HUB of TALENTS SustainMat^{CE}

Chula Chulalongkorn University

PETROMAT PERDO

CEGT

APAC Green & Sustain 2025

Pathumwan Princess Hotel,
Bangkok, Thailand
9 – 12 November 2025

The 1st Asia-Pacific Conference on Green Chemical Engineering and Sustainability

PROGRAM BOOK

Join Asia-Pacific's Researchers to Advance "Greenovations Toward Global Sustainability"

https://apacgreensustain2025.org

secretariat@apacgreensustain2025.org

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GENERAL INTRODUCTION, APAC-Green & Sustain 2025

The First Asia-Pacific Conference on Green Chemical Engineering and Sustainability (APAC-Green & Sustain 2025) is a collaborative initiative, hosted and organized by the Center of Excellence on Petrochemical and Materials Technology (PETROMAT), in collaboration with Mahanakorn University of Technology, Institute of Process Engineering, Chinese Academy of Sciences, and supported by Hub of Talents for Sustainable Materials for Circular Economy (HubSustainMat) under the National Research Council of Thailand.

APAC Green & Sustain 2025 is an inaugural event dedicated to advancing Green Chemical Engineering & Sustainability across the Asia-Pacific. This conference is initiated by inspiration from the highly regarded Asia-Pacific Conference on Ionic Liquids and Green Processes (APCIL). Since its launch in 2008 by the Ionic Liquids Board of the Chemical Industry and Engineering Society of China, the APCIL has been hosted in key cities across the region, including Beijing, Dalian, Sydney, Hangzhou, Tottori, and Suzhou, with APCIL-8 in Kaifeng, China (May 11–14, 2024) highlighting low-carbon innovation. The participation of Prof. Hathaikarn Manuspiya, APAC 2025 Chair, as a keynote speaker at APCIL-8, and Prof. Suojiang Zhang, APAC 2025 Co-chair, as APCIL-8's Chair of the Scientific Committee, highlights the strong scientific ties and shared commitment to expand green chemical engineering and sustainable solutions through this year's gathering in Thailand.

APAC-Green & Sustain 2025 aims to provide scientific and technological support for achieving the goal of "Greenovations in Chemical Engineering toward Global Sustainability". Besides, it provides a platform for experts and scholars from all over the world to conduct in-depth discussion on key scientific and engineering application, for instance, Green Catalysis, Functional Materials, Sustainable Processing, and Carbon Technologies.

The theme of APAC-Green & Sustain 2025 is "Advancing Green Innovations and Sustainable Solutions in Chemical Engineering", which covers various fields of Green Catalysts & Materials, Green Reaction Engineering, Green Separation Process, New Energy & Materials, and Carbon Neutrality & Sustainability.

For the conference, distinguished local and foreign speakers from industries and academia have been invited to share with the participants their new findings and research work. Also, there will be about 2 Plenary Speakers, 8 Keynote Speakers, 4 Invited Speakers, 17 oral presentations and 24 poster presentations from the various research units participating in the event.

We are looking forward to giving a warm welcome to you at APAC-Green & Sustain 2025. We hope that you will find the conference both enjoyable and valuable and have a chance to connect with expertise from scientific community, influential entrepreneurs, and large corporate companies so that you can collaborate with people to make a great development in the fields of scientific and engineering application, for instance, Green Catalysis, Functional Materials, Sustainable Processing, and Carbon Technologies.

WELCOME MESSAGE

On behalf of the Center of Excellence on Petrochemical and Materials Technology (PETROMAT), it is my distinct pleasure to extend a cordial welcome to The First Asia-Pacific Conference on Green Chemical Engineering and Sustainability (APAC–Green & Sustain 2025). This prestigious conference, being held for the first time in Thailand, is the result of a collaborative effort between PETROMAT, Mahanakorn University of Technology, and the Institute of Process Engineering, Chinese Academy of Sciences. We are also honored to have the support of the Hub of Talents for Sustainable Materials for Circular Economy (HubSustainMat), operating under the auspices of the National Research Council of Thailand.

PETROMAT serves as a vital conduit between academic research and industrial development. With a network comprising over 240 researchers from eleven distinguished institutions—including Chulalongkorn University, Kasetsart University, Silpakorn University, Suranaree University of Technology, Walailak University, Burapha University, and Thammasat University—PETROMAT plays a pivotal role in cultivating innovation. Moreover, through our current initiative, the Hub of Talents: Sustainable Materials for Circular Economy, which is funded by the National Research Council of Thailand, our objective is to establish a global research network dedicated to the advancement of sustainable materials.

It is an honor for PETROMAT to host APAC–Green & Sustain 2025 from November 9 to 12, 2025, at the Pathumwan Princess Hotel in Bangkok, Thailand. This conference is designed to serve as an excellent platform for researchers, industry leaders, and experts to engage in the exchange of knowledge and insights across key scientific and engineering applications, notably Green Catalysis, Functional Materials, Sustainable Processing, and Carbon Technologies.

In closing, I sincerely hope that your participation in APAC–Green & Sustain 2025 will be both enjoyable and professionally rewarding, and that the discussions and collaborations fostered here will ultimately contribute to technological advancement for a better life and a more sustainable future.

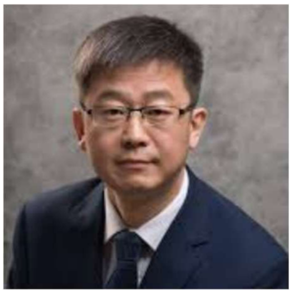
Hathaikarn M.

Professor Hathaikarn Manuspiya

Chairman, APAC-Green & Sustain 2025

Acting Director of Center of Excellence on
Petrochemical and Materials Technology

WELCOME MESSAGE



On the behalf of the conference chairs, I would like to extend my warmest welcome and gratitude to all scientists, experts, and young talents to attend “The First Asia-Pacific Conference on Green Chemical Engineering and Sustainability”. I also would like to express my sincere appreciation to all supporters, volunteers, and others! IPE severs as a co-organizer with Mahanakorn University of Technology and Center of Excellence on Petrochemical and Materials Technology for this conference.

The conference theme will concentrate on the "green catalytic materials, green reaction engineering, green separation processes, new energy and materials, carbon neutrality and sustainability". We will jointly share the profound idea and cutting-edge research achievements with each to promote international cooperation. We will also discuss deeply to seek novel technologies to solve challenging problems in green chemical engineering and sustainable development. I believe that this conference will consolidate the deep cooperation between China and Thailand as well as the Asia-Pacific region, and accelerate the development of green and sustainable chemical technologies.

This conference is not only an academic exchange, but also a bridge to promote international cooperation. I wish it will bring a new situation for the green and sustainable chemical industry with our great efforts!

Finally, I would like to thank all guests again. I hope this conference will be hosted successfully. I also wish all of you have enjoyable harvest and good health throughout the event.

C.S.Li

Professor Chunshan Li

Co-Chairman, APAC-Green & Sustain 2025

WELCOME MESSAGE

It is our great pleasure to warmly welcome all distinguished delegates, researchers, and professionals to the First Asia-Pacific Conference on Green Chemical Engineering and Sustainability (APAC Green & Sustain 2025), proudly co-organized by Mahanakorn University of Technology, a member of the Hub of Talents: Sustainable Materials for Circular Economy. This conference marks an important milestone in promoting collaboration and the exchange of knowledge across the Asia-Pacific region. As global challenges related to energy, the environment, and sustainable development continue to grow, this event provides a valuable platform to share innovative ideas and practical solutions in green chemical engineering and sustainable technologies.

Mahanakorn University of Technology is strongly committed to research in green technology, sustainable materials, and green energy, including the development of green materials for biosensor technology. The university has established the Bionova Laboratory as an international co-creation lab to enhance collaboration and innovation in sustainability-focused research. Through keynote speeches, technical sessions, and academic networking, APAC Green & Sustain 2025 aims to inspire meaningful discussions and build long-term partnerships for a more sustainable and resilient future.

We sincerely thank all organizers, partners, and participants for their dedication and contributions to this inaugural event. Together, let us move forward toward a greener and more sustainable Asia-Pacific region.

Welcome to APAC Green & Sustain 2025.

Satita TH.

Dr.Satita Thiangtham

Secretariat, APAC-Green & Sustain 2025

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GENERAL INFORMATION

The First Asia-Pacific Conference on Green Chemical Engineering and Sustainability (APAC-Green & Sustain 2025)

“Greenovations in Chemical Engineering toward Global Sustainability”
November 9 to December 12, 2025
Pathumwan Princess Hotel, Bangkok, Thailand

Organizer

Center of Excellence on Petrochemical and Materials Technology

Co-Organizers

Mahanakorn University of Technology
Institute of Process Engineering, Chinese Academy of Sciences
CAS-TWAS Centre of Excellence for Green Technology

Supported by

Hub of Talents for Sustainable Materials for Circular Economy under
National Research Council of Thailand

Sponsored by

Time Zone

The time in Thailand is seven hours ahead of Greenwich Mean Time (GMT+T+7)

Registration Hours

Date	Registration Hours	Place
9 December 2025	17.00 – 18.00 hr.	Pathumwan Princess Hotel Ballroom A+B
10 December 2025	08.30 – 9.00 hr.	

COMMITTEES

Chairman

Prof. Hathaikarn Manuspiya
Acting Director of Center of Excellence on Petrochemical and Materials Technology (PETROMAT), Thailand

Co-Chairman

Prof. Suojiang Zhang
Institute of Process Engineering, Chinese Academy of Sciences, China
Prof. Chunshan Li
Vice President of Institute of Process Engineering (IPE), Chinese Academy of Sciences, China

Advisory Committees

Prof. Vissanu Meeyoo
Vice President of Thailand Science Research and Innovation, Thailand
Prof. Boonyarach Kitiyanan
Assistant to the President (Sustainable Development Goals), Chulalongkorn University, Thailand
Prof. Duangdao Aht-Ong
Principal Investigator in High Performance and Smart Materials, Center of Excellence on Petrochemical and Materials Technology (PETROMAT), Thailand
Prof. Pramoch Rangsunvigit
Principal Investigator in Sustainable Petrochemicals, Center of Excellence on Petrochemical and Materials Technology (PETROMAT), Thailand
Assoc. Prof. Prapan Kuchonthara
Principal Investigator in Materials for Future Energy, Center of Excellence on Petrochemical and Materials Technology (PETROMAT), Thailand
Assoc. Prof. Anusorn Seubsai
Principal Investigator in Green Petrochemical Industries, Center of Excellence on Petrochemical and Materials Technology (PETROMAT), Thailand

Local Committees

Assoc. Prof. Apichat Imyim
Head of Department of Chemistry, Faculty of Science, Chulalongkorn University, Thailand
Assoc. Prof. Paiboon Ngernmeesri
Head of Department of Chemistry, Faculty of Science, Kasetsart University, Thailand
Assoc. Prof. Chaiwat Ruksakulpiwat
Head of School of Polymer Engineering, Suranaree University of Technology, Thailand
Asst. Prof. Narit Triamnak
Head of Department of Materials Science and Engineering, Faculty of Engineering and Industrial Technology, Silpakorn University, Thailand
Asst. Prof. Prachid Sramolee
Head of Department of Petrochemical and Polymer, School of Engineering and Technology, Walailak University, Thailand
Assoc. Prof. Supet Jirakajohnkool
Dean of Faculty of Science and Technology, Thammasat University, Thailand

COMMITTEES

Local Committees

Dr. Charoen Chinwanitcharoen
Head of Department of Chemical Engineering, Faculty of Engineering, Burapha University, Thailand
Dr. Nikornpon Prapaitrakul
PTT Global Chemical Public Company Limited, Thailand
Dr. Phairat Phiriyawirut
SCG Chemicals Public Company Limited, Thailand

Committee and Secretary

Dr. Satita Thiangtham
Head of Advancement Unit, Mahanakorn University of Technology, Thailand

Committee and Assistant Secretary

Ms. Kaewjai Khumvilaisak
Office Manager of Center of Excellence on Petrochemical and Materials Technology (PETROMAT), Thailand

Scientific Committees

Prof. Rathanawan Magaraphan	Chulalongkorn University, Thailand
Prof. Sirirat Jitkarnka	Chulalongkorn University, Thailand
Prof. Thirasak Rirksomboon	Chulalongkorn University, Thailand
Assoc. Prof. Pailin Ngaotrakanwiwat	Burapha University, Thailand
Assoc. Prof. Thanakorn Wasanapiarnpong	Chulalongkorn University, Thailand
Assoc. Prof. Thanyalak Chaisuwan	Chulalongkorn University, Thailand
Assoc. Prof. Sirithan Jiemsirilers	Chulalongkorn University, Thailand
Assoc. Prof. Uthaiporn Suriyapraphadilok	Chulalongkorn University, Thailand
Assoc. Prof. Gasidit Panomsuwan	Kasetsart University, Thailand
Assoc. Prof. Paweena Prapainainar	Kasetsart University, Thailand
Assoc. Prof. Waleeporn Donphai	Kasetsart University, Thailand
Assoc. Prof. Khwanchit Wongcharee	Mahanakorn University of Technology, Thailand
Assoc. Prof. Sarute Ummartyotin	Thammasat University, Thailand
Assoc. Prof. Suwadee Kongparakul	Thammasat University, Thailand
Asst. Prof. Suthaphat Kamthai	Chiang Mai University, Thailand
Asst. Prof. Nuttapol Pootrakulchote	Chulalongkorn University, Thailand
Asst. Prof. Supacharee Roddecha	Kasetsart University, Thailand
Asst. Prof. Noppadol Panchan	Mahanakorn University of Technology, Thailand
Asst. Prof. Nutthira Pakkang	Nagoya University, Japan
Asst. Prof. Mongkol Tipplook	Shinshu University, Japan
Dr. Charoen Chinwanitcharoen	Burapha University, Thailand
Dr. Bhumin Than-ardna	Chulalongkorn University, Thailand
Dr. Chuanchom Aumnate	Chulalongkorn University, Thailand

COMMITTEES

Scientific Committees

Dr. Jitima Preechawong	Chulalongkorn University, Thailand
Dr. Sorapat Niyomsin	Chulalongkorn University, Thailand
Dr. Treerat Vacharanukrauh	Chulalongkorn University, Thailand
Dr. Wasupon Wongvitvichot	Chulalongkorn University, Thailand
Dr. Natthapong Sueviriyapan	Chulalongkorn University, Thailand
Dr. Nuttapol Risangud	Chulalongkorn University, Thailand
Dr. Nitikorn Ditthawat	Mahanakorn University of Technology, Thailand
Dr. Phimchanok Sakunpongpitiporn	Mahanakorn University of Technology, Thailand
Dr. Satita Thiangtham	Mahanakorn University of Technology, Thailand
Dr. Sasimaporn Treepet	National Science and Technology Development Agency, Thailand
Dr. Jiangqi Niu	National University of Singapore, Singapore
Dr. Jitti Niyompanich	Pathum Wan Institute of Technology, Thailand
Dr. Kornkanok Noulta	Ubon Rtachathani University, Thailand
Dr. Waroton Paisuwan	Walailak University, Thailand, Thailand
Dr. Palawat Unruean	IRPC Public Company Limited, Thailand
Dr. Trin Jedsukontorn	PTT LNG Company Limited, Thailand
Dr. Jaturon Kumchompoo	Thammasat University, Thailand
Mr. Piyapol Siriwat	Mahanakorn University of Technology, Thailand
Ms. Wimolsiri Sriphochai	Mahanakorn University of Technology, Thailand

Session Chairs

Prof. Hathaikarn Manuspiya	Chulalongkorn University, Thailand
Prof. Boonyarach Kitiyanan	Chulalongkorn University, Thailand
Assoc. Prof. Sarute Ummartyotin	Thammasat University, Thailand
Dr. Charoen Chinwanitcharoen	Burapha University, Thailand
Dr. Natthapong Sueviriyapan	Chulalongkorn University, Thailand
Dr. Bhumin Than-ardna	Chulalongkorn University, Thailand

PLENARY SPEAKERS

Prof. Kotohiro Nomura
Tokyo Metropolitan University, Japan
"Design of Biobased Polyesters, and the Exclusive Chemical Recycling"

Prof. Suojiang Zhang
Henan University / Chinese Academy of Sciences (CAS), China
"Ionic Liquids: From Fundamentals to Applications"

KEYNOTE SPEAKERS

Prof. Wei Han
The Hong Kong University of Science and Technology, Hong Kong
"High-performance Environmental Catalysts Prepared from Molecular Structure Units"

Prof. Hongyan He
Institute of Process Engineering, Chinese Academy of Sciences (CAS), China
"Molecular insights into the nanoconfined ionic liquids and their cutting-edge applications toward green chemistry"

Prof. Xingmei Lyu
Institute of Process Engineering, Chinese Academy of Sciences (CAS), China
"The alcoholysis of waste PET and the green preparation of gel materials"

Prof. Chunshan Li
Institute of Process Engineering, Chinese Academy of Sciences (CAS), China
" Ionic microenvironment and its catalysis in aldol condensation reactions"

Prof. Vissanu Meeyoo
Thailand Science Research and Innovation, Thailand
"Driving Sustainability through Science, Research, and Innovation: Thailand's National Policy Pathways"

Prof. Pramoch Rangsunvigit
Chulalongkorn University, Thailand
"Roles of Cations and Anions in Gas Hydrate Formation"

KEYNOTE SPEAKERS

Prof. Supa Hannongbua
Kasetsart University, Thailand
"Computational Science Supports the Green Transition"

Prof. Metta Chareonpanich
Kasetsart University, Thailand
"Sustainable Solutions for Catalytic CO2 Conversion to Value-Added Chemicals via Environmentally Friendly, Magnetic Field-Assisted Green and Innovative Processes"

INVITED SPEAKERS

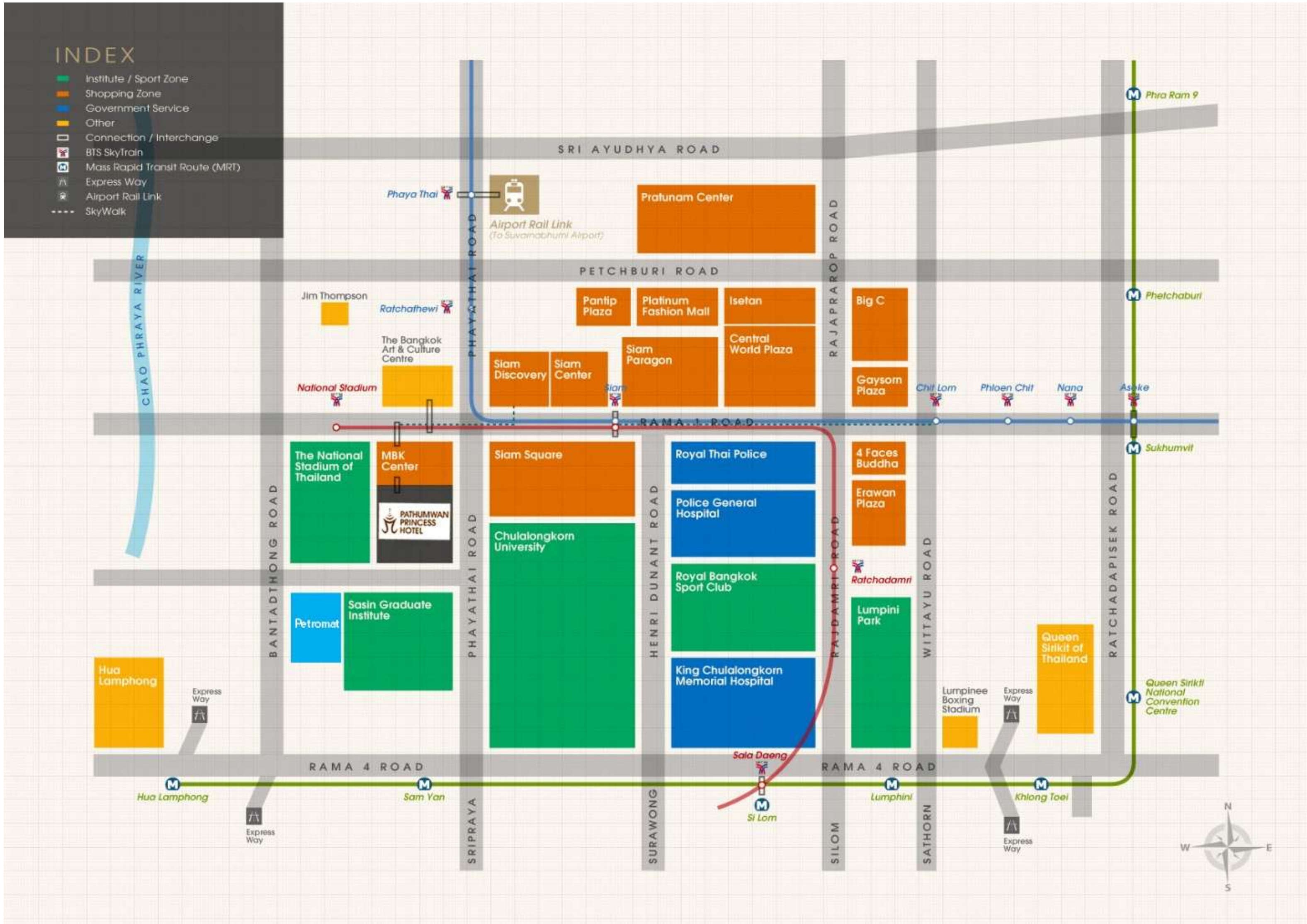
Assoc. Prof. Sarute Ummartyotin
Thammasat University, Thailand
"Polysaccharides for Medical Technology: Properties and Applications"

Assoc. Prof. Pailin Ngaotrakanwiwat
Burapha University, Thailand
"Dual-Band Electrochromic Window for Energy-Efficient Glass Buildings"

Assoc. Prof. Gasidit Panomsuwan
Kasetsart University, Thailand
"Solution Plasma-Derived Carbon Materials for Energy Applications"

Assoc. Prof. Anyarat Watthanaphanit
Mahidol University, Thailand
"Bifunctional ZnO/Activated Hydrochar Composites from Mangosteen Peel: A Sustainable Approach for Dye Removal"

Map & Venue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🟧 Shopping Zone
🟦 Government Service
🟨 Other
☐ Connection / Interchange
BTS SkyTrain
M Mass Rapid Transit Route (MRT)
Express Way
Airport Rail Link
---- SkyWalk
SRI AYUDHYA ROAD
PETCHBURI ROAD
RAMA 1 ROAD
RAMA 4 ROAD
CHAO PHRAYA RIVER
BANTADTHONG ROAD
PHAYATHAI ROAD
HENRI DUNANT ROAD
RAJAPRAROP ROAD
RAJDAMRI ROAD
WITTAYU ROAD
RATCHADAPISEK ROAD
SRIPRAYA
SURAWONG
SILOM
SATHORN
Phaya Thai
Airport Rail Link
(To Suvarnabhumi Airport)
Pratunam Center
Jim Thompson
Ratchathewi
Pantip Plaza
Platinum Fashion Mall
Isetan
Big C
Central World Plaza
The Bangkok Art & Culture Centre
Siam Discovery
Siam Center
Siam Paragon
Siam
Gaysorn Plaza
National Stadium
Chit Lom
Phloen Chit
Nana
Asoke
Phra Ram 9
Phetchaburi
Sukhumvit
The National Stadium of Thailand
MBK Center
PATHUMWAN PRINCESS HOTEL
Siam Square
Royal Thai Police
4 Faces Buddha
Police General Hospital
Erawan Plaza
Chulalongkorn University
Royal Bangkok Sport Club
Ratchadamri
Petromat
Sasin Graduate Institute
Lumpini Park
Queen Sirikit of Thailand
King Chulalongkorn Memorial Hospital
Hua Lamphong
Express Way
Lumpinee Boxing Stadium
Queen Sirikit National Convention Centre
Sala Daeng
Hua Lamphong
Sam Yan
Si Lom
Lumphini
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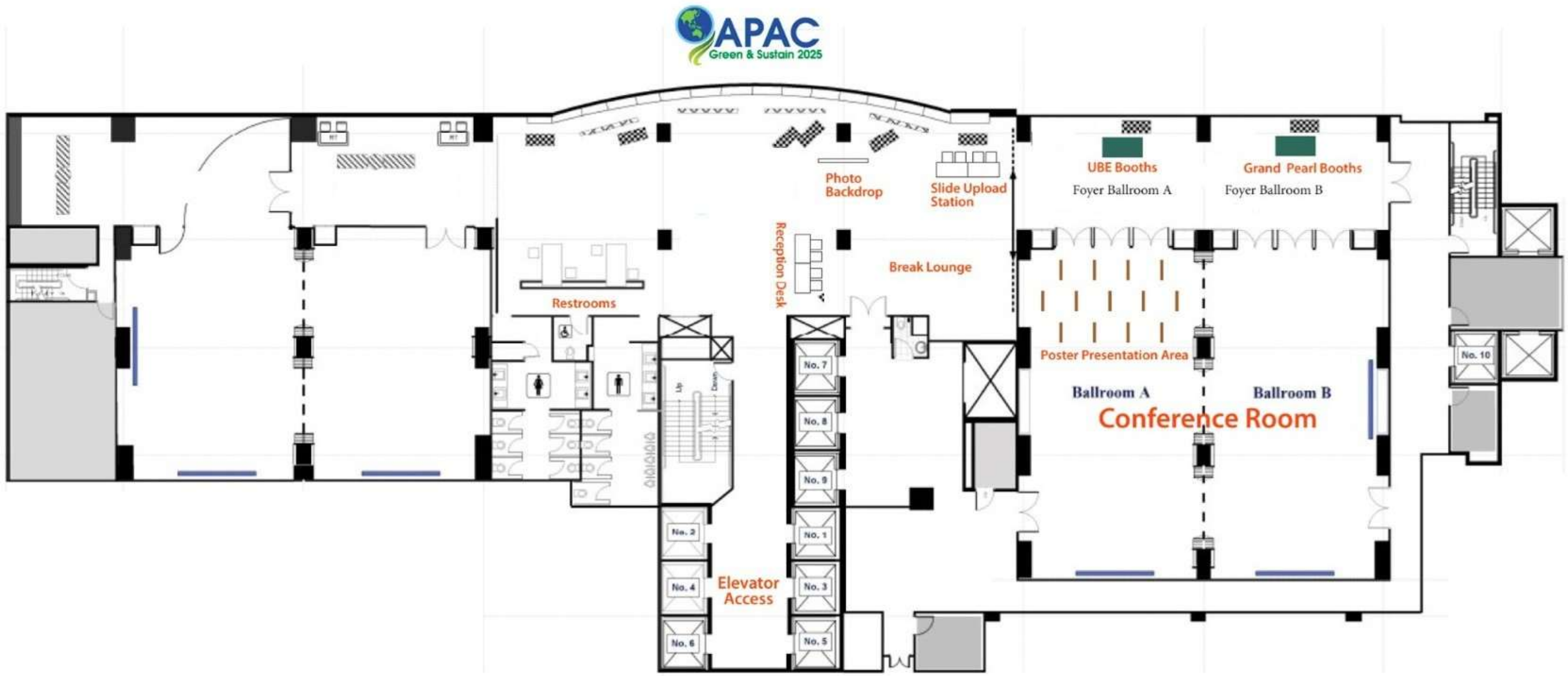
FLOOR PLAN: M Floor



AGENDA

AGENDA (Main Schedule)

Sunday, Nov 9, 2025		
Time	Schedule	Venue
17.00 – 18.00 hr.	Local Registration	Foyer
18.00 – 20.00 hr.	Welcome Reception	Jamjuree Ballroom B

Monday, Nov 10, 2025		
Time	Schedule	Venue
9.00 – 9.30 hr.	Opening Ceremony	Jamjuree Ballroom A+B
9.30 – 10.00 hr.	**Plenary Speaker 1** Title “Design of Biobased Polyesters, and the Exclusive Chemical Recycling” Prof. Kotohiro Nomura Tokyo Metropolitan University, Japan	Jamjuree Ballroom A+B
10.00 – 10.25 hr.	**Keynote Speaker 1** Title “High-performance Environmental Catalysts Prepared from Molecular Structure Units” Prof. Wei Han The Hong Kong University of Science and Technology, Hong Kong	Jamjuree Ballroom A+B
10.25 – 10.35 hr.	Break	Foyer
10.35 – 11.00 hr.	**Keynote Speaker 2** Title “Computational Science Supports the Green Transition” Prof. Supa Hannongbua Kasetsart University, Thailand	Jamjuree Ballroom A+B
11.00 – 11.25 hr.	**Keynote Speaker 3** Title “Sustainable Solutions for Catalytic CO_2 Conversion to Value-Added Chemicals via Environmentally Friendly, Magnetic Field-Assisted Green and Innovative Processes” Prof. Metta Chareonpanich Kasetsart University, Thailand	Jamjuree Ballroom A+B
11.25 – 11.45 hr.	**Invited Speaker 1** Title “Dual-Band Electrochromic Window for Energy-Efficient Glass Buildings” Assoc. Prof. Pailin Ngaotrakanwiwat Burapha University, Thailand	Jamjuree Ballroom A+B
11.45 – 12.05 hr.	**Invited Speaker 2** Title “Solution Plasma-Derived Carbon Materials for Energy Applications” Assoc. Prof. Gasidit Panomsuwan Kasetsart University, Thailand	Jamjuree Ballroom A+B

AGENDA (Main Schedule)

Monday, Nov 10, 2025			
Time	Schedule		Venue
12.05 – 13.30 hr.	Lunch		CiTi BiSTRo (G Floor)
13.30 – 15.15 hr.	Oral Presentation Session 1 (Jamjuree Ballroom A)	Oral Presentation Session 2 (Jamjuree Ballroom B)	Jamjuree Ballroom A+B
15.15 – 17.00 hr.	Break & Poster Presentation		Jamjuree Ballroom A
17.00 – 18.00 hr.	Transportation to the Chao Phraya River		
18.00 – 21.30 hr.	Dinner on the Chao Phraya River Cruise		
21.30 – 22.00 hr.	Return to Pathumwan Princess Hotel		

Tuesday, Nov 11, 2025		
Time	Schedule	Venue
9.00 – 9.30 hr.	**Plenary Speaker 2** Title “Ionic Liquids: From Fundamentals to Applications” Prof. Suojiang Zhang Institute of Process Engineering, Chinese Academy of Sciences, China	Jamjuree Ballroom A
9.30 – 9.55 hr.	**Keynote Speaker 4** Title “Roles of Cations and Anions in Gas Hydrate Formation” Prof. Pramoch Rangsunvigit Chulalongkorn University, Thailand	Jamjuree Ballroom A
9.55 – 10.20 hr.	**Keynote Speaker 5** Title “Molecular Insights into the Nanoconfined Ionic Liquids and Their Cutting-edge Applications Toward Green Chemistry” Prof. Hongyan He Institute of Process Engineering, Chinese Academy of Sciences, China	Jamjuree Ballroom A
10.20 – 10.35 hr.	Break	Foyer
10.35 – 11.00 hr.	**Keynote Speaker 6** Title “The Alcoholysis of Waste PET and the Green Preparation of Gel Materials” Prof. Xingmei Lyu Institute of Process Engineering, Chinese Academy of Sciences, China	Jamjuree Ballroom A
11.00 – 11.20 hr.	**Invited Speaker 3** Title “Bifunctional ZnO/Activated Hydrochar Composites from Mangosteen Peel: A Sustainable Approach for Dye Removal” Assoc. Prof. Anyarat Watthanaphanit Mahidol University, Thailand	Jamjuree Ballroom A

AGENDA (Main Schedule)

Tuesday, Nov 11, 2025		
Time	Schedule	Venue
11.20 – 12.05 hr.	Oral Presentation Session 3	Jamjuree Ballroom A
12.05 – 13.30 hr.	Lunch	CiTi BiSTRo (G Floor)
13.30 – 13.55 hr.	**Keynote Speaker 7** Title "Ionic Microenvironment and Its Catalysis in Aldol Condensation Reactions" Prof. Chunshan Li Institute of Process Engineering, Chinese Academy of Sciences, China	Jamjuree Ballroom A
13.55 – 14.10 hr.	**Nagase Session** Dr. Masahiro Matsumoto Nagase (Thailand) Co., Ltd., Thailand	Jamjuree Ballroom A
14.10 – 14.35 hr.	**Keynote Speaker 8** Title "Driving Sustainability through Science, Research, and Innovation: Thailand's National Policy Pathways" Prof. Vissanu Meeyoo Thailand Science Research and Innovation, Thailand	Jamjuree Ballroom A
14.35 – 14.55 hr.	**Invited Speaker 4** Title "Polysaccharides for Medical Technology: Properties and Applications" Assoc. Prof. Sarute Ummartyotin Thammasat University, Thailand	Jamjuree Ballroom A
14.55 – 15.25 hr.	Closing Ceremony	Jamjuree Ballroom A
15.25 – 15.45 hr.	Break	Foyer
18.00 – 20.00 hr.	VIP Dinner	Erawan Tea Room, Level 2, Grand Hyatt Erawan

Wednesday, Nov 12, 2025		
Time	Schedule	Venue
9.00 – 17.00 hr.	Excursion in Ayutthaya	

AGENDA (Sessions)

Oral Presentation Session 1

Monday, Nov 10, 2025 – Jamjuree Ballroom A		
Time	Schedule	Code
13.30 – 13.45 hr.	Title “Aptamer-Based Electrochemical Platform Utilizing the Size-Exclusion Effect of an Agarose Hydrogel Electrode for Simultaneous Detection of E. coli and Interleukin-6” Dr. Whitchuta Jesadabundit Chulalongkorn University, Thailand	O1-GCM-01
13.45 – 14.00 hr.	Title “Lead-Free Perovskite/Metal Oxides Heterojunction Photocatalyst for Sustainable Toluene Oxidation” Mr. Zakarya Hazaea Chulalongkorn University, Thailand	O1-GCM-02
14.00 – 14.15 hr.	Title “Bimetallic NiCu Catalysts Supported on Rice Husk-Derived Silica for Efficient Hydrogen Production via Methane Steam Reforming” Dr. Jidapa Chantaramethakul Kasetsart University, Thailand	O1-GCM-03
14.15 – 14.30 hr.	Title “Electrically Controlled Transdermal Release of Insulin from PEDOT:PSS/SF Hydrogel for Diabetes Mellitus Basal Treatment” Dr. Phimchanok Sakunpongpitiporn Mahanakorn University of Technology, Thailand	O1-GCM-04
14.30 – 14.45 hr.	Title “Chemical Conversion of PET Wastes with Alcohol by Transesterification by FeCl3–amine Catalyst” Dr. Kanticha Jaiyen Tokyo Metropolitan University, Japan	O1-GCM-05
14.45 – 15.00 hr.	Title “Valorizing Agricultural Residues into Biodegradable Mulch Films for Circular Farming System” Ms. Alyssa Bea Sison The Meridian International Learning Experience, Inc., Philippines	O1-GCM-06
15.00 – 15.15 hr.	Title “Green Synthesis of Tannin-Derived Nanomaterials from Carica papaya Leaves for Electrochemical Applications in Bio-Batteries” Mr. Ronnel Encina The Meridian International Learning Experience, Inc., Philippines	O1-GCM-07

AGENDA (Sessions)

Oral Presentation Session 2

Monday, Nov 10, 2025 – Jamjuree Ballroom B		
Time	Schedule	Code
13.30 – 13.45 hr.	Title “Feasibility Study of Pilot Scale Synthesis of Iso-amyl Acetate Using Reactive Distillation Technique” Mr. Chanatip Somsrang Suranaree University of Technology, Thailand	O2-GSP-01
13.45 – 14.00 hr.	Title “Single-Step Synthesis of Propylene Oxide from Propane in Dielectric Barrier Discharge Reactor: Impacts of Propane Separate Feed” Dr. Nitikorn Ditthawat Mahanakorn University of Technology, Thailand	O2-GRE-01
14.00 – 14.15 hr.	Title “Advancing Organic and Perovskite Photovoltaic through Material Innovation” Prof. Guilong Cai Institute of Process Engineering, Chinese Academy of Sciences, China a	O2-NEM-01
14.15 – 14.30 hr.	Title “Development of Multilayer TiO2–PEGS/SiO2–PEGL Coatings for Solar Cell Antireflection Applications” Mr. Numporn Thungphotrakul Kasetsart University, Thailand	O2-NEM-02
14.30 – 14.45 hr.	Title “Sustainable Self-Calibrating Electrochemical Biosensor for Multiplex Detection of Kidney Injury Biomarkers” Dr. Surinya Traipop Chulalongkorn University, Thailand	O2-CNS-01
14.45 – 15.00 hr.	Title “A Novel DNA-Based Lateral Flow Assay for Rapid and Early Detection of Treponema pallidum” Dr. Napakporn Poosinuntakul Chulalongkorn University, Thailand	O2-CNS-02
15.00 – 15.15 hr.	Title “Ammonia Recovery from Wastewater via Electrochemical Process: A Parametric Study on Membrane Pretreatment and Electrochemical Optimization” Asst. Prof. Khwanchit Wongcharee Mahanakorn University of Technology, Thailand	O2-CNS-03

AGENDA (Sessions)

Oral Presentation Session 3

Tuesday, Nov 11, 2025 – Jamjuree Ballroom A		
Time	Schedule	Code
11.20 – 11.35 hr.	Title “Up-cycling of Waste PET Based on Ionic Liquid Catalysts” Prof. Jiayu Xin Institute of Process Engineering, Chinese Academy of Sciences, China	O3-GCM-08
11.35 – 11.50 hr.	Title “Catalytic Cracking of Crude Oil into Light Olefins/Aromatics” Prof. Hui Wang Institute of Process Engineering, Chinese Academy of Sciences, China	O3-GCM-09
11.50 – 12.05 hr.	Title “Ionic Liquid-Enhanced Lignin Degradation” Prof. Yumiao Lyu Institute of Process Engineering, Chinese Academy of Sciences, China	O3-GRE-02

Poster Presentation

Monday, Nov 10, 2025 – 15.15 – 17.00 hr. – Jamjuree Ballroom A	
Schedule	Code
Title “Electrocatalytic Upcycling of Waste PBAT into High-Value Products PBS” Prof. Yu Zhang Institute of Process Engineering, Chinese Academy of Sciences, China	P-GCM-01
Title “New Technology for Synthesis of Carbonate from CO_2 and Low-carbon Alcohols” Prof. Li Dong Institute of Process Engineering, Chinese Academy of Sciences, China	P-GCM-02
Title “Functions of Surface Brønsted and Lewis Acidic Sites in the Catalytic Transfer Hydrogenation of Methyl Levulinate with 2-Propanol” Prof. Dan Yang Shanxi Normal University, China	P-GCM-03
Title “Development of particulate air filtration media with antimicrobial Property” Ms. Nareerat Punvitayakul Center of Excellence on Petrochemical and Materials Technology, Thailand	P-GCM-04
Title “Modification of Biochar and Its Application in Acetin Synthesis from Glycerol” Miss Ashiraya Thitacharoen Chulalongkorn University, Thailand	P-GCM-05
Title “Effect of Manganese Oxide Morphologies on Alumina-Supported Catalysts on Water-assisted Ketonization of FAME for Biowax Production” Mr. Dhimas Giffarie Wardhana Chulalongkorn University, Thailand	P-GCM-06

AGENDA (Sessions)

Poster Presentation

Monday, Nov 10, 2025 – 15.15 – 17.00 hr. – Jamjuree Ballroom A	
Schedule	Code
Title "Fe-Modified Pineapple Leaf Biochar for Efficient H2S Removal: Adsorption Performance and Mechanistic Insights" Miss Pimchanok Khwanprasert Kasetsart University, Thailand	P-GCM-07
Title "Banana Pseudostem Cellulose-Based Mulch Films for Sustainable Plant Growth" Mr. Nicholas Garrett Ng The Meridian International Learning Experience Inc., Philippines	P-GCM-08
Title "Development of Biodegradable Seed Sheets from Rice Husk and Banana Pseudostem" Ms. Mariska Rilo Kintanar The Meridian International Learning Experience Inc., Philippines	P-GCM-09
Title "Biodegradable Rice Husk Cellulose Sheets for Enhanced Plant Growth" Ms. Eowyn Llagas The Meridian International Learning Experience Inc., Philippines	P-GCM-10
Title "Dual-Layer Proton-Conducting Membrane for Controlled Hydration in PEMFC" Assist. Prof. Noppadol Panchan Mahanakorn University of Technology, Thailand	P-GCM-11
Title "Bio-Based CMC/PVA Nanofiber Wound Dressings Enhanced with Liquorice Extract for Improved Antibacterial and Healing Performance" Mr. Piyapol Siriwat Mahanakorn University of Technology, Thailand	P-GCM-12
Title "Synthesis and Characterization of Biobased Sulfonated Cellulose (SC)-Acetate Membranes for Wastewater Treatment" Ms. Wimolsiri Sriphochai Mahanakorn University of Technology, Thailand	P-GCM-13
Title "Effective Catalyst Design and Process Innovation for CO_2 Selective Hydrogenation" Prof. Gang Wang Institute of Process Engineering, Chinese Academy of Sciences, China	P-GCM-14
Title "Optimization and Application of Combined Impeller Reactor in Ionic Liquid-Mediated Aldol Condensation" Prof. Qiu Zhao Institute of Process Engineering, Chinese Academy of Sciences, China	P-GRE-01
Title "Multicomponent Modeling of Adsorption Isotherm: A Case Study of Cadmium(II) and Nickel(II) Ions Adsorbed onto Rice Husk Ash" Mr. Bawornpong Pornchuti Mahanakorn University of Technology, Thailand	P-GSP-01

AGENDA (Sessions)

Poster Presentation

Monday, Nov 10, 2025 – 15.15 – 17.00 hr. – Jamjuree Ballroom A	
Schedule	Code
Title "Tuning Interfacial Properties in Sodium-Ion Batteries with Imidazole-Based Ionic Liquid Additives" Prof. Xinyue Liu Institute of Process Engineering, Chinese Academy of Sciences, China	P-NEM-01
Title "Posture Analysis for Surveillance using Camera Sensor on Electric Adjustable and Flipping Beds" Dr. Asavaron Limsuebchuea Center of Excellence on Petrochemical and Materials Technology, Thailand	P-NEM-02
Title "Enhancing the Electrochemical Performance of Silicon–Carbon Composite Anodes Using Tween 80 and Sorghum for Sodium-Ion Batteries" Mr. Phathaporn Laocharoen Kasetsart University, Thailand	P-NEM-03
Title "Life Cycle Assessment on Conventional and Oxy-fuel Natural Gas Combined Cycle Power Plant Integrated with Carbon Capture Technology for Low Carbon Society" Miss Aye Myat Theint Kyaw Kasetsart University, Thailand	P-CNS-01
Title "Porphyrin-conjugated Microporous Polymer Nanospheres Functionalized MXene as an Alternative Counter Electrodes for Dye-sensitized Solar Cells" Mr. Peera Comchamnan Kasetsart University, Thailand	P-CNS-02
Title "Fabrication of UiO-66/Bacterial Cellulose Membranes for CO_2/CH_4 Separation" Miss Nongnapat Budsrijaroen Chulalongkorn University, Thailand	P-CNS-03
Title "Multimodal Chromatography and Spectroscopy Analysis with Machine Learning for Crude Palm Oil Fingerprinting" Mr. Abdul Nggofur Chulalongkorn University, Thailand	P-CNS-04
Title "Fabrication of ZIF-8@BC/SA Composite Beads for Carbon Dioxide Adsorption" Mr. Phuwadol Pornsawangwat Chulalongkorn University, Thailand	P-CNS-05

LIST OF ORAL PRESENTATION

O1-GCM-01 **Aptamer-Based Electrochemical Platform Utilizing the Size-Exclusion Effect of an Agarose Hydrogel Electrode for Simultaneous Detection of *E. coli* and Interleukin-6**

Whitchuta Jesadabundit,[a,b] *Sakda Jampasa,*[c] *and Orawon Chailapakul*[a,*]

[a] Electrochemistry and Optical Spectroscopy Center of Excellence (EOSCE), Department of Chemistry, Faculty of Science, Chulalongkorn University, Bangkok 10330, Thailand

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[c] Futuristic Science Research Center, School of Science, Walailak University, Nakhon Si Thammarat 80160, Thailand

O1-GCM-02 **Lead-Free Perovskite/Metal Oxides Heterojunction Photocatalyst for Sustainable Toluene Oxidation**

Zakarya A.M. Hazaea,[a] *Peradon Phonglamjiakngam,*[a] *and Nuttapol Pootrakulchote*[a,b,*]

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[b]Center of Excellence on Petrochemicals and Materials Technology (PETROMAT), Chulalongkorn University, Bangkok 10330, Thailand

O1-GCM-03 **Bimetallic NiCu Catalysts Supported on Rice Husk-Derived Silica for Efficient Hydrogen Production via Methane Steam Reforming**

Jidapa Chantaramethakul,[a] *Nattapat Chaiammart,*[a] *Kasidit Janbooranapinij,*[a] *Jirayu Kongtip,*[a] *Apirat Laobuthee,*[a] *Chinnathan Areeprasert,*[b] *Navadol Laosiripojana,*[c,**] *and Gasidit Panomsuwan*[a,*]

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[c]The Joint Graduate School of Energy and Environment (JGSEE), King Mongkut's University of Technology Thonburi, Bangkok 10140, Thailand

O1-GCM-04 **Electrically Controlled Transdermal Release of Insulin from PEDOT:PSS/SF Hydrogel for Diabetes Mellitus Basal Treatment**

Phimchanok Sakunpongpitiporn,[a] *Nitikorn Ditthawat,*[a,*] *and Anuvat Sirivat*[b,*]

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[b]The Petroleum and Petrochemical College, Chulalongkorn University, 254 Soi Chulalongkorn 12, Wangmai, Pathumwan, Bangkok 10330, Thailand

O1-GCM-05 **Chemical Conversion of PET Wastes with Alcohol by Transesterification by $FeCl_3$–amine Catalyst**

*Kanticha Jaiyen, Youshu Jiang, and Kotohiro Nomura**

Tokyo Metropolitan University, 1-1 Minami Osawa, Hachioji, Tokyo 192-0927, Japan

LIST OF ORAL PRESENTATION

O1-GCM-06 Valorizing Agricultural Residues Into Biodegradable Mulch Films for Circular Farming System

Alyssa Bea M. Sison,[a,]* *Mariska Rilo C. Kintanar,*[a] *Eowyn Denise S. Llagas,*[a] *Nicholas Garrett V. Ng,*[a] *Ronnel V. Encina,*[a] *and Yvonne Krisha E. Estrada*[a]

[a]The Meridian International Learning Experience, Inc., Quezon City, Philippines

O1-GCM-07 Green Synthesis of Tannin-Derived Nanomaterials from *Carica papaya* Leaves for Electrochemical Applications in Bio-Batteries

Ronnel V. Encina[a] *and William John S. Reantaso*[b]

[a]The Meridian International Learning Experience, Inc., Quezon City, Philippines
[b]Don Bosco Technical Institute of Makati, Makati City, Philippines

O3-GCM-08 Up-cycling of Waste PET Based on Ionic Liquid Catalysts

Jiayu Xin,[a,b] *Dongxia Yan,* [a,b] *Qing Zhou,* [a,b] *and Xingmei Lu* [a,b]

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[b]Longzihu New Energy Laboratory, School of Energy science and Technology, Henan University, Zhengzhou 450000, P.R. China

O3-GCM-09 Catalytic Cracking of Crude Oil into Light Olefins/Aromatics

Hui Wang and Nianming Jiao*

Center of Ionic Liquids and Green Energy, Beijing Key Laboratory of Solid State Battery and Energy Storage Process, Institute of Process Engineering, Chinese Academy of Sciences, Beijing 100190, PR China

O2-GRE-01 Single-Step Synthesis of Propylene Oxide from Propane in Dielectric Barrier Discharge Reactor: Impacts of Propane Separate Feed

Nitikorn Ditthawat,[a] *Sumaeth Chavadej,*[b] *and Phimchanok Sakunpongpitiporn*[a,]*

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O3-GRE-02 Ionic Liquid-Enhanced Lignin Degradation

*Yumiao LYU, Ziqi Zhai, Guangyong Liu, Suojiang Zhang, and Hongyan He**

Beijing Key Laboratory of Solid State Battery and Energy Storage Process, State Key Laboratory of Mesoscience and Engineering, CAS Key Laboratory of Green Process and Engineering, Institute of Process Engineering, Chinese Academy of Sciences, Beijing 100190, China

O2-GSP-01 Feasibility Study of Pilot Scale Synthesis of Iso-amyl Acetate Using Reactive Distillation Technique

*Chanatip Somsrang and Apichat Boontawan**

SUT - Biorefinery Pilot Plant School of Biotechnology, Institute of Agricultural Technology, Suranaree University of Technology, Nakhon Ratchasima 30000, Thailand

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O2-NEM-01 **Advancing Organic and Perovskite Photovoltaic through Material Innovation**
Guilong Cai, [a,b,]* *Changhua Li,*[b] *Yalin Gao,*[b] *and Hongfei Liu*[b]
[a]Institute of Process Engineering, Chinese Academy of Sciences, Beijing, China
[b]Longzihu New Energy Laboratory, Zhengzhou, China

O2-NEM-02 **Development of Multilayer TiO_2–PEGS/SiO_2–PEGL Coatings for Solar Cell Antireflection Applications**
Numporn Thungphotrakul,[a] *Ittikorn Kongnugul,*[b] *Boonyarach Kitiyanan,*[c] *and Paweena Prapainainar*[a,]*
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[b]Thaitanwa Engineer co.,Ltd., Bangkok, 10220, Thailand
[c]Center of Excellence on Petrochemical and Materials Technology, Chulalongkorn University, Bangkok, 10330, Thailand

O2-CNS-01 **Sustainable Self-Calibrating Electrochemical Biosensor for Multiplex Detection of Kidney Injury Biomarkers**
Surinya Traipop[a,b] *and Orawon Chailapakul*[a,b,]*
[a]Electrochemistry and Optical Spectroscopy Center of Excellence (EOSCE), Department of Chemistry, Faculty of Science, Chulalongkorn University, Pathumwan, Bangkok 10330, Thailand
[b]Center of Excellence on Petrochemical and Materials Technology (PETROMAT), Chulalongkorn University, Pathumwan, Bangkok 10330, Thailand

O2-CNS-02 **A Novel DNA-Based Lateral Flow Assay for Rapid and Early Detection of *Treponema pallidum***
Napakporn Poosinuntakul[a,b]*, Orawon Chailapakul*[c]*, and Natthaya Chuaypen*[b,]*
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O2-CNS-03 **Ammonia Recovery from Wastewater via Electrochemical Process: A Parametric Study on Membrane Pretreatment and Electrochemical Optimization**
Khwanchit Wongcharee, Bawornpong Pornchuti, Noppadol Punchan, Tanasorn Boon-in, Nuttanid Homruen*
Department of Process and Industrial Engineering, School of Engineering and Industrial Technology, Mahanakorn University of Technology, Bangkok 10530, Thailand

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P-GCM-01 **Electrocatalytic Upcycling of Waste PBAT into High-Value Products PBS**
Jiali Meng,[a] *Yang Liu,*[a] *Qiu Zhao,*[a] *Yu Zhang,*[a]* *Xingmei Lv*[a]*
[a] Center of Ionic Liquids and Green Energy， Beijing Key Laboratory of Solid State Battery and Energy Storage Process， Institute of Process Engineering, Chinese Academy of Sciences, Beijing 100190, China

P-GCM-02 **New Technology for Synthesis of Carbonate from CO_2 and Low-carbon Alcohols**
Li Dong, Jielin Huang, Suojiang Zhang*
Institute of Process Engineering, Chinese Academy of Sciences, Beijing, China

P-GCM-03 **Functions of Surface Brønsted and Lewis Acidic Sites in the Catalytic Transfer Hydrogenation of Methyl Levulinate with 2-Propanol**
Dan Yang
College of Chemistry and Chemical Engineering, Shaanxi Normal University, Xi’an, China

P-GCM-04 **Development of Particulate Air Filtration Media with Antimicrobial Property**
Nareerat Punvitayakul,[a,b] *Rattha Wattanachai,*[c] *and Ratthapol Rangkupan,*[a,*]
[a] Metallurgy and Materials Science Research Institute, Chulalongkorn University, Bangkok,Thailand
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[c] Crm International Company limited, Bangkok 10150, Thailand

P-GCM-05 **Modification of Biochar and Its Application in Acetin Synthesis from Glycerol**
Ashiraya Thitacharoen,[a] Apanee Luengnaruemitchai, [a,b,c*]
[a] The Petroleum and Petrochemical College, Chulalongkorn University, Pathumwan, Bangkok 10330, Thailand
[b] Center of Excellence in Catalysis for Bioenergy and Renewable Chemical (CBRC), Chulalongkorn University, Thailand
[c] Center of Excellence on Petrochemical and Materials Technology, Chulalongkorn University

P-GCM-06 **Effect of Manganese Oxide Morphologies on Alumina-Supported Catalysts on Water-assisted Ketonization of FAME for Biowax Production**
Dhimas Giffarie Wardhana,[a,c] *Ungki Bella Athania,*[a,c] *Echa Febriyana FN,*[a,c] *Tawan Sooknoi,*[b] *and Siriporn Jongpatiwuta,*[c,*]
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P-GCM-07 **Fe-Modified Pineapple Leaf Biochar for Efficient H_2S Removal: Adsorption Performance and Mechanistic Insights**
Pimchanok Khwanprasert,[a] Napassorn Chanka,[a] Nevzat Yigi,[b] Günther Rupprechter,[b] and Anusorn Seubsaia,[c,]*
[a] Department of Chemical Engineering, Faculty of Engineering, Kasetsart University, Bangkok, Thailand
[b] Institute of Materials Chemistry, Technische Universität Wien, Vienna, Austria
[c] Center of Excellence on Petrochemical and Materials Technology, Kasetsart University, Bangkok 10900, Thailand

P-GCM-08 **Banana Pseudostem Cellulose-Based Mulch Films for Sustainable Plant Growth**
Alyssa Bea M. Sison,[a] Mariska Rilo C. Kintanar,[a] Eowyn Denise S. Llagas,[a] Nicholas Garrett V. Ng,[a,] Ronnel V. Encina,[a] and Yvonne Krisha E. Estrada[a]*
[a] The Meridian International Learning Experience, Inc., Quezon City Philippines

P-GCM-09 **Development of Biodegradable Seed Sheets from Rice Husk and Banana Pseudostem**
Alyssa Bea M. Sison,[a] Mariska Rilo C. Kintanar,[a] Eowyn Denise S. Llagas,[a] Nicholas Garrett V. Ng,[a,]_ Ronnel V. Encina,[a] and Yvonne Krisha E. Estrada[a]*
[a] The Meridian International Learning Experience, Inc., Quezon City Philippines

P-GCM-10 **Biodegradable Rice Husk Cellulose Sheets for Enhanced Plant Growth**
Alyssa Bea M. Sison,[a] Mariska Rilo C. Kintanar,[a] Eowyn Denise S. Llagas,[a] Nicholas Garrett V. Ng,[a,]_ Ronnel V. Encina,[a] and Yvonne Krisha E. Estrada[a]*
[a] The Meridian International Learning Experience, Inc., Quezon City Philippines

P-GCM-11 **Dual-Layer Proton-Conducting Membrane for Controlled Hydration in PEMFC**
Noppadol Panchan[a], Mongkol Tipplook[b], Katsuya Teshima[b], Nagiro Saito[c], Satita Thiangthama [a,d]*
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P-GCM-12 **Bio-Based CMC/PVA Nanofiber Wound Dressings Enhanced with Liquorice Extract for Improved Antibacterial and Healing Performance**
Piyapol Siriwat,[a] *Wimolsiri Sripochai,*[a] *Mongkol Tipplook,*[b] *Katsuya Teshima,*[b] *and Satita Thiangthama,*[c*]
[a] Center of Excellence in Sustainable Engineering, Mahanakorn University of Technology, Bangkok, 10530, Thailand
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P-GCM-13 **Synthesis and Characterization of Biobased Sulfonated Cellulose (SC)-Acetate Membranes for Wastewater Treatment**
Wimolsiri Sriphochai[a], *Piyapol Siriwat*[a], *Mongkol Tipplook*[b], *Katsuya Teshima*[b], *Satita Thiangthama* [a,c*]
[a] Center of Excellence in Sustainable Engineering, Mahanakorn University of Technology, Bangkok, 10530, Thailand
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P-GCM-14 **Effective Catalyst Design and Process Innovation for CO_2 Selective Hydrogenation**
*Gang Wang**
Institute of Process Engineering, Chinese Academy of Sciences, Beijing, China

P-GRE-01 **Optimization and Application of Combined Impeller Reactor in Ionic Liquid-Mediated Aldol Condensation**
Qiu Zhao,[a,*] *Shichong Yang,*[a] *Yu Zhang,*[a] *and Chunshan Li* [a,*]
[a] Center of Ionic Liquids and Green Energy, Beijing Key Laboratory of Solid State Battery and Energy Storage Process, Institute of Process Engineering, Chinese Academy of Sciences, Beijing, 100190, China

P-GSP-01 **Multicomponent Modeling of Adsorption Isotherm: A Case Study of Cadmium(II) and Nickel(II) Ions Adsorbed onto Rice Husk Ash**
B. Pornchuti [a,*]
[a] Department of Process and Industrial Engineering, School of Engineering and Industrial Technology, Mahanakorn University of Technology, Bangkok 10530, Thailand

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P-NEM-01 **Tuning Interfacial Properties in Sodium-Ion Batteries with Imidazole-Based Ionic Liquid Additives**
Xinyue Liu[a,b]*, Tao Donga,*[b*]*, Zengxi Li*[a,b*]
[a] University of Chinese Academy of Sciences, Beijing 100049, PR
[b] Center of Ionic Liquids and Green Energy, Beijing Key Laboratory of Solid State Battery and Energy Storage Process, CAS Key Laboratory of Green Process and Engineering, State Key Laboratory of Multiphase Complex Systems, Institute of Process Engineering, Chinese Academy of Sciences, Beijing 100190, PR China

P-NEM-02 **Posture Analysis for Surveillance using Camera Sensor on Electric Adjustable and Flipping Beds**
Asavaron Limsuebchuea,[a,*] *Nalinee Kovitwanawong,*[b] *and Sakrawee Raweekul*[c]
[a] Center of Excellence on Petrochemical and Materials Technology, Chulalongkorn University
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[c] Rajamangala University of Technology Isan (Khon Kaen Campus), Department of Electrical Engineering, 150 Srichan Road, Muang District, Khon Kaen 40000, Thailand

P-NEM-03 **Enhancing the Electrochemical Performance of Silicon–Carbon Composite Anodes Using Tween 80 and Sorghum for Sodium-Ion Batteries**
Phathaporn Laocharoen[a] *and Supacharee Roddecha*[a,b]
[a] Department of Chemical engineering, Kasetsart University, Thailand
[b] Center of Excellence on Petrochemical and Materials Technology, Chulalongkorn University

P-CNS-01 **Life Cycle Assessment on Conventional and Oxy-fuel Natural Gas Combined Cycle Power Plant Integrated with Carbon Capture Technology for Low Carbon Society**
Aye Myat Theint Kyaw,[a,b] *Penjit Srinophakun,*[a,b] *Anusith Thanapimmetha,*[a,b] *Maythee Saisriyoot,*[a,b] *Khemmathin Lueangwattanapong,*[a,b] *and Nutchapon Chiarasumran*[a,b,*]
[a] Department of Chemical Engineering, Faculty of Engineering, Kasetsart University, Bangkok, Thailand
[b] Center of Excellence on Petrochemical and Materials Technology, Chulalongkorn University

P-CNS-02 **Porphyrin-conjugated Microporous Polymer Nanospheres Functionalized MXene as an Alternative Counter Electrodes for Dye-sensitized Solar Cells**
Peera Comchamnan,[a] *Chadchalerm Raksakoon,*[a,*] *and Panitat Hasin*[b,*]
[a] Department of Chemistry, Faculty of Science, Kasetsart University, Bangkok 10900, Thailand
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P-CNS-03 **Fabrication of UiO-66/Bacterial Cellulose Membranes for CO_2/CH_4 Separation**
Nongnapat Budsrijaroen,[a] Bhumin Than-ardna,[a] and Hathaikarn Manuspiya,[a,b,]*
[a] The Petroleum and Petrochemical College, Chulalongkorn University, Bangkok, Thailand
[b] Center of Excellence on Petrochemical and Materials Technology, Bangkok, Thailand

P-CNS-04 **Multimodal Chromatography and Spectroscopy Analysis with Machine Learning for Crude Palm Oil Fingerprinting**
Abdul Nggofur [a,b], Natthapong Sueviriyapan [a], Krittiya Pornmai [a], Noppadon Nuntawong [c], Ketsada Sutthiumporn [d], Tawan Sooknoi [e], Suwabun Chirachanchai[a] , Siriporn Jongpatiwut [a,b]*
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[d] Department of Chemistry, King Mongkut's Institute of Technology Ladkrabang, Bangkok, Thailand
[e] Department of Energy Business, Ministry of Energy, Bangkok, Thailand

P-CNS-05 **Fabrication of ZIF-8@BC/SA Composite Beads for Carbon Dioxide Adsorption**
Phuwadol Pornsawangwat,[a] Hathaikarn Manuspiya, [a,b] and Bhumin Than-ardna[a,b,]*
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Plenary Speakers' Abstracts

Development of Recyclable Biobased Polyesters, and the Exclusive Chemical Recycling including PET Bottle, Textile Wastes

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Development of functional polymers from renewable feedstocks, especially biobased polyesters derived from plant resources (plant oil etc.) attracts considerable attention in terms of circular economy.[1] We recently reported synthesis of biobased aliphatic polyesters, derived from castor oil and glucose, that exhibit promising tensile properties (tensile strength and elongation break) better than conventional polyolefins.[2] Development of synthetic methods for obtainment of high molar mass polymers plays a key role.[2,3] The resultant polymers exhibited different crystallization behavior from those possessing all linear aliphatic chains;[4] the thermal and mechanical properties in these polyesters are thus affected by the monomer repeat units employed. Moreover, the properties in the resultant polyesters were also affected by the end-groups.[5]

We also developed acid-, base-free methods for depolymerization of various polyesters (the biobased polyesters, PET, PBT, PEA, PBT) by transesterification with alcohol.[6-8] These reactions afforded starting monomers in exclusive selectivity, yields; the titanium catalysts are also effective for the depolymerization with amines (aminolysis).[9] In particular, the catalytic activity in the $FeCl_3$ catalyzed depolymerization of PET increased by addition of amine. The method can be thus applied to chemical recycling of not only PET bottles, but also textile waste and selective chemical recycling of polyester from a plastic waste mixture. Details will be introduced in the symposium.

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[3] X. Wang, W. Zhao, K. Nomura, *ACS Omega* **2023**, *8*, 7222.
[4] K. Nomura et al. *ACS Polym. Au* **2025**, *5*, 241.
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[6] K. Nomura et al., (a) *ACS Sustain. Chem. Eng.* **2022**, *10*, 12504. (b) *Catalysts* **2023**, *13*, 421. (c) To be submitted.
[7] S. Sudhakaran, S. M. A. H. Siddiki, B. Kitiyanan, K. Nomura, *ACS Sustain. Chem. Eng.* **2022**, *10*, 12864.
[8] K. Nomura et al., (a) *Ind. Chem Mat*. **2025**, *3*, 49. (b) submitted.
[9] K. Nomura et al., (a) *ACS Org. Inorg. Au* **2023**, *3*, 37. (b) *Catalysts* **2025**, *15*, 129. (c) To be submitted.

Ionic Liquids: From Fundamentals to Applications

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Ionic liquids (ILs) are the compounds completely composed entirely of ions, typically exhibiting melting points below 100°C. Recognized as next-generation green solvents, ILs have garnered substantial global scientific interest over the past two decades owing to their unique combination of tunable physicochemical properties and wide-ranging industrial applicability. This presentation systematically outlines the cutting-edge research trajectory on ILs developed by our group, demonstrating a coherent transition from mechanistic discovery to technological innovation. Our fundamental investigations have elucidated the intrinsic nature of ILs through the pioneering "Z-bond" concept, which quantifies the synergistic interplay between electrostatic interactions and hydrogen bonds. Advanced characterization of interfacial quasi-liquids and bulk ionic clusters has facilitated precise molecular engineering of IL functionality. Building on these fundamental discoveries, we have developed innovative IL-based solutions for critical industrial challenges including CO_2 capture and utilization, electrochemical energy storage and biomass conversion, etc. Our efforts have culminated in a comprehensive IL research infrastructure that synergistically connects molecular design, process optimization, and industrial implementation. This platform not only accelerates material innovation but also provides a paradigm for translating fundamental discoveries into practical technologies.

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Keynote Speakers' Abstracts

High-performance Environmental Catalysts Prepared from Molecular Structure Units

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Environmental catalysts play a crucial role in pollutant remediation and carbon dioxide conversion. Supported noble metal catalysts and metal oxide composite catalysts offer significant advantages, including a wide application range, high conversion, and long lifespan. However, three main technical bottlenecks, i.e., poor catalytic activity at low temperatures, high fabrication cost and low thermal stability, limit their large-scale application towards green chemical process. Our previous work reported a series of metal oxide composite catalysts derived from metal organic frameworks for the oxidation of volatile organic compounds (VOCs) at low temperatures1-3. This work highlights our recent advances in constructing high-performance environmental catalysts from molecular structure units, such as metal salts, zeolites and metal organic frameworks, through mechanochemical route. The zeolitic structure units within VOC oxidation catalysts contribute to multi-scale, three-dimensional, synergistic adsorption and catalytic active sites, enhancing catalytic activity. In the reverse water gas shift reaction, the optimized copper oxide-ceria composite catalyst is able to achieve equilibrium CO_2 conversion (i.e., 48%) and 99% CO selectivity at 500°C, and remains stable in material structure and catalytic performance after thermal treatment at 700°C.

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Molecular Insight into the Nanoconfined Ionic Liquids and Their Frontier Applications Toward Green Chemistry

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Ionic liquids, as a new class of green media, possess dual functionality as both solvent and catalyst and thus hold broad promise for applications in green chemistry, energy storage, and advanced materials. However, the complexity of their hydrogen-bonding networks, the ubiquity of nano–micro interfacial structures, and their strong coupling with transport and reaction phenomena in practical use present significant challenges for property regulation and engineering-scale prediction. This talk focuses on the structural characteristics and property regulation of ionic liquids under nanoscale confinement. By integrating multiscale simulations with experiments, we elucidate the correlated ionic behavior, dynamical features, and confinement effects at the nanoscale. Building on these insights, we develop a predictive model for viscosity under nanoconfinement and verify the process-intensification role of nanoconfinement in green processes such as carbon capture and utilization and humidity-driven power generation. These results provide theoretical underpinning for a deeper understanding of transport mechanisms and property regulation in ionic liquids, and they suggest new avenues for the rational design and development of high-efficiency green processes.

The Alcoholysis of Waste PET and The Green Preparation of Gel Materials

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Polyethylene terephthalate (PET) has become the fifth most widely produced synthetic plastic. With its extensive use, the accumulation of waste has made the chemical recycling of PET a research hotspot. Currently, the recycling rate of post-consumer PET waste is only 1/3, while the remainder is disposed of through landfilling or incineration, leading to resource wastage and environmental pollution. Compared to reprocessing, products derived from plastic waste can save 50% to 60% of energy. Therefore, promoting the green closed-loop recycling of post-consumer PET, extending its lifecycle, and facilitating the development of a circular economy are crucial. In this study, we used the high yield monomer or oligomer obtained by controlled glycolysis of PET to combine the building block with rigid aromatic ring and hydrogen bonding active site into gel, resulting in a series of high-value materials such as ionicgels, eutectogels, and hydrogels. The abundant benzene ring structures and the double network system within the PET building blocks endow the gels with excellent mechanical properties, outstanding conductivity, and numerous binding sites. This enables the fabrication of high-performance gel-based electronic skin and adsorbent materials. This research offers a simple and cost-effective solution for the high-value utilization of PET.

Keywords：PET, valorization, controlled glycolysis, e-skin, adsorbent

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Ionic Microenvironment and Its Catalysis in Aldol Condensation Reactions

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The designability of cation and anion structures in ionic liquids (IL) enables to achieve the best adaptation to specific catalysis system through precise molecular regulation. The directional regulation of ionic microenvironment provides an important approach for the improvement of reaction efficiency at mild condition. Research show that the significant advantages of ILs in catalytic reactions mainly stem from the following aspects. Firstly, the synergistic effect of cations and anions can mediate "proton shuttle" effect, effectively promoting the activation and transformation of reactants. For instance, the protonation/deprotonation can be optimized by regulating the acid-base properties of cation, while increase of proton affinity of anion accelerates the proton transfer process, thereby significantly promoting the main reaction. Secondly, water will induce the generation of ion clusters with multi-scale characteristics to form specific reaction microenvironment. The spatial confinement effect not only increases the local concentration of reactants but also stabilizes the reaction transition state, enabling the reconstruction of reaction pathway and reduction of activation barrier. Additionally, the strong electrostatic field generated by ion pairs can trigger chemical bond polarization, improving the kinetics of key steps. These discoveries provide important basis for the efficient and directional conversion of low-carbon hydrocarbons under mild conditions, and also points out the direction for the rational design of new functionalized ionic liquids.

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Driving Sustainability through Science, Research, and Innovation: Thailand’s National Policy Pathways

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Thailand has outlined a strategic national direction for achieving the Sustainable Development Goals (SDGs) [1] by positioning science, technology, and innovation (STI) as fundamental enablers of national transformation. The Ministry of Higher Education, Science, Research and Innovation (MHESI), together with Thailand Science Research and Innovation (TSRI), plays a pivotal role in aligning research and innovation with national priorities under the 20-Year National Strategy and the Bio-Circular-Green (BCG) Economy Model [2].

This presentation highlights policy frameworks, flagship programs, and funding schemes that mobilize STI to address urgent environmental and societal challenges while enhancing Thailand’s global competitiveness. Key initiatives include advancing the clean energy transition through energy storage systems (ESS), hydrogen technologies, and sustainable aviation fuel (SAF); scaling up carbon capture, utilization, and storage (CCUS); and promoting open science and international collaboration as essential instruments of inclusivity and innovation. By linking research outcomes with actionable policy frameworks [3], MHESI and TSRI aim to accelerate Thailand’s pathway toward carbon neutrality by 2050 and net-zero greenhouse gas emissions by 2065 [4].

Thailand also prioritizes human capital development, knowledge transfer, and sustained investment in science and technology infrastructure to strengthen its innovation ecosystem. These efforts foster inclusiveness, equity, and resilience, while expanding opportunities for cross-border collaboration. This policy-oriented contribution underscores Thailand’s pathways that leverage STI to achieve the SDGs, reinforce regional and global cooperation, and position the country as a hub for sustainable innovation in the Asia-Pacific.

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Roles of Cations and Anions in Gas Hydrate Formation

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This study explores the influence of various cation–anion salt combinations on methane hydrate formation at 277.2 K and 8 MPa using 1.0 wt% methionine as a kinetic promoter. Salts—$NaCl$, KCl, $CaCl_2$, $MgCl_2$, Na_2SO_4, Na_2CO_3, and $NaOH$—were evaluated at three concentrations (0.20, 0.40, and 0.60 mol%) to understand how ion-specific properties, particularly charge density and ionic radius, affect hydrate formation kinetics and gas uptake. The findings reveal that salts with higher charge densities, particularly divalent cations such as Ca^{2+} and Mg^{2+}, significantly inhibit hydrate formation. These ions form rigid hydration shells that reduce water activity, suppressing gas uptake by up to 98% and decreasing the initial formation rate by more than 95% compared to the salt-free system. In contrast, monovalent cations such as Na^+ and K^+ exhibit much milder effects, causing only a 25% reduction in methane uptake. Anion effects follow the Hofmeister series, with kosmotropic ions such as CO_3^{2-} and SO_4^{2-} demonstrating dual behaviors. Notably, at 0.60 mol%, CO_3^{2-} reduces induction time by 79%, likely due to enhanced water structuring and pseudo-cage formation. Despite accelerated nucleation, final gas storage remains limited due to growth inhibition. Morphological analysis reveals that interfacial nucleation is followed by propagation patterns that varies with the ionic environment.

Computational Science Supports the Green Transition

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The global green transition requires innovative approaches to minimize environmental impact, enhance resource efficiency, and accelerate the development of sustainable technologies. Computational calculations provide powerful tools to address these challenges by enabling the design, prediction, and optimization of materials and processes before large-scale experimental investment. Through advanced modeling and simulations, quantum chemical calculations support the discovery of carbon-based and optical materials with applications in optoelectronics and photochemistry, as well as the study of mechanical and transport properties of carbon nanomaterials, thereby reinforcing their role in sustainable material development. Moreover, molecular simulations, when combined with digital twins, high-performance computing, and machine learning, can efficiently screen bioactive compounds from natural products as potential antimalarial and anti-Alzheimer's agents, thereby shortening the pathway from concept to application. This talk highlights how computational calculations not only reduce the need for resource-intensive laboratory work but also accelerate innovation, providing a strategic foundation for a sustainable and low-carbon future.

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Sustainable Solutions for Catalytic CO_2 Conversion to Value-Added Chemicals via Environmentally Friendly, Magnetic Field-Assisted Green and Innovative Processes

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This study presents an innovative approach to advancing green and sustainable solutions in chemical engineering by converting carbon dioxide (CO_2) into valuable chemicals through magnetic field-assisted, environmentally friendly catalysts and reaction processes. By integrating cutting-edge innovations, this method addresses the critical need for sustainable and responsible chemical processes, transforming CO_2, a major greenhouse gas, into economically and industrially significant compounds. The application of a magnetic field enhances the efficiency and selectivity of catalytic reactions, reducing energy consumption and minimizing CO_2 emissions, thus promoting the development of eco-friendly technologies. Key findings reveal substantial improvements in conversion rates and product yields, demonstrating the potential for large-scale implementation within the chemical industry [1,2]. This approach aligns with global sustainability goals and fosters the transition toward carbon neutrality by utilizing CO_2 as a secondary raw material. Ultimately, this research underscores the pivotal role of innovative and green chemistry strategies in creating sustainable, environmentally conscious, and economically viable chemical processes, contributing meaningfully to the advancement of sustainable solutions in chemical engineering.

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Invited Speakers' Abstracts

Polysaccharides for Medical Technology: Properties and Applications

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Over the past decade, the use of polysaccharides has gained tremendous attention in the field of medical technology. They have been applied in various sectors such as tissue engineering, drug delivery system, face mask, and bio-sensing. This review article provides an overview and background of polysaccharides for biomedical uses. Different types of polysaccharides e.g. cellulose and its derivatives, chitin and chitosan, hyaluronic acid, alginate, and pectin are presented. They are fabricated in various forms such as hydrogels, nanoparticles, membranes, and as porous mediums. Successful development and improvement of polysaccharide-based materials will effectively help users to enhance their quality of personal health, decrease cost, and eventually increase the quality of life with respect to sustainability.

Keywords: Polysaccharide-based material; Medical technology; Drug delivery system; Biosensor; Artificial face mask; Sustainability

Dual-Band Electrochromic Window for Energy-Efficient Glass Buildings

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Global warming has led to a significant increase in the energy consumption of heating, ventilation, and air conditioning (HVAC) systems in glass buildings, as windows play a critical role in solar heat gain and heat loss, thereby influencing the need to maintain indoor thermal comfort. The dual-band electrochromic window is a promising technology for individual control of visible light and NIR transmission through the window by applying a suitable voltage [1]. This study focused on the development of the electrochromic layer and ion storage layer, which are the main components of the window. The four operating modes of the window, including cool mode and dark mode for hot climates, and warm mode and bright mode for cold climates, demonstrate its adaptability to different climates. The cool mode reduced the transmittance of NIR (at 1000 nm) to 27% while maintaining the visible light transmittance (at 500 nm) at 85%. The dark mode suppressed the transmittance of visible light and NIR to 0.6% and 0.04%, respectively. In contrast, the warm mode permitted 75% transmittance of NIR while reducing the visible light transmittance to 47%. The bright mode exhibited transmittance of 88% and 82% for visible light and NIR, respectively. The electrochromic layer exhibits high coloration efficiency, defined as the change in optical density per unit charge consumed, with values of 290 and 414 cm^2/C in the cool and dark mode, respectively [2]. Therefore, the dual-band electrochromic window represents an innovative approach to enhancing energy efficiency in glass buildings while simultaneously reducing CO_2 emissions associated with electricity generation.

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Solution Plasma-Derived Carbon Materials for Energy Applications

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Solution plasma has emerged as a powerful and innovative method for producing carbon materials with tailored nanostructures and surface functionalities. Unlike conventional high-temperature synthesis, solution plasma enables the direct conversion of precursors into nanoporous carbons through carbonization and polymerization processes. The resulting materials exhibit unique features, such as tunable porosity, high surface area, abundant defect sites, and heteroatom doping, all of which are highly beneficial for energy applications. This talk highlights recent progress in applying solution plasma-derived carbon materials to three key areas of energy applications. First, in fuel cells, the engineered carbons through heteroatoms and transition metal doping exhibited efficient and durable electrocatalysts for the oxygen reduction reaction. Second, for supercapacitors, the hierarchical pore structure and surface functionalities of carbons can be tailored by thermal treatment to facilitate ion transport and optimize the charge storage mechanism. Finally, in mesoscopic perovskite solar cells, carbon was utilized as the top electrode. Its intrinsic mesoporous structure allows the penetration of the perovskite precursor solution, enabling efficient perovskite infiltration and robust electrode–absorber contact, and improved device performance. Overall, solution plasma offers a versatile platform for designing multifunctional carbon materials. Its compatibility with diverse precursors and its ability to tailor structural and chemical properties make it an attractive route toward advancing next-generation fuel cells, supercapacitors, and perovskite solar cells.

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Bifunctional ZnO/Activated Hydrochar Composites from Mangosteen Peel: A Sustainable Approach for Dye Removal

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The dual goals of managing agricultural waste and controlling water pollution are central to sustainable development. This study transformed mangosteen peel into activated hydrochar (AHC) and integrated with zinc oxide nanoparticles (ZnO-NPs) to form bifunctional ZnO-NPs/AHC nanocomposites via a solution plasma process (SPP). The effects of varying precursor loadings on structure and performance were explored. XRD, FTIR, Raman, and FESEM characterizations confirmed the successful incorporation of ZnO-NPs and structural alteration of the AHC. The ZnO-NPs/AHC composites exhibited increased surface area, porosity, and photocatalytic activity, enabling efficient methylene blue (MB) removal through combined photocatalysis and adsorption. The optimal sample (ZnO-NPs/AHC-1.0) achieved complete MB degradation within 20 min under sunlight and 45 min under visible light without UV assistance. High recyclability and structural changes during reuse were observed. These results highlight the potential of ZnO-NPs/AHC as low-cost, solar-activated materials for fast and sustainable wastewater treatment.

Oral Presentation Abstracts

O1-GCM-01

Aptamer-Based Electrochemical Platform Utilizing the Size-Exclusion Effect of an Agarose Hydrogel Electrode for Simultaneous Detection of *E. coli* and Interleukin-6

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Sepsis is a life-threatening condition commonly encountered in hospitals and can rapidly progress to severe stages if not diagnosed and treated promptly. Current diagnostic approaches, including hemoculture and blood lactate analysis, are slow, often requiring 2–3 days, which can delay treatment and increase mortality risk. To overcome this limitation, we developed a rapid electrochemical biosensing platform for the simultaneous detection of Escherichia coli, a frequent bacterial pathogen, and interleukin-6 (IL-6), an early immune biomarker of sepsis. The sensing system employs aptamers labeled with methylene blue (MB) and ferrocene (Fc) as redox reporters, immobilized on a supporting substrate. Signal amplification is achieved through DNase I-assisted cleavage: upon target binding in a microcentrifuge tube, the aptamer detaches and is digested at its phosphodiester backbone [1], releasing the target for further binding cycles while liberating redox tags. The resulting mixture is transferred onto an agarose gel-based electrode, whose nanoporous network permits diffusion of the released redox molecules while excluding large interfering biomolecules [2]. As the target concentration increases, more redox labels reach the electrode surface, generating a proportional current response in a signal-on mode. The functionalization of sensing components and proof of operation were validated by cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS). These findings highlight the potential of this platform as a rapid and practical tool for sepsis screening.

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O1-GCM-02

Lead-Free Perovskite/Metal Oxides Heterojunction Photocatalyst for Sustainable Toluene Oxidation

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The sustainable synthesis of value-added chemicals such as benzaldehyde and benzyl alcohol from organic pollutants like toluene represents an important research direction [1]. Lead-free halide perovskites, with their attractive photoelectric properties, have emerged as promising photocatalysts [2,3]. However, their efficiency is often limited by rapid charge recombination and insufficient charge separation [4]. In this work, we demonstrate a straightforward anti-solvent strategy to construct heterojunctions of the lead-free perovskite $Cs_2AgBiBr_6$ (CABB) with Cu_2O and Cu-Cu_2O. The resulting composites enhance C(sp^3)-H bond activation, thereby improving the photocatