandarSindri, Ajmer, 305817, Rajasthan, India

Email: garimakaushik@curaj.ac.in

Sustainable Development Goals directly address the problem raised by emerging contaminants (ECs). Adopting better lifestyles can eradicate the threats posed by ECs in human life. Bisphenol A (BPA) is used as an additive to harden the plastic component in polycarbonate plastic wares including plastic drinking bottles, plastic cups, food cans, infant bottles, package wrappings, cutleries, dishes and a number of other consumer products. Food-grade plastics are intended to store and serve food/ beverages. The manufacturing of plastics for food grade is significant as it protects food from different variables that may cause chemical, physical, and microbiological degradation. Concerns arise when the additive chemicals like BPA migrate from plastic containers into the food in contact during this preservation and storage process and trigger damaging health hazards Bisphenol A (BPA) is commonly added to polycarbonate plastics to enhance their strength and is found in items like drinking bottles, cups, food cans, infant bottles, packaging, cutlery, dishes, and various consumer products. Concerns arise when BPA and similar additives leach from these containers into food, posing potential health risks. This highlights the need to evaluate the safety of food and beverage storage materials. This study measures BPA levels in everyday food-grade plastic containers and assesses its toxicity in environmental samples contaminated by BPA leachates. BPA was extracted from food-grade plastics and quantified using UV-Vis spectrophotometry and HPLC. The toxicity of *Rhizobium* and *Chlorella* sp. was then evaluated. The highest concentration of BPA was detected in black poly bags (42.78 ppm), followed by slice juice bottles and infant milk bottles. Toxicity tests significantly affected *Rhizobium* and *Chlorella* species, representing soil and aquatic environments. Two potential bacterial strains, *Brucella* sp. and *Brevibacillus parabrevis*, were isolated from a municipal dumping site and used to biodegrade BPA. Qualitative and quantitative analyses of biodegraded BPA using U-HPLC and GC-MSMS revealed various BPA metabolites. The findings suggest that these native bacterial strains are promising strains for BPA degradation, transforming it into a less toxic form. The study also highlights the risks associated with food-grade plastic containers and recommends developing sustainable methods for managing plastic waste.

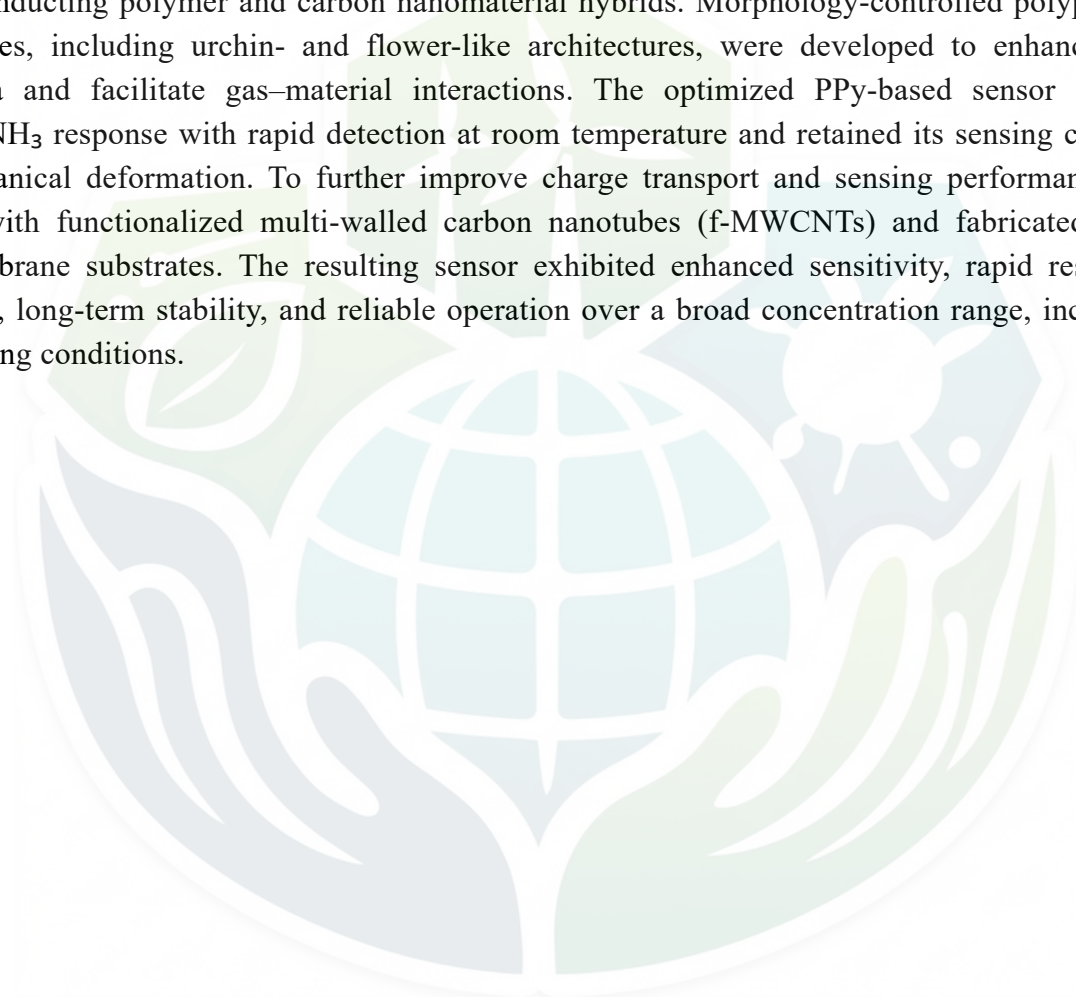
Keywords: Biodegradation, Bisphenol A, Food-grade Plastics, *Rhizobium*, Toxicity

Flexible Conducting Polymer Nanocomposite Sensors for Room-Temperature Ammonia Detection

Dr. Kamlendra Awasthi

*Department of Physics, Malaviya national Institute of Technology Jaipur, Jaipur-302017, India
kawasthi.phy@mnit.ac.in*

Ammonia (NH_3) is an important environmental and industrial pollutant, necessitating sensitive, rapid, and reliable detection for environmental monitoring, occupational safety, and emerging wearable technologies. Our research focuses on the development of flexible, low-cost, and room-temperature ammonia sensors based on conducting polymer and carbon nanomaterial hybrids. Morphology-controlled polypyrrole (PPy) nanostructures, including urchin- and flower-like architectures, were developed to enhance the active surface area and facilitate gas-material interactions. The optimized PPy-based sensor demonstrated significant NH_3 response with rapid detection at room temperature and retained its sensing characteristics under mechanical deformation. To further improve charge transport and sensing performance, PPy was integrated with functionalized multi-walled carbon nanotubes (f-MWCNTs) and fabricated on flexible PVDF membrane substrates. The resulting sensor exhibited enhanced sensitivity, rapid response, good repeatability, long-term stability, and reliable operation over a broad concentration range, including under severe bending conditions.



Biomass-derived carbon bioelectrode from coconut husk for energy storage applications

Dr. Vivekanand

*Centre for Energy and Environment, Malaviya National Institute of Technology Jaipur, Jaipur, India
vivekanand.cee@mnit.ac.in*

Biomass-derived carbon materials have gained considerable attention for applications in electrochemical energy storage and water treatment due to their renewable nature, low cost, and tunable physicochemical properties. In this study, coconut husk waste is utilized as a sustainable precursor for the synthesis of porous carbon electrodes for supercapacitors and potential wastewater treatment applications. The pyrolysis was performed on the biomass under different levels of power under microwave heating to produce biochar, and chemical activation was done using ZnCl_2 to functionalize the biochar improved porosity and surface area. The obtained materials were characterized in terms of density, micro-crystallinity, surface morphology, elemental composition, and surface area. The findings show that chemical activation substantially enhance the pore structure and surface properties of the carbon mixture causing it to become electrochemical capable. Electrochemical performance was evaluated using cyclic voltammetry, revealing good capacitive behavior of the prepared electrodes. The activated biochar exhibited a specific capacitance in the range of $\sim 145\text{--}212\text{ F/g}$. Variations in performance between coconut husk derived carbons were attributed to differences in lignin and influencing structural and electrochemical properties.

Keywords: Coconut husk, Activated carbon electrode, Supercapacitor, Electrochemical energy storage

Developing SAF Through Advanced Hydroprocessing Technologies: From Research to Refinery Implementation

Dr. Vinay Amte

Reliance Industries Limited, Navi Mumbai, India

Sustainable Aviation Fuel (SAF) is one of the most viable near-term pathways for decarbonizing the aviation sector, particularly for long-haul flights where electrification and hydrogen face by energy-density and infrastructure constraints. Hydroprocessing is a leading platform for SAF production owing to its technological maturity, established catalyst systems, and compatibility with existing refinery infrastructure. Leveraging refinery assets for renewable feedstock co-processing offers a potentially cost-effective pathway to accelerate SAF deployment with minimal CAPEX. Among the ASTM-approved pathways, Hydroprocessed Esters and Fatty Acids (HEFA) is the most technologically mature pathway, while Fischer-Tropsch (FT), Methanol-to-Jet (MTJ), and Alcohol-to-Jet (ATJ) offer opportunities for future feedstock diversification and scale up. India's emerging SAF ecosystem, supported by blending targets, policy initiatives, and substantial hydroprocessing capacity, provides a strong foundation for competitive domestic SAF production. The talk will discuss the key challenges in converting renewable feedstocks into aviation-range hydrocarbons, with emphasis on deoxygenation, hydro-isomerization, hydrocracking, hydrogen management, catalyst performance and product quality. It will further highlight the challenges associated with renewable-feedstock co-processing in existing hydroprocessing units, including feed variability, catalyst deactivation, reactor and equipment adequacy, product properties and ASTM fuel qualification. Research-to-Refinery translation, supported by catalyst evaluation, process-modelling, pilot-scale validation and techno-economic assessment, will be essential for developing robust and commercially viable SAF pathways. Integrated hydroprocessing technologies can enable scalable SAF production using existing refinery assets, contributing to India's energy security, technology leadership and transition toward a lower-carbon aviation sector.

Bio-Derived Quantum Materials: A Sustainable Approach to Renewable Energy Applications

Dr. T Pandiyarajan

*Department of Sciences, Indian Institute of Information Technology Design and Manufacturing Kurnool,
Kurnool, Andhra Pradesh 518008, INDIA*

Corresponding Author E-mail: pandiyarajan@iiitk.ac.in

Since the discovery of graphene quantum dots (GQDs) in 2008, significant attention has been devoted to their synthesis and understanding of their unique physical and chemical properties, owing to their immense potential across a wide range of technological applications. The commonly used method for producing GQDs mainly relies on harsh acids such as H_2SO_4 and HNO_3 , strong oxidants such as KMnO_4 , or additional chemical treatments, and is time-consuming and energy-intensive [10]. Thus, pushing researchers to develop a novel route to produce GQDs from natural resources without harmful acids/strong oxidants. In this talk, a simple, chemical-free, and rapid microwave-assisted route for the production of excitation-dependent multicolour emissive GQDs from *Bougainvillea* flower extracts will be discussed. The comprehensive analysis highlighting the influence of surface functional groups and quantum confinement on their optical, photophysical behavior and the origin of unconventional excitation-dependent and excitation-independent emission from GQDs is presented in detail. Numerical simulations confirmed that incorporating graphene quantum dots into solar cells could effectively improve overall photoconversion efficiency. The findings provide a sustainable approach to chemical-free, biomass-derived GQDs by contributing to Sustainable Development Goal SDG 12, converting bio-waste into a usable product, and advancing understanding of their physical and chemical properties for the utilisation of GQDs in renewable energy device applications.

Keywords: Quantum Materials, Solar cells, Graphene Quantum Dots, Microwave

Agro-Waste to Functional Materials: Enabling Circular Economy and Sustainable Resource Recovery

Prof. Jagpreet Singh

*Bahra Research Innovation & Knowledge Cluster (BRIKC), Rayat Bahra University, Punjab, Mohli, India
e-mail address: jagpreet.prof@gmail.com*

The rapid generation of agricultural waste has emerged as a major environmental challenge, while the increasing demand for advanced materials continues to place pressure on finite natural resources. This invited talk will explore the transformation of agro-waste into high-value functional materials as a promising strategy for integrating waste valorisation, circular economy, and sustainable resource recovery. Particular emphasis will be placed on two important classes of biomass-derived materials: biochar and carbon dots.

The talk will highlight how abundant agricultural residues, particularly lignocellulosic wastes, can be converted through appropriate thermal and hydrothermal strategies into biochar with tunable surface chemistry, porosity, and functional groups, enabling its application in water purification, contaminant removal, catalysis, soil remediation, and resource recovery. In parallel, the development of biomass-derived carbon dots will be discussed, focusing on their unique photoluminescence, surface functionality, aqueous stability, and potential for selective sensing of environmental contaminants. The relationship between precursor composition, synthesis conditions, surface chemistry, and functional performance will be addressed to demonstrate how waste-derived materials can be rationally engineered for targeted applications.

Beyond material synthesis, the talk will discuss the broader role of these technologies in establishing closed-loop resource pathways, where agricultural residues are transformed from low-value waste into functional materials capable of addressing environmental challenges and supporting resource recovery. Challenges related to scalability, reproducibility, energy consumption, material performance, life-cycle considerations, and practical implementation will also be discussed. Finally, the talk will present future perspectives on integrating green synthesis, nanotechnology, circular bioeconomy, and sustainable resource recovery to develop next-generation materials and technologies for cleaner environments and more resource-efficient societies.

Keywords: Agro-waste valorisation; Biochar; Carbon dots; Biomass-derived nanomaterials; Circular economy; Green synthesis; Environmental remediation; Water purification; Sustainable nanotechnology.

Employing Chemical Engineering to Recycle Batteries for a Sustainable Value Chain

Dr. Sulalit Bandopadhyay

Department of Chemical Engineering, Faculty of Natural Sciences, NTNU, Norway

Globally, batteries comprise the fastest growing energy storage technology that is playing a key role in electrification of the transport sector leading to a driving demand for lithium-ion batteries (LIBs). However, there is a substantial need for innovation that will help mitigate the environmental effects of production and use of LIBs – like energy use, mineral extraction and chemical processing. Unfortunately, battery recycling is one of the least developed parts in the battery value chain. Presently available hydrometallurgical routes suffer from several key limitations, primarily, complex separation and purification steps, impurity issues in the final product caused by excessive use of reagents such as alkalis, losses of valuables at every process step and so on.

To address these current technology problems, our research activities focus on developing omnivore processes that not only focus on developing process flowsheets that target recovery of high valuable metals from black mass (a black mixture of cathode and anode materials formed via dismantling and crushing of batteries) but also target recovery of less valuables, such as graphite. In addition, we exploit fundamentals of hydrometallurgy to facilitate selective and early-stage recovery of lithium, an important component of LIBs. Our activities rely on use of a plethora of characterization techniques including in-situ characterization of particle dissolution, precipitation and coagulation processes with an aim to optimize recovery and resource efficiency as well as fostering industrial symbiosis. This talk will focus on our hydrometallurgical process strategies for maximizing metal and material recovery from black mass, with particular emphasis on selective, early-stage lithium and graphite recovery and the characterization approaches that underpin process optimization and industrial symbiosis.

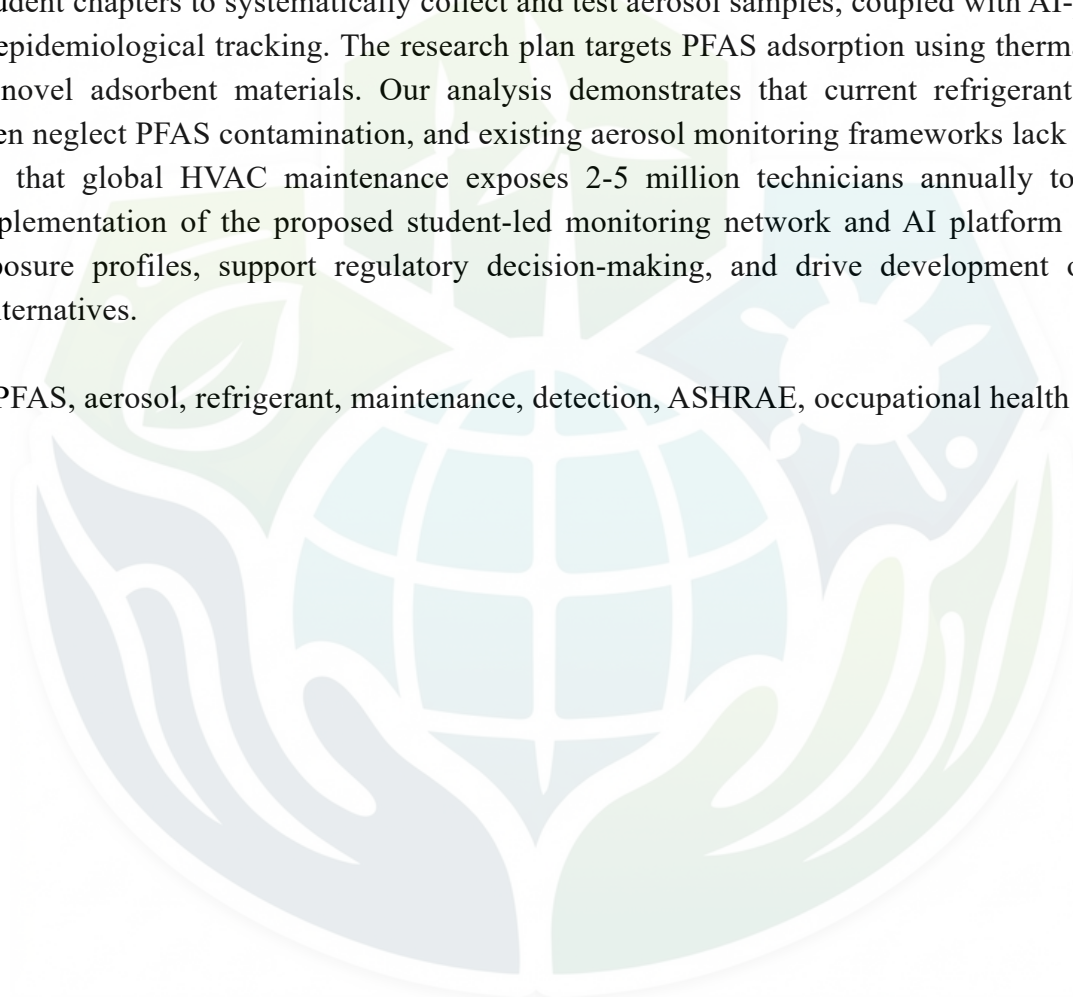
PFAS in Refrigerant Aerosols: Detection, Precaution, and Global Student-Led Monitoring Frame

Mr. Jeekesh Arora

Director, Inch Enviro Technologies Pvt. Ltd.

Per- and polyfluoroalkyl substances (PFAS) are persistent organic pollutants that accumulate in refrigeration systems and are released through aerosol emissions during maintenance and operational routines. This article reviews the prevalence of PFAS in refrigerant aerosols, establishment of detection protocols, and operational precautions to minimize exposure. We propose a global framework leveraging ASHRAE student chapters to systematically collect and test aerosol samples, coupled with AI-powered data banking for epidemiological tracking. The research plan targets PFAS adsorption using thermally activated carbon and novel adsorbent materials. Our analysis demonstrates that current refrigerant replacement practices often neglect PFAS contamination, and existing aerosol monitoring frameworks lack coordination. We estimate that global HVAC maintenance exposes 2-5 million technicians annually to PFAS-laden aerosols. Implementation of the proposed student-led monitoring network and AI platform can establish baseline exposure profiles, support regulatory decision-making, and drive development of PFAS-free refrigerant alternatives.

Keywords: PFAS, aerosol, refrigerant, maintenance, detection, ASHRAE, occupational health



Sustainable Innovation Through Sustainable Chemistry: Key Characteristics, Critical Thinking, and Early Assessment

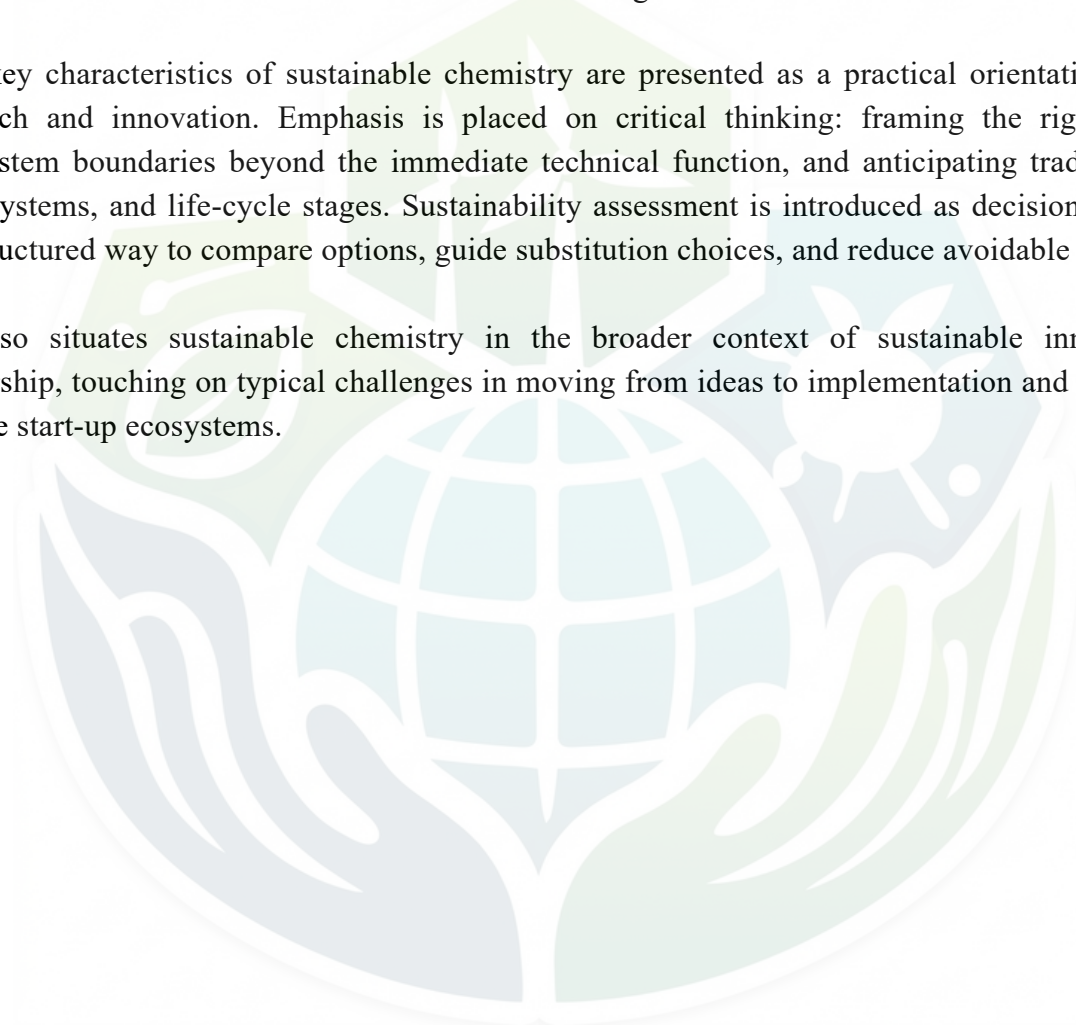
Dr. Dorota Bartkowiak

Innovation Manager, ISC3 Innovation Hub, Germany

Innovation in chemistry is no longer driven by performance and cost alone. Environmental constraints, resource depletion, and resilience failures together with a fast-changing landscape of expectations for safer and more sustainable solutions are reshaping the directions of research, innovation, and chemical production. This talk introduces sustainable innovation through the lens of sustainable chemistry.

Simplified key characteristics of sustainable chemistry are presented as a practical orientation for early-stage research and innovation. Emphasis is placed on critical thinking: framing the right questions, widening system boundaries beyond the immediate technical function, and anticipating trade-offs across people, ecosystems, and life-cycle stages. Sustainability assessment is introduced as decision support in a form of a structured way to compare options, guide substitution choices, and reduce avoidable risk early.

The talk also situates sustainable chemistry in the broader context of sustainable innovation and entrepreneurship, touching on typical challenges in moving from ideas to implementation and the relevance of supportive start-up ecosystems.



Harnessing Mycochitinases for the Biocatalytic Transformation of Coastal Residual Biomass into Value-Added Bioactives

Nidhi Pareek

*Department of Microbiology, School of Life Sciences,
Central University of Rajasthan, Bandarsindri NH8, Kishangarh 305817, Ajmer, Rajasthan, INDIA
nidhipareek@curaj.ac.in*

Chitin-derived products have emerged as high-value biobased materials with considerable industrial significance owing to their diverse biological activities, natural abundance, cost-effectiveness, and sustainable availability. Chitin-derived bioactives, particularly chitooligosaccharides and their derivatives, exhibit a broad spectrum of therapeutic and functional properties, including antitumor, immunomodulatory, antimicrobial, antioxidant, wound-healing, and hypocholesterolemic activities. They also serve as promising candidates for drug and gene delivery systems, while chitinase inhibitors have shown potential for malaria control. The biological efficacy of these molecules is largely determined by their physicochemical characteristics, including molecular weight, degree of polymerization, and degree of acetylation. Recent advances have further expanded the applications of chitin-based nanomaterials across biomedical, pharmaceutical, agricultural, and environmental sectors. However, the highly crystalline structure and poor aqueous solubility of chitin remain major bottlenecks to its efficient utilization and commercialization. Conventional chemical methods for producing chitooligosaccharides often require harsh processing conditions, generate structurally heterogeneous products with inconsistent functional properties, and pose significant environmental concerns due to the use of hazardous chemicals and high energy inputs.

In contrast, biological conversion strategies employing chitinolytic enzymes, including chitinases, chitosanases, and chitin-binding proteins, offer an environmentally benign, highly selective, and sustainable alternative. These biocatalytic approaches enable the production of structurally defined bioactive molecules under mild reaction conditions, ensuring superior product quality, process efficiency, and reduced environmental impact. Integrating enzymatic chitin valorization within a biorefinery framework facilitates the comprehensive utilization of marine biomass and shellfish waste, transforming low-value residual resources into a portfolio of high-value bioactive compounds and biomaterials while minimizing waste generation. Such a circular biorefinery approach contributes to resource efficiency, promotes a circular bioeconomy, and aligns with the objectives of the United Nations Sustainable Development Goals (SDGs), particularly SDG 3 (Good Health and Well-being) through the development of therapeutic bioactives, SDG 9 (Industry, Innovation and Infrastructure) by fostering sustainable bioprocessing technologies, SDG 12 (Responsible Consumption and Production) through waste valorization and resource recovery, SDG 13 (Climate Action) by reducing the environmental footprint of biomass processing, and SDG 14 (Life Below Water) by enabling the sustainable management and utilization of marine bioresources. Consequently, the development of efficient mycochitinase-based biocatalytic platforms represents a promising strategy for advancing sustainable biomanufacturing while creating economically viable products from marine residual biomass.

Keywords: Chitin, Chitinase, Thermophilic fungi, Glucosamine, Chitooligosaccharides

Advancing Safe and Sustainable Energy Systems through Physics-Based Computational Modelling: Applications in Hydrogen Technologies

Dr Chandra Madhav Rao Vendra

University of Hertfordshire, UK

The transition towards sustainable energy systems requires energy carriers that combine low carbon intensity with high levels of safety, reliability and scalability. Hydrogen is increasingly recognised as an important component of future energy systems; however, its widespread deployment presents complex challenges associated with high-pressure release, dispersion, combustion, deflagration, explosion and structural response. This invited talk will present the role of physics-based computational modelling in addressing these challenges, with particular emphasis on Computational Fluid Dynamics (CFD), Large Eddy Simulation (LES), combustion modelling and fluid–structure interaction. The presentation will draw upon more than two decades of research in CFD-Modelling, hydrogen fire, explosion and safety, including contributions to the UK-funded and EU-funded projects. The modelling approaches developed and applied in these studies have been used to investigate hydrogen release and combustion behaviour, flame propagation, flame–wall interactions, congestion effects, vented deflagrations and explosion-induced pressure load in representative hydrogen energy environments.

The talk will demonstrate how physics-based modelling can bridge the gap between fundamental combustion science and practical engineering design, risk assessment and safety mitigation for emerging hydrogen technologies. Results from selected project case studies will be presented, including numerical investigations of hydrogen explosions in refuelling environments, hydrogen–air deflagrations in congested and confined geometries, vented deflagrations in ISO containers, and coupled fluid–structure interaction analyses of explosion-induced structural response. Attention will be given to the verification and validation of computational and engineering models, the influence of confinement and congestion on explosion behaviour, and the potential of modelling to support safer system design and improved safety standards. The talk will conclude by discussing the opportunities and challenges associated with integrating high-fidelity computational modelling, validated engineering correlations and advanced simulation techniques into the design of safe, resilient and sustainable hydrogen energy systems.

Keywords : Hydrogen energy; Hydrogen safety; Computational Fluid Dynamics; Physics-based modelling; Hydrogen combustion; Deflagration and explosion; Large Eddy Simulation; Fluid–structure interaction; Sustainable energy systems

From Viscose to Lyocell: Enabling Sustainable Regenerated Cellulose Fibers

Aakash Sharma, PhD

King Abdullah University of Science and Technology (KAUST), Saudi Arabia

The textile industry is increasingly transitioning from the conventional Viscose process to the more environmentally sustainable Lyocell process for manufacturing regenerated cellulose fibers. However, the widespread adoption of Lyocell is hindered by its high tendency to fibrillate during wet processing, limiting its use in several applications. In this work, the hierarchical structure of commercial Viscose and Lyocell fibers was systematically investigated using wide and small angle X-ray scattering, neutron scattering, birefringence and mechanical characterization to establish quantitative processing-structure-property relationships. The study identifies the structural features responsible for the contrasting fibrillation behavior of the two fibers and demonstrates how differences introduced during manufacturing govern their mechanical response and durability. These insights provide a scientific framework for tailoring fiber microstructure to minimize fibrillation while retaining the environmental advantages of the Lyocell process, thereby supporting the development of next-generation sustainable cellulose-based materials.





CONTRIBUTORY TALKS

Dual-Modal Deep Network with Adaptive Attention for Accurate Plant Leaf Segmentation in Challenging Environments

Ankur Kulhari¹, Sanjeev Patwa¹

¹*Department of Computer Science and Engineering, School of Engineering and Technology, Mody University of Science and Technology, Lakshmangarh, India*

*Corresponding Author E-mail: ankur.jii@gmail.com

ABSTRACT

In real-world conditions, separating plant leaves from an image is not as straightforward as it may seem. Leaves often overlap, the background can be messy, and lighting changes from one image to another. Methods that use only RGB images struggle when the light is too bright or uneven, while thermal images by themselves fail to show the fine edges and textures of the leaves. In this work, we put forward a model that brings the two image types together. By using an adaptive attention mechanism, the network is able to decide which parts of the RGB data and which parts of the thermal data matter most for the task, making it easier to outline leaves accurately even in complicated scenes. This fusion improves the identification of leaf boundaries and structures even under difficult conditions. The proposed model is evaluated on a dataset of paired RGB and thermal images captured in challenging conditions. Experimental results show that the proposed method outperforms state-of-the-art methods across multiple metrics, including accuracy, precision, recall, F1-score, Jaccard index, and mean average precision (MAP) at IoU thresholds of 0.5 and 0.75.

Keywords: Segmentation; Thermal imaging; Fruit Quality Classification; Deep Learning

A Real-Time Monitoring System for Physiological Parameters Associated with Hypertension

Mr. Dhanna Ram¹, Dr. Somil Jain², Dr. Rajesh Yadav³

¹*Department of Computer Science and Engineering School of Engineering and Technology, Mody University of Science and Technology, Laxmangarh, Sikar, Rajashtan, India*

²*Department of Computer Science and Engineering School of Engineering and Technology, Mody University of Science and Technology, Laxmangarh, Sikar, Rajashtan, India*

³*Department of Computer Science and Engineering School of Engineering and Technology, Mody University of Science and Technology Laxmangarh, Sikar, Rajashtan, India*

*Corresponding Author E-mail:dr.mecs2009@gmail.com

ABSTRACT

Hypertension is a major global health concern that requires continuous monitoring to prevent severe cardiovascular complications. Traditional methods of measuring physiological parameters such as blood pressure are often periodic and fail to provide real-time insights. This research presents the development of a real-time monitoring system for physiological parameters associated with hypertension using an embedded system approach. The proposed system integrates sensors for measuring systolic and diastolic blood pressure, heart rate, and oxygen saturation (SpO₂), interfaced with a microcontroller-based platform. Data acquired from the sensors are transmitted to a computer system via serial communication, where a graphical user interface (GUI) dashboard is designed to visualize real-time trends through dynamic graphs. The system also includes threshold-based alert mechanisms to indicate abnormal physiological conditions. Experimental results demonstrate that the system provides continuous, reliable, and efficient monitoring of vital parameters. The developed solution is cost-effective, user-friendly, and suitable for remote healthcare applications.

Keywords: Real-Time Monitoring, Hypertension, Blood Pressure, Heart Rate, SpO₂

Study of Existing Restoration Methods Used for Leukemia Blood-Smear Images

Mr. Mohit Kumar Saini¹, Dr. Sanjeev Patwa^{1*}, Dr. Somil Jain¹, Mr. Dhanna Ram¹

¹*Department of Computer Science and Engineering School of Engineering and Technology, Mody University of Science and Technology, Laxmangarh, Sikar, Rajasthan, India*

*Corresponding Author E-mail: 1saini1mohit1@gmail.com

ABSTRACT

Leukemia is a life-threatening blood cancer that requires early and accurate diagnosis to improve patient survival rates. Microscopic blood-smear image analysis is a widely used diagnostic approach; however, the quality of these images is often degraded due to noise, poor contrast, uneven illumination, and staining variations. Such degradations significantly affect the performance of automated leukemia detection systems. Therefore, image restoration plays a vital role as a preprocessing step to enhance image quality and improve diagnostic accuracy. This paper presents a comprehensive study of existing image restoration techniques used for leukemia bloodsmear images. The study categorizes restoration methods into four major groups: traditional methods, image processing-based techniques, machine learning-based approaches, and deep learning-based methods. Traditional techniques such as median filtering, Wiener filtering, and histogram equalization provide basic enhancement but lack robustness in handling complex noise patterns. Advanced image processing methods improve structural details, while machine learning approaches introduce adaptability through data-driven techniques. Recent deep learning-based methods, including convolutional neural networks (CNNs), autoencoders, and generative adversarial networks (GANs), demonstrate superior performance in restoring image quality and preserving critical features. A comparative analysis of these techniques highlights their strengths and limitations in terms of accuracy, computational complexity, and generalization capability. The study identifies key challenges such as high computational cost, limited dataset diversity, and lack of standardized evaluation frameworks. Finally, potential research directions are discussed to develop efficient, robust, and scalable restoration techniques for realworld clinical applications. This work provides valuable insights into the role of image restoration in enhancing leukemia diagnosis systems and serves as a foundation for future research in medical image processing.

Keywords: Leukemia Detection, Blood Smear Images, Image Restoration, Image Processing, Noise Reduction, Deep Learning

Microplastic Pollution and Its Remediation in Different Environment: Current Advances and Future Perspectives

Shruti Prabha Patel¹, Abhay Dinker¹, Manisha Sharma¹

¹Department of Biotechnology and Chemical Engineering, Manipal University Jaipur

ABSTRACT

Considering its ubiquitous presence in aquatic, terrestrial, and atmospheric ecosystems, microplastic toxicity, which includes plastic particles less than five millimeters constitutes a serious threat to the environment worldwide. The larger plastic waste breaking apart is one of the secondary sources of these pollutants, while microbeads and synthetic fibers are primary contributors. The implications on ecosystem and human well-being are dire. Additionally, fragmentation increases their surface area, which increases their ability to adsorb pollutants and exacerbates the harm they cause to the environment. The physical, chemical, and biological approaches used in remediation today include membrane filtration, Advanced Oxidation Processes (AOPs), microorganisms, and plant mediated. Sustainable waste management, however, depends on the incorporation of economical and natural methods for the circular economy framework. This includes converting trash into resources by upcycling recovered materials in addition to remediation.

Keywords: Microplastic, Human health, Environmental contamination, Remediation.

Advances in Vitamin B2 Production: A Review of Conventional and Emerging Technologies

Anushka Agarwal¹, Abhay Dinker¹, Manisha Sharma¹-

¹*Department of Biotechnology and Chemical Engineering, Manipal University Jaipur*

ABSTRACT

Vitamins are essential organic compounds required in minute quantities to support normal physiological functions and metabolic processes. Vitamin B2 also known as Riboflavin is an important Active Pharmaceutical Ingredient (API) and water soluble, however, it cannot be synthesized by higher animals. Vitamin B2 can be synthesized by both chemical and biological methods. In chemical synthesis method the starting ingredient was either glucose or ribose followed by six to nine chemical reactions to process its synthesis while in biological method through submerged fermentation it is produced by pentose phosphate pathway in wide range of microorganisms. This review summarizes various microbial strains, feedstocks, fermentation strategies, and recovery techniques employed for Vitamin B2 production. In commercial production Vitamin B2 is extracted using *Candida famata*, *Bacillus Subtilis*, *Yarrowia lipolytica*, *Ashbya gossypii* and it was found that the highest yield (11.73 ± 0.68 g/L) was obtained from *Bacillus* species. This review highlights the various approaches for Vitamin B2 production using different types of feedstocks and emphasizes the importance of sustainable approach to mitigate the possible toxicity which arises due to chemical approach of vitamin productions.

Living BandAid: A Sustainable Bacterial Cellulose-Based Smart Wound Dressing Platform for Green Biomedical Applications

Dhriti D. Shah¹

¹*Institute of Advanced Research (IAR) – Gandhinagar, Gujarat, India , BSc. Honours Microbiology Student*

*Corresponding Author E-mail: a shahdhrimi@gmail.com

ABSTRACT

Chronic wounds, burn injuries, and microbial infections continue to represent major healthcare challenges worldwide. Conventional wound dressings are commonly composed of synthetic materials that may exhibit poor biodegradability, limited biological activity, and inadequate healing support. The present study proposes “Living BandAid,” a smart bacterial cellulosebased bioactive wound healing platform integrating microbial biotechnology, biomaterials engineering, bio sensing systems, and regenerative healthcare concepts. Bacterial cellulose synthesized by *Komagataeibacter xylinus* is utilized as the primary scaffold material due to its nanofibrillar structure, high water retention capacity, mechanical strength, flexibility, purity, and biocompatibility. The proposed platform incorporates antimicrobial compounds, pH-responsive sensing components, and controlled therapeutic release functionality for enhanced wound management. The methodology involves microbial cellulose biosynthesis under static aerobic conditions, purification of cellulose pellicles, fabrication of flexible wound dressing scaffolds, incorporation of antimicrobial and biosensing agents, and characterization of physical and biological properties. The system is additionally designed to monitor infection-associated pH variations through visible colorimetric response mechanisms. Expected outcomes include development of a biodegradable multifunctional wound dressing capable of supporting tissue regeneration, reducing microbial contamination, maintaining optimal wound hydration, and providing real-time visual wound monitoring. The proposed platform aims to serve as a sustainable alternative to conventional wound care systems while contributing to advancements in smart regenerative biomaterials and green biomedical technology.

Keywords: Bacterial cellulose, Smart wound dressing, Regenerative medicine, Biosensor, Sustainable biomaterials.

A Multimodal Prognostic Framework for Early Parkinson's Disease Detection Using Spiral Drawing Biomarkers and Voice Modulation Analysis

Vedanshee Upadhyay¹, Sourabh Sharma², Dibakar Sinha

¹*School of Computer Science and Engineering, Avantika University, Ujjain, Madhya Pradesh, India,*

²*School of CSIT, Symbiosis University of Applied sciences, Indore, Madhya Pradesh, India,*³*School of CSE,*

³*Manipal University Jaipur, Jaipur, Rajasthan, India*

*Corresponding Author E-mail: Vedanshee.upadhyay@avantika.edu.in, ssharmacse@gmail.com

ABSTRACT

Parkinson's disease (PD) is one of the most prevalent neurodegenerative diseases that impact more than millions of people worldwide. Voice data and handwriting correlations help diagnose PD in patients with vocal degenerations, despite challenges in foreseeing the illness. A direct correlation between a patient's handwriting and the severity of their PD has been found in some patients who are suffering from PD. By accurately identifying such biomarkers at the onset of disease, more accurate clinical diagnosis can be achieved. The core objective of this analysis was to perceive changes in voice and hand movements to detect Parkinson's disease early. This study evaluated 188 PD patients' data with sustained phonation of the vowel, 27 PD patients' data with spiral sketches and wave drawings, and histogram equalization and contrast augmentation. ML models like Naïve Bayes, KNN (K-Nearest Neighbour), and Logistic Regression were used to recognize and classify PD outcomes, with convolutional neural networks receiving spiral drawing. The Logistic Regression algorithm achieved an accuracy of 88.11% with the widest feature space, while the Multi-Layer Perceptron Classifier (MLP) achieved a good result of 85.02%. The human-machine interface effectively recognizes Parkinson's disease prevalence using voice and pattern data, with enlarged feature spaces increasing classification accuracy.

Keywords: Parkinson's Disease; Multi-Layer Perceptron Classifier; Minimum Distance classifier; Convolutional neural network

Industrial Symbiosis in Water-Stressed Regions: Voluntary Wastewater Reuse in Rajasthan's Industrial Sector

Poonam Kumari¹, Chandni Kirpalani², and Sonika Saxena³

¹*Department of Chemistry, Poornima University, Jaipur, India;*

²*Department of Chemistry, Poornima University, Jaipur, India;*

³*Dr. B. Lal Institute of Biotechnology, Jaipur, India*

*Corresponding Author E-mail: poonamkumari229@gmail.com

ABSTRACT

Water scarcity is a growing global concern. Industries account for a significant share of freshwater consumption while simultaneously contributing to water degradation. In India, where only a small share of urban wastewater is treated and freshwater availability is increasingly constrained, industrial operations face acute pressure to secure alternative water sources. This study examines the voluntary adoption of treated municipal wastewater at a cement plant and a biomass-based power plant in the Shekhawati region of Rajasthan, a water-stressed "dark zone." Using a qualitative case study design, data were collected through interviews, on-site observations, and document analysis to explore the drivers, barriers, and impacts of wastewater reuse. The findings show that water scarcity, sustainability commitments, and operational resilience drive voluntary adoption, while technical, financial, and institutional challenges constrain implementation. Both plants source SBR-treated wastewater from municipal sewage treatment plants and polish it further through activated carbon and multimedia filtration before deploying it across core operations. The cases illustrate how the circular economy principle of closing resource loops can be realised in practice through industrial symbiosis between municipal sewage treatment plants and water-intensive industries. The study contributes insights into how cross-sector resource exchange advances environmental sustainability and organizational resilience in water-scarce industrial contexts.

Keywords: Water scarcity, Treated wastewater, Circular economy, Industrial symbiosis

Electrolyte Engineering for Suppression of Hydrogen Evolution and Corrosion in Aluminium-Air Batteries Using Organic and Inorganic Additives

Ranjit Mohili¹, Rajesh K. Khatirkar¹

¹*Visvesvaraya National Institute of Technology (VNIT), Nagpur, Department of Metallurgical and Materials Engineering*

*Corresponding Author E-mail: ranjitmohili@gmail.com

ABSTRACT

Aluminium-air (Al-air) batteries are promising candidates for next-generation energy storage due to their high theoretical energy density, low cost, and material abundance. However, their practical deployment is hindered by severe anodic corrosion and parasitic hydrogen evolution in alkaline electrolytes. In the present study, the effect of selected electrolyte additives such as glycerol, urea, barium acetate, and zinc chloride on the corrosion behaviour and hydrogen evolution of aluminium alloy anodes (Al-0.14%Sn, Al-0.44%Sn, and Al-Ga) has been investigated. Hydrogen evolution tests (HET) and electrochemical analyses were conducted in KOH and NaOH electrolytes of varying concentrations (2M, 4M, and 6M). Results indicate that glycerol (20% v/v) significantly suppresses hydrogen evolution, particularly in 2M and 6M KOH, due to increased electrolyte viscosity and interfacial stabilization and demonstrated notable inhibition, likely via protective film formation. Among the prepared alloys, Al-Ga exhibited superior performance with the lowest hydrogen evolution rate. These findings highlight the importance of electrolyte modification and alloy design in enhancing Al-air battery efficiency and provide a pathway for optimizing anode-electrolyte interactions.

Keywords: Aluminium-air battery; Hydrogen evolution; Corrosion inhibition; Electrolyte additives; Aluminium alloys

Sustainable Biochar–Starch Composite Foams for Controlled Humidity Adsorption: Effect of Composition on Performance and Structure

Asmi Dhadiwal¹, Arnav Gupta¹, Kavya Sharma¹ and Dr. Anees Y. Khan¹

¹*Department of Biotechnology and Chemical Engineering, Manipal University Jaipur, Dehmi Kalan, Off. Jaipur-Ajmer Expressway, Jaipur 303007, Rajasthan, India*

*Corresponding Author E-mail: asmi.dhadiwal7@gmail.com

ABSTRACT

The development of sustainable materials for moisture management has attracted increasing attention as environmentally benign alternatives to conventional synthetic adsorbents. In this study, biodegradable biochar–starch composite foams were fabricated and evaluated for vapour-phase humidity adsorption. Biochar derived from cashew nut shell biomass was incorporated into a starch matrix at varying compositions containing 33, 50, 60, and 70 wt.% biochar (BC33, BC50, BC60, and BC70) to investigate the influence of composition on adsorption behaviour and structural stability. A systematic experimental methodology was developed to assess humidity adsorption under controlled vapour-phase conditions. Preliminary studies conducted under saturated environments exhibited limited variation in adsorption behaviour due to rapid attainment of equilibrium humidity. To overcome this limitation, a gravimetric water-dosing approach was implemented, enabling reproducible generation of sub-saturated humidity conditions and improved discrimination of composition-dependent adsorption performance. Adsorption capacity was determined from the mass gain of foam samples exposed to controlled humidity environments. All compositions exhibited increasing adsorption capacity with increasing relative humidity; however, the extent of adsorption was strongly dependent on composition. BC33 displayed comparatively lower adsorption due to the limited availability of porous adsorption sites, while BC70 showed reduced performance consistency because of compromised structural integrity at high biochar loading. Among all compositions, BC60 demonstrated the most favourable overall performance, exhibiting a consistent increase in adsorption capacity across the investigated humidity range and achieving values approaching 90 mg g⁻¹. The results indicate that adsorption performance is governed by a balance between pore availability and matrix cohesion rather than biochar content alone. Fourier transform infrared spectroscopy confirmed the presence of characteristic functional groups associated with both biochar and starch, indicating successful incorporation of the two components without significant chemical modification. Contact angle analysis revealed hydrophilic behaviour and progressive wetting of the optimized composition, while scanning electron microscopy demonstrated a porous and interconnected microstructure conducive to vapour diffusion and moisture uptake. The findings highlight the importance of controlled vapour-phase evaluation for humidity adsorption studies and identify BC60 as the optimal composition, providing an effective balance between adsorption capacity and structural stability. The developed biochar–starch composite foams show potential as sustainable materials for moisture-control applications in packaging, storage, and related environmental systems

Keywords: Biochar–starch composite; Humidity adsorption; Sustainable materials; Vapour-phase adsorption

Polyaniline and Sulphur-Doped Carbon Nano-Onions Towards Nano-Sensors For Detecting Food Spoilage Biomarkers

Ananya Sabu¹, Kamlendra Awasthi¹, Kamakshi Pandey¹ and Harsh Pandey¹

¹*Department of Biotechnology and Chemical Engineering, Manipal University Jaipur, Jaipur 303007, INDIA*

*Corresponding Author E-mail: harsh.pandey@jaipur.manipal.edu

ABSTRACT

Food spoilage poses a major threat to public health, economic sustainability, and global food security, underscoring the need for rapid, accurate and sensitive detection technology. Thus, reliable sensors are essential to ensure food safety and quality. Ammonia (NH₃), a major by-product of protein degradation, is a steady indicator of food spoilage. Here, a flexible paper-based sensor is developed using polyaniline (PANI), carbon nano-onions (CNOs), and sulphur-doped carbon nano-onions (S-CNOs) to improve charge-transfer interactions, adsorption, and sensing response in ambient conditions. The sensor is developed by first drop-casting an optimized amount of CNOs and then in-situ polymerizing PANI chains onto the cellulose filter paper. To study the effect of polymerization time on sensing performance PANI growth was optimized at different time intervals (2h, 4h, 6h, 8h, 12h, 24h). Results revealed a strong dependence of sensor response on polymerization time, with the composite prepared at 6 h exhibiting the highest ammonia sensing performance. The enhanced response at this optimum polymerization period is attributed to the formation of a well-interconnected conductive network with sufficient active sites for gas adsorption while maintaining efficient charge transport pathways. To further enhance sensing performance, S-CNOs were prepared, which introduced additional defect sites, altering the electronic structure of carbon network, facilitating stronger interaction with ammonia molecules. Thus, the resulting S-CNO/PANI paper sensor exhibited an improved response at room temperature compared to the undoped CNO/PANI network. As the sensor operates at low temperature, the composite offers low power consumption, high stability, and scalability for practical deployment. Overall, S-CNO/PANI provides a low-cost, energy-efficient sensing platform with strong integration into smart packaging systems for spoilage detection.

Keywords: Food spoilage, Gas sensing, Conducting polymers, Flexible substrates.

Monitoring and Analysis of Air Quality Variations in Jaipur through Spatio -Temporal Techniques

Karishma Chauhan¹, Anil Dutt Vyas¹, Meena Kumari Sharma¹

¹*Department of Civil Engineering, Manipal University Jaipur, Jaipur*

*Corresponding Author E-mail: karishma.2491050003@mun.manipal.edu

ABSTRACT

Air pollution has emerged as one of the most acute environmental and public health crises of the 21st century. This study undertakes a spatio-temporal analysis of Jaipur, India, over a decade (2013–2023), examining the dynamics of key pollutants, their spatial distribution, and health implications. The findings indicate an alarming deterioration in air quality, with particulate matter (PM_{2.5} and PM₁₀) consistently exceeding national (CPCB) and international (WHO) standards. Industrial zones, notably the Vishwakarma Industrial Area (VKIA), emerged as critical hotspots, while commercial and residential sites also reported pollutant levels beyond permissible limits. Seasonal dynamics, such as winter inversions, Diwali fireworks, and crop residue burning in neighbouring states, further aggravate pollution episodes. Health risk assessments demonstrate significant correlations between high pollutant exposure and rising cases of respiratory and cardiovascular diseases. The study highlights the paradox of urban development, where infrastructural projects such as metro expansion, intended to mitigate emissions, contribute substantially to short-term pollution during construction. Policy recommendations emphasize strict regulatory enforcement, expansion of green infrastructure, sustainable transport interventions, and community engagement. The paper concludes that Jaipur requires an urgent paradigm shift in urban governance and environmental management to ensure sustainable and equitable development.

Keywords: Air pollution, particulate matter, spatio-temporal analysis, public health, green infrastructure, environmental policy.

Fabrication and Characterization of Cost-Effective Cambrian Blue Clay Ceramic Membrane for Microfiltration Applications

Mansi chundawat¹, Sudarshana Deepa V¹, Vinoth Kumar Raja²

¹*Department of Biotechnology, National Institute of Technology Andhra Pradesh, Tadepalligudem – 534101, Andhra Pradesh, India.*

²*Membrane Research Laboratory, Department of Chemical Engineering, National Institute of Technology Andhra Pradesh, Tadepalligudem – 534101, Andhra Pradesh, India.*

*Corresponding Author E-mail: vinoth@nitandhra.ac.in, sudarshanadeepa@nitandhra.ac.in

ABSTRACT

Natural clay materials have been extensively studied as potential inexpensive precursors for the production of ceramic membranes, providing an alternative source to the expensive commercial membranes such as alumina, zirconia, etc., for treating water and wastewater. In the current study, ceramic membranes were fabricated using naturally and abundantly available Cambrian Blue Clay (CBC), which is composed of natural illite-smectite. This composition provides high plasticity, strong particle binding, dimensional stability by limiting swelling and shrinkage, reducing warping and cracking before sintering. Green membranes were fabricated through uniaxial dry pressing technique. Flat disc-shaped membranes (55 mm) were produced through the compaction of the CBC powder at 5 MPa pressure, followed by sintering the samples at five different sintering temperatures ranging from 750 to 1150 °C. A study was conducted to find the optimum sintering temperature through linear shrinkage, apparent porosity, and flexural strength. The raw material and fabricated membrane characterization was done by XRD, XRF, FTIR, FESEM-EDX, and TGA. Characterization results revealed the mineral composition of the raw material as illite-smectite-quartz along with high Fe₂O₃ content, which gives blue-gray colouration to the clay sample. The membranes showed a gradual change in color from blue-gray to red-brown due to oxidation of Fe²⁺ to Fe³⁺. Pore size of the optimum membrane was calculated with the help of Hagen-Poiseuille's equation. These results indicate that Cambrian Blue Clay is a potential raw material for ceramic membrane preparation in the field of water and wastewater treatment due to its abundance and low cost.

Keywords: Cambrian blue clay, Ceramic membrane, Sintering studies, Dry Pressing

Improved Short-term Load Prediction with Hybrid Deep Learning method- A Case Study

Mahendra Ram¹

¹*Indian Institute of Technology, Patna*

*Corresponding Author E-mail: mahendra.cbe@iitp.ac.in

ABSTRACT

Methane recovery from human excreta is technically feasible and sustainable, especially in high-density settings such as hostels, hotels, railway stations, public toilets, and institutional campuses with more than 500 users. A continuous supply of waste supports stable anaerobic digestion and can improve biogas output. Low-water or vacuum-assisted flushing systems, such as those used in Indian Railways, reduce fecal matter dilution, thereby improving digester performance, reducing reactor volume requirements, and enhancing methane recovery. However, conventional septic tanks are not designed to capture gas efficiently. Thus, the septic tank has been reconfigured as gas-tight anaerobic digesters with improved solids retention, controlled flow, sludge removal, and outlet treatment. Co-digestion of human excreta with kitchen waste can further increase methane yield by improving the carbon-to-nitrogen ratio and adding more biodegradable substrate, making it particularly suitable for institutions that generate both waste streams. Successful implementation still requires odor control, pathogen management, safe digestate handling, and regular maintenance to prevent clogging and ensure reliable operation. Overall, decentralized toilet-linked anaerobic digestion systems with low-water flushing and kitchen-waste co-digestion present a practical, energy-efficient approach for large-scale methane recovery and sustainable sanitation.

Improved Short-term Load Prediction with Hybrid Deep Learning method- A Case Study

Avinash Gupta¹ and Dr. Poonam Syal¹

¹*Electrical Engineering Department, NITTTR Chandigarh, and Government Polytechnic College, Dhaulpur, Rajasthan, India*

*E-mail: aviguptanit@gmail.com

ABSTRACT

Short-term load forecasting (STLF) is crucial for Rajasthan's electricity grid with extreme summers, monsoons, festivals and increasing renewables. ARIMA is linear and fails to capture nonlinearities; this paper introduces a hybrid Temporal Fusion Transformer (TFT)-XG-Boost model incorporating local weather (temperature, humidity, wind, solar irradiance), time (hour, day, holiday) and historical load data. TFT models multi-horizon relationships using attention, GRN, and VSN (interpretability); XG-Boost reduces residuals. On Rajasthan data, TFT achieves Mean Absolute Error (MAE) 435.45 MW, Root Mean Square Error (RMSE) 588.98 MW, Mean Absolute Percentage Error (MAPE) 3.83%; tuned hybrid yields RMSE 286.44 MW, MAPE 1.44% RMSE gains over baselines. This forecasting shows that Rajasthan's socio-culture and climatic conditions are directly linked with humidity, temperature, along with solar irradiance and holiday effects. The reduction in the RMSE shows the annual saving of the thousands of tons of coal along with reduction in the emission of CO₂, SO₂, Nox by avoiding over generation and improved renewable energy advancing the UN sustainable development goals 7 (affordable and clear energy), 9 (Industry, Innovation, and Infrastructure), and 13 (Climate Action).

Keywords: Short-term load forecasting, Temporal Fusion Transformer, XG-Boost hybrid, Sustainable development goals, Green house gas.

Sodium ferrous phosphate :- electrode preparation battery development

Rishabh Rakesh Parekh¹, Mahimna vishal joshi¹, Koshal Kishor Singh¹,
Subhangi BAJAD¹

¹Department, Institute of Advanced Research, Gandhinagar, Gujarat-382426, India

*Corresponding Author E-mail: pareshrakesh.btbio2023@iar.ac.in

ABSTRACT

Over past 54 years there is no innovation in the battery chemistry of world though an essential components in each and every electronic devices in 21st century, there is a need of converting the battery chemistry since increases Chinese dominance on lithium and manufacturing of lithium ion battery the lithium . India's increasing need of EV and border tension with China gave the world a rise to na + ion battery. Sodium the lithium closest element in the periodic table able to acquire the ability of lithium ion battery The electrode preparation is just similar to that of Li ion battery; the polyanion battery consists of ferrous, phosphate and sodium chloride in the ratio of (1:0.3:1) based cathode which increases the charge holding capacity of the battery. We have also found a sustainable option for making fepo₄ via using the dairy processing industry waste Since dairy has a huge output of calcium phosphate waste which can be turned into ferrous phosphate via adding Fecl₃ to it. Since the sodium ion battery is sustainable but the efficiency is less compared to lithium ion batteries ,therefore a hard practice and hope is done by the whole world . Till now we have successfully completed the cv and Electrochemical impedance spectroscopy as well GCD for the battery Nafepo₄ cathode. The Indian government is also taking steps like providing funds to the emerging startup , and company of India. Therefore a large scale production initiative is done

Keywords: Sodium ion battery, China Chinese dominance, Dairy processing, waste management Government initiative Polyanion

The Sol-Gel Method-Prepared Dimethyl Ether Synthesis from Syngas over Cu-Zn/Al₂O₃ Catalysts

Uday Som^{1*}

¹Shizuoka University, Faculty of Integrated Science and Technology, Department of Engineering, Applied Chemistry and Biochemical Engineering, Japan

*Corresponding author E-mail: udaysomjust@gmail.com

ABSTRACT

Dimethyl ether (DME) is the simplest ether, a neither toxic nor carcinogenic molecule with a boiling point of -25 °C, but it is a liquid at room temperature under a relatively low pressure. DME is a clean fuel alternative to liquified petroleum gas (LPG), diesel engine, power generation in gas turbine plants, propellant of cosmetic products, and used as a chemical intermediate for light olefins and synthetic gasoline production. DME burns without any particulate matter (PM), sulfur-free property and low emission of NO_x and CO. DME has a high cetane number and easy to carry and storage of hydrogen and energy. The surface, texture, and structure all perform a major role in intermediate manufacturing. For insight into this, we performed gas chromatography analysis. We have produced DME at various pressures (0.4, 0.9, 1.4, 1.9, 2.4) MPaG using Cu-Zn/Al₂O₃ catalysts. All three of the solid acids exhibited some degree of deactivation during the reaction, but they were all active and selective in the formation of DME when paired with the copper-based catalyst. The highest production rate of DME was observed when the reaction pressure is 2.4 MPaG.

Keywords: Hydrogenation, CO Conversion, sol-gel method, dimethyl-ether (DME), XRD analysis.

Study of low temperature Latent heat storage using a Shell and Tube type Thermal energy storage system

Aani Raza¹, Sankirthana¹, Abhay¹ and Noshita¹

¹*Department Of Chemical Engineering, Manipal University Jaipur, Dehmi Kalan, Jaipur, India*

*Corresponding Author E-mail: aani.2426010013@mun.manipal.edu

ABSTRACT

Thermal energy storage plays a crucial role in improving energy efficiency and addressing the intermittent nature of renewable energy sources. This study presents a shell-and-tube latent heat thermal energy storage system using beeswax as a Phase Change Material (PCM) for low temperature energy storage. Beeswax was selected due to its suitable melting temperature, non-toxicity, availability, and thermal stability and tested at different flow rates and inlet fluid temperatures to store energy with high efficiency. It was found that the charging time decreases with increase in flow rate and inlet fluid temperature. The efficiency of energy storage system is the function of flow rate and inlet temperature of fluid.

Keywords: Thermal Energy Storage; Phase Change Material; Beeswax; Shell-and-Tube Heat Exchanger.

Development of a Low-Alcohol Functional Fruit Beverage Using Non-Conventional Yeast Fermentation

Vissrut.P¹

¹*Department of Chemical Engineering, Manipal University Jaipur, Dehmi Kalan, Jaipur, India*

ABSTRACT

Healthier beverages with lower alcohol content, good sensory attributes and nutritional benefits are becoming more popular among consumers. The production of low alcohol functional drinks has become a very interesting area of interest because of their potential to provide bioactive, natural antioxidants and health benefits. Most of the fermentable sugars, however, are usually converted into ethanol by conventional brewing yeasts, making it difficult to obtain a low alcohol content beverage with good functional properties. The objective of this study is to formulate a low alcohol functional fruit beverage using a non-conventional strain of yeast with low ethanol production and desirable flavour compound production.

The research proposed would use a controlled fermentation process with a non-conventional yeast strain on a selected fruit substrate like jamun, pomegranate juice etc. Physicochemical parameters such as pH, total soluble solids, alcohol content and titratable acidity will be determined for the beverage. Standard analytical techniques will also be used to determine functional features like total phenolic content and antioxidant activity. Sensory evaluation will also be carried out to determine consumer acceptance of the product in terms of colour, smell, taste, mouthfeel and overall acceptability.

Developed beverage is expected to have low alcohol content and high antioxidant potential with good sensory properties. The non-conventional yeasts are expected to contribute to the complexity of aroma and to flavour the beers, while not producing too much ethanol. Results from this study could help in the development of innovative functional foods in the form of beverages that meet the modern consumer demand for healthier fermented foods. In addition, the research can contribute towards sustainable food and beverage processing by fostering natural fermentation technologies and increasing the use of non-conventional microorganisms in the brewing and beverage sector.

Computational Fluid Dynamics-Investigations into the Hydrodynamic and Thermal Transport Characteristics of Nanofluids

Neel Upadhyaya¹ and Piyush Yadav¹

¹*Department of Chemical Engineering, Manipal University Jaipur, Dehmi Kalan, Jaipur, India*

E-mail: neel.2426010004@mun.manipal.edu

ABSTRACT

The improvement of heat transfer in systems is still a big challenge because conventional heat transfer fluids do not conduct heat well. Nanofluids, made by adding particles to a base fluid seem like a good solution to improve heat transfer in things like heat exchangers, electronic cooling and chemical process equipment. This study looks at how water-based CuO and Al₂O₃ nanofluids flow and transfer heat around a square cylinder using computer simulations. We used a computer program called COMSOL Multiphysics to simulate the flow and heat transfer of these nanofluids. We looked at how factors like Reynolds number (which ranges from 1 to 40) the number of nanoparticles (from 0 to 5%), the size of the particles (from 20 to 100 nm) and the orientation of the cylinder (from 0° to 90°) affect the flow and heat transfer. Our results show that increasing the Reynolds number and the number of nanoparticles greatly improves the heat transfer. We found that a cylinder orientation of 45° works best for heat transfer because it disrupts the layer and mixes the fluid better. However, we also found that more nanoparticles improve heat transfer but make the flow more resistant and increase drag.

According to the grid independence study refining the mesh from G2 to G3 resulted in less than 1% change in drag coefficient and Nusselt number, while increasing the computational cost by nearly five times. Therefore, grid G2 (Np = 100, N = 60,000 in the half domain) was considered sufficient to accurately capture thin boundary layer gradients with acceptable accuracy and reasonable computational effort. This means there is a trade-off between improving heat transfer and the power needed to pump the fluid. We also compared CuO-based nanofluids and Al₂O₃ nanofluids. Found that CuO-based nanofluids have a bit more drag but similar heat transfer performance. Our study shows that computer simulations can be a tool for designing better thermal systems that use nanofluids. These findings can help design energy-efficient cooling technologies and advanced heat transfer devices.

Keywords: Nanofluids; COMSOL multiphysics; ; Numerical Simulation

A Review on Synthesis and Environmental Applications of Carbon Nanodots

Prakriti Mathur^{1*}, Aarushi Saxena¹, Kirti Tyagi¹, Dhakshayani Pujari¹, Nikhil Kumar²

¹*Department of Biotechnology and Chemical Engineering, Manipal University Jaipur, Dehmi Kalan, off Jaipur-Ajmer Expressway, near GVK Toll Plaza, Jaipur, Rajasthan, India*

*Corresponding Author E-mail: prakriti.2426020025@mun.manipal.edu

ABSTRACT

Carbon nanodots (CNDs) have attracted significant attention as next-generation carbon-based nanomaterials due to their excellent photoluminescence, high biocompatibility, low toxicity, water solubility, and environmentally friendly synthesis routes. Their unique physicochemical properties have led to widespread investigation in environmental monitoring, sensing, and pollutant detection. This review provides a comprehensive overview of the recent progress in the synthesis, characterization, and environmental applications of carbon nanodots, with particular emphasis on green and sustainable approaches.

The review compares the major synthesis techniques, including hydrothermal, solvothermal, microwave-assisted, pyrolysis, ultrasonic and electrochemical methods, highlighting their underlying principles, scalability, advantages, limitations, cost-effectiveness and influence on the structural and optical properties of CNDs.

Furthermore, the review critically examines the environmental applications of CNDs, focusing on fluorescence-based detection of heavy metal ions such as Fe^{3+} , Cu^{2+} and Hg^{2+} , as well as the photocatalytic degradation of organic pollutants and industrial dyes including Methylene Blue, Rhodamine B and Congo Red. Current challenges, limitations, and future prospects for the large-scale implementation of carbon nanodots in sustainable environmental technologies are also discussed. Overall, the reviewed literature demonstrates the potential of carbon nanodots as versatile and sustainable nanomaterials for environmental applications while highlighting opportunities for future research and technological development.

Keywords: Carbon nanodots; Green synthesis; Synthesis methods; Environmental applications.

Evaluating Waste Cooking Oil as a Sustainable Feedstock for HEFA-Based SAF Production: A Critical Review

Sritama Chatterjee¹

¹*Department of Biotechnology and Chemical Engineering, Manipal University Jaipur, Rajasthan, India*

*Corresponding Author E-mail: sritama.2503010018@mun.manipal.edu

ABSTRACT

The aviation sector contributes to approximately 2-3% of global carbon dioxide (CO₂) emissions, and the continued growth of air traffic has intensified the need for effective decarbonization strategies. Unlike other transport sectors, aviation remains dependent on high-energy-density liquid fuel, making large-scale electrification challenging. Consequently, Sustainable Aviation Fuel (SAF) has emerged as one of the most promising pathways for reducing lifecycle greenhouse emissions while maintaining compatibility with existing aircraft and airport infrastructure. Among the approved SAF production pathways, Hydroprocessed Esters and Fatty Acids (HEFA) has achieved a Technology Readiness Level (TRL) 9 and is currently the most commercially mature technology owing to its certification under ASTM D7566, drop-in fuel capability, and successful commercial deployment. Furthermore, international regulatory initiatives such as the International Civil Aviation Organization's Carbon Offsetting and Reduction Scheme for International Aviation (ICAO CORSIA), together with increasing national SAF blending targets, have accelerated the demand for certified and commercially scalable sustainable aviation fuels. Despite the commercial maturity of HEFA, its long-term sustainability and scalability remain highly dependent on feedstock selection. No single feedstock simultaneously satisfies the requirements of environmental sustainability, economic viability, large-scale availability, traceability, and fuel quality. Among the lipid feedstock investigated, Waste Cooking Oil (WCO) has emerged as a promising second-generation resource because it enables the valorization of an otherwise discarded waste stream into renewable aviation fuel, supports circular economy principles, minimizes lifecycle greenhouse gas emissions, and eliminates direct competition with food resources. However, concerns regarding feedstock variability, verification, limited availability, collection infrastructure, pretreatment requirements, hydrogen-intensive processing, catalyst deactivation, and process economics continue to constrain its widespread utilization. This paper presents a critical review of recent peer-reviewed literature evaluating the suitability of Waste Cooking Oil (WCO) for HEFA-based Sustainable Aviation Fuel production. It critically examines feedstock characteristics, hydroprocessing chemistry, catalyst performance, lifecycle assessment, techno-economic feasibility, commercialization status, regulatory compliance, and sustainability certification, while synthesizing quantitative evidence on waste diversion, feedstock availability, fuel yields, and lifecycle greenhouse gas emission reductions to assess WCO's contribution to circular economy objectives. By comparing WCO with first- and third-generation lipid feedstocks, the review identifies key research gaps and provides a comprehensive framework for evaluating its long-term viability. The literature consistently demonstrates that WCO is among the most commercially feasible and environmentally sustainable feedstocks for HEFA production due to its compatibility with existing refinery infrastructure and its role in waste valorization. However, challenges related to feedstock quality, traceability, limited supply, hydrogen demand, catalyst stability, and supply-chain efficiency continue to constrain large-scale commercialization. Overall, the findings suggest that the primary challenge facing HEFA is no longer technological maturity but securing a sustainable, scalable, and verifiable feedstock supply, highlighting the need for advancements in feedstock verification, renewable hydrogen integration, catalyst development, and supportive policy frameworks.

Keywords: Sustainable Aviation Fuel; Hydroprocessed Esters and Fatty Acids; Waste Cooking Oil.

Computational Fluid Dynamics Modelling of a Microfluidic Electrochemical Aptasensor for Bisphenol A Detection

Khushi Chaudhary¹ and Harsh Pandey¹

¹*Department of Biotechnology and Chemical Engineering, Manipal University Jaipur, Jaipur 303007, INDIA*

*Corresponding Author E-mail: harsh.pandey@jaipur.manipal.edu

ABSTRACT

Even at minimal environmental concentrations, bisphenol A (BPA), a monomer essential to the production of polycarbonate plastic and epoxy resin, affects endocrine function, making its detection in water an increasingly important analytical priority. Although conventional methods like ELISA, HPLC, and GC-MS are still accurate, their cost, turnaround time, and instrumentation requirements make them unsuitable for quick, field-deployable monitoring. By integrating aptamer specificity with microscale fluid handling, microfluidic electrochemical aptasensors fill this gap and enable sensitive, low-volume, near-real-time detection. By combining fluid transport, analyte diffusion, and aptamer-BPA binding kinetics into a single finite-element modeling framework, this work creates a computational fluid dynamics (CFD) model of such a sensor. By combining laminar flow and dilute-species transport physics under stationary-state conditions, a three-dimensional microchannel was created. The governing parameters were defined as diffusivity, binding-kinetics constants, inlet velocity, and inlet concentration. The model's geometry-optimization logic is based on finite-element techniques that have been demonstrated to improve biosensor sensitivity through channel-scale design. The transport-limited response of the sensor is anticipated to be characterized by simulated concentration and velocity distributions across the microchannel, with predictions compared to an experimentally verified microfluidic aptasensor platform reported for BPA detection. The resulting framework provides a simulation-first approach to biosensor design that lowers the cost of prototyping before fabrication and is yet adaptable to other new water pollutants, such as tetracycline residues from pharmaceuticals.

Keywords: Bisphenol A, Microfluidic aptasensor, Computational fluid dynamics, Finite-element modelling

Multiphysics Simulation for Site-Specific Haemodynamic Analysis and Drug Delivery Assessment in Atherosclerosis

Amiksha Meena¹ and Harsh Pandey^{1*}

¹*Department of Biotechnology and Chemical Engineering, Manipal University Jaipur, Jaipur 303007, INDIA*

*Corresponding Author E-mail: harsh.pandey@jaipur.manipal.edu

ABSTRACT

Atherosclerosis, a leading factor of mortality in cardiovascular disease, commonly originates at arterial bifurcations where low wall shear stress promotes lipid retention in the arterial intima. At low velocity disturbed flow is unable to clear lipid deposits that trigger macrophage recruitment to engulf the trapped cholesterol, progressively becoming lipid-laden foam cells. Over time this cholesterol-laden macrophage pile-up becomes necrotic debris and calcified deposits. That ultimately blocks the artery leading to stroke or cardiac arrest. This study demonstrates a validated multiphysics simulation framework for non-invasive haemodynamic assessment and therapeutic evaluation. CFD-driven (fluid-structure interaction) FSI model validated against the published benchmark data for velocity profile, pressure distribution, and von Mises stress distribution. This FSI model is optimized for comparative study of Newtonian and non-Newtonian (Carreau-Yasuda) blood rheology for wall shear stress distribution across the artery, demonstrating that the Newtonian blood assumption underestimates WSS by approximately 5.1% in plaque-prone low-shear recirculation zones (1.95 Pa in Newtonian vs. 2.05 Pa in non-Newtonian), which necessitates the consideration of blood rheology as non-Newtonian for accurate haemodynamic prediction. This model is further optimized for Transport of Diluted Species interface, modelling the convective-diffusive transport as therapeutic agents through the blood domain and into the arterial wall, treated as a porous medium. Drug deposition of approximately 59 mol/m³ at 1.5 sec is observed at bifurcated plaque-prone areas which were identified as wall shear stress zones. This study integrates the site-specific haemodynamic diagnosis with therapeutic evaluation within a single validated computational framework.

Keywords: Atherosclerosis, macrophage, drug delivery, wall shear stress, FSI, foam cell, Newtonian and non-Newtonian model.

AI-Powered Resource Economy: The Role of FinTech platforms affect start-up funding and entrepreneurial growth with special reference to Jaipur

Dr. Neha Mathur¹ and Ms. Suvidha Chaplot²

¹Manipal University Jaipur, Jaipur 303007, INDIA

²IPS College of Technical Education

ABSTRACT

Access to finance remains one of the most persistent constraints faced by young firms. Traditional lenders often ask for collateral, long credit histories and stable cash flows, while early-stage ventures usually possess exactly the opposite: limited records, volatile revenue and uncertain markets. AI-enabled financial technology platforms attempt to narrow this gap by using digital data, automated analysis and intelligent matching to evaluate, fund and support start-ups. This paper examines how such platforms influence five connected areas: alternative lending, crowdfunding, venture funding, financial planning and start-up performance. It uses an integrative review of peer-reviewed research and policy literature, supported by a secondary-data multiple-case analysis of Jaipur-origin or Jaipur-based firms: CarDekho, Rupyy, Finova Capital, DealShare and WoodenStreet. The paper develops a conceptual model in which AI-FinTech capability improves funding accessibility and financial decision quality; these, in turn, strengthen investor readiness, capital efficiency and entrepreneurial growth. The analysis also shows that the relationship is conditional rather than automatic. Poor data, opaque algorithms, aggressive lending, weak unit economics and inadequate governance can convert financial convenience into financial fragility. The Jaipur cases demonstrate that firms from a Tier-2 city can attract national and global capital, build specialised digital-finance capabilities and scale beyond their home market. At the same time, they underline a basic lesson: funding is an enabler, not a substitute for a sound business model. The paper concludes with testable propositions, a detailed empirical research design for future validation, a governance framework and practical recommendations for founders, investors, fintech platforms and public agencies.

Keywords: Start-up finance; venture capital; Entrepreneurship.

Advancing Circular Water Systems in Water-Stressed Regions: A Case Study of Treated Wastewater Reuse by an Industry in Bhilwara, Rajasthan

Neha Agarwal¹, Chandani Kirpalani¹, Sudipti Arora²

¹*Poornima University, Jaipur, India*

²*Dr. B. Lal Institute of Biotechnology, Jaipur, India*

*Corresponding Author E-mail: aggarwal.nehaa@gmail.com

ABSTRACT

The industrial sector is a major consumer of freshwater, while Common Sewage Treatment Plants (CSTPs) generate substantial quantities of treated domestic wastewater. Despite its availability, reuse of treated wastewater in industries remains limited due to water quality constraints and inadequate policy support. Advanced treatment technologies such as Sequencing Batch Reactors (SBRs) can improve treated wastewater quality, enabling safe and sustainable industrial reuse. This promotes a circular water economy by reducing freshwater dependency and productive reuse of treated wastewater, particularly in water-stressed regions like Rajasthan. This study evaluates the seasonal treatment performance and industrial reuse potential of a 10 MLD SBR-based municipal sewage treatment plant in Bhilwara, Rajasthan, India. The treated effluent is reused for industrial applications, demonstrating both circular economy principles and an exemplary Public–Private Partnership (PPP) model in line with the Rajasthan Sewerage Policy, 2025. The study also supports SDG 6 (Clean Water and Sanitation), SDG 11 (Sustainable Cities), and SDG 12 (Responsible Consumption and Production). One year of treated effluent monitoring data from a NABL-accredited laboratory was analysed for physicochemical parameters, including BOD, COD, TSS, and nutrients, and compared with CPCB discharge standards. The SBR system achieved consistently high removal efficiencies for TSS (88–95%), BOD (>93%), and COD (91–95%) across seasons, with effluent concentrations within prescribed regulatory limits. Nutrient concentrations showed moderate seasonal variation and remained suitable for non-potable reuse. The study concludes that SBR-based treatment can reliably produce reuse-quality effluent, support circular water management, and reduce groundwater dependency in water-stressed industrial regions.

Keywords: Sequencing Batch Reactor; Common Sewage Treatment Plant; Treated Water Reuse; Industrial Reuse.

Seaweed Valorization through Integrated Biorefinery: Biofuels and Engineered Biochar to Advanced Energy Storage Materials

Anshika Kunwar¹, Harish Chandra Joshi¹

¹*Graphic Era Deemed to be University Dehradun*

*Corresponding Author E-mail: anshikakunwar976@gmail.com

ABSTRACT

The establishment of sustainable and ecologically favorable alternatives to conventional agriculture is imperative due to the growing effects of global warming, climate change, rapid population increase, and growing demands for food, feed, and renewable resources. Seaweed is a very sustainable and resource-efficient biomass because it doesn't require freshwater or arable land like other agricultural systems do. Seaweed has become an attractive feedstock for circular biorefineries due to its broad commercial uses and strong nutritional makeup. In addition to pretreatment techniques like acid/alkali hydrolysis, enzymatic hydrolysis, microwave-assisted, and ultrasound-assisted extraction, this review focuses on a number of seaweed transformation technologies, such as pyrolysis, hydrothermal liquefaction (HTL), anaerobic digestion, fermentation, and acetone–butanol–ethanol (ABE) fermentation. These methods support a zero-waste and resource-efficient approach while enabling the production of value-added products such as bioethanol, biogas, biochar, bio-oil, and biofertilizers. All things considered, seaweed-based biorefineries present a great deal of potential for carbon sequestration, sustainable development, and the growth of a carbon-neutral circular economy and blue bioeconomy, helping to accomplish a number of Sustainable Development Goals (SDGs). With modification of the surface, metal doping, metal loading, and the addition of nanomaterials, biochar can be further upgraded into engineered biochar to create sophisticated composites like MgO–biochar and FeO₃ biochar. Its applications in supercapacitors, batteries, soil amendment, environmental remediation, wastewater treatment, and heterogeneous catalysis are expanded by modifying it, which greatly increase its surface area, pore size, functional groups, and catalytic performance. This work shows how marine biomass can help make better biofuels and more environmentally friendly energy systems.

Keywords: biofuel, biochar, macroalgae, supercapacitor

Integrated Marine Macro algae Bio refineries for Sustainable Bioenergy and Functional Bio-char toward Carbon Neutrality

Sakshi Sharma¹, Harish Chandra Joshi¹

¹Department of Chemistry, Graphic Era (Deemed to be University), Dehradun, Uttarakhand, India

**Corresponding Author E-mail: manviks668@gmail.com*

ABSTRACT

The worldwide transition to sustainable resources and low-carbon technologies has promoted an increasing interest in marine macro algae as a renewable and environmentally friendly biomass resource for integrated bio-refineries. Marine macro algae are fast growing, carbohydrate rich and efficient in uptake of atmospheric CO₂. They can be cultivated without competition for arable land and fresh water, unlike terrestrial biomass. These unique properties make them an ideal feedstock for renewable energy and high-value carbon-based material production and thus supporting the circular bio-economy.

The paper summarizes the recent progress in the integrated marine macro algae bio-refineries for the co-production of bioenergy and value-added bio-char. Various green pre-treatment techniques such as deep eutectic solvents (DES), microwave-assisted, ultrasound-assisted and enzymatic pre-treatment are investigated to improve biomass fractionation and enhance fermentable sugar recovery. Furthermore, the paper discusses the major biochemical and thermochemical conversion routes such as fermentation, anaerobic digestion, hydrothermal liquefaction, gasification and pyrolysis for production of bioethanol, biogas, bio-hydrogen, bio-oil and bio-char. We pay special attention to the preparation of engineered functional bio-char through chemical activation, heteroatom doping, metal loading and nanoparticle modification to improve its performance in wastewater treatment, CO₂ capture, heterogeneous catalysis and electrochemical energy storage. Moreover, integrated bio-refinery configurations, techno-economic assessment (TEA) and life-cycle assessment (LCA) are discussed to evaluate the sustainability and commercial viability of such systems. Current problems such as feedstock unpredictability, process integration, scale-up and economic feasibility are critically reviewed and future research possibilities identified. In conclusion, integrated marine macro algae bio-refineries are promising for efficient exploitation of biomass, development of sustainable functional materials, reduction of environmental impact and safeguarding of carbon neutrality via circular bio-economy.

Keywords: Marine macro algae; Integrated bio-refinery; Functional bio-char; Bioenergy; Sustainable materials; Carbon neutrality; Circular bio-economy.

Explainable Machine Learning for Plastic Waste: Towards Intelligent and Sustainable Recycling Systems

Shanu Jangid Khati¹, Mantena Sireesha², Abdul Gaffar Sheik¹

¹*Department of Biotechnology and Chemical Engineering, Manipal University Jaipur, Jaipur, 303007, Rajasthan, India*

²*Faculty of Computing & Digital Technology, No. 15, Jalan Sri Semantan 1, Off Jalan Semantan, HELP University, Bukit Damansara 50490 Kuala Lumpur, Malaysia*

ABSTRACT

The explosive increase in the volume of recyclable waste streams necessitates the development of intelligent and sustainable waste management systems that could be efficient in terms of performance improvement and resource utilization. In this paper, an explainable artificial intelligence (XAI)-based machine learning model for predicting waste generation and optimization of the plastic waste management process is presented. The training and evaluation of various machine learning models, such as Random Forest (RF), Extreme Gradient Boosting (XGBoost), Light Gradient Boosting Machine (LightGBM), and CatBoost, were performed using a comprehensive dataset involving demographic, socio-economic, climate, and operational features. Model performance was measured using the coefficient of determination (R^2), root mean square error (RMSE) and mean absolute error (MAE). Of all considered models, the best performance was obtained by XGBoost with $R^2 = 0.98$. To increase the interpretability of models, SHapley Additive exPlanations (SHAP), Local Interpretable Model-Agnostic Explanations (LIME), Partial Dependence Plots (PDP), and Individual Conditional Expectation (ICE) were used. This proposed framework managed to detect the key drivers that influence the production of waste and operational efficiency, thus providing a transparent and reliable basis for decision-making. In addition, the optimized framework has the ability to save between 15–35% on collection expenses and increase efficiency by 20–40%. The proposed AI-XAI framework is a decision support tool for intelligent waste management, allowing the efficient use of resources and sustainable development of cities.

Keywords: Plastic, Explainable Artificial Intelligence, Machine Learning, Recyclable Waste.

Development and Performance Evaluation of Low-Cost Multi-Media Filtration Units for Sustainable Greywater Treatment and Reuse

Maulik Sharma¹

¹Department of Biotechnology and Chemical Engineering, Manipal University Jaipur, Jaipur, 303007, Rajasthan, India

ABSTRACT

The increasing urban water stress and associated risks to freshwater availability and quality have triggered renewed interest in developing decentralised and low-cost technologies for greywater treatment and reuse.

The paper describes the design, fabrication, and comparative performance analysis of three low-cost gravity filtration (GF) units, namely GF Unit 1, GF Unit 2, and GF Unit 3, that utilise a combination of sand, gravel, biochar, and manufactured sand (M-sand). Contrary to existing technologies based on chemical or membrane processes, the proposed GF units are cost-effective, modular, and use readily available materials. The study assessed the performance of the developed GF units for greywater treatment in terms of physicochemical properties. In each unit, raw greywater was filtered through a multi-layer of granular media and analysed for various parameters, including turbidity, total dissolved solids (TDS), hardness, fluoride, sulphate, etc.

Compared to other constructed units, the use of biochar in GF Unit 2 showed the highest decrease in turbidity and organic load because of its excellent absorption capacity for the organic matter. Meanwhile, the use of M-sand in GF Unit 3 showed comparable performance to conventional river sand in terms of the water filtration process and is therefore sustainable in reducing dependence on river sand and associated environmental impacts. The overall performance of all GF units improved the water quality of greywater in terms of the measured parameters, thus meeting the acceptable standards for secondary uses such as irrigation and for cattle use.

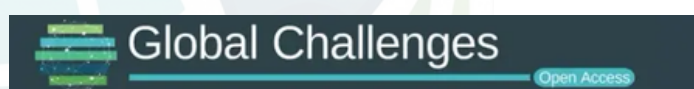
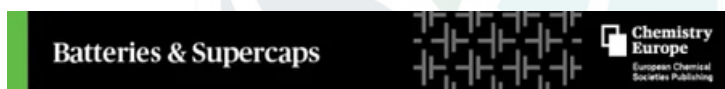
The study concluded that the low-cost GF units are a viable option for decentralised greywater treatment and reuse, which promotes sustainability and conserves the environment in the long run.

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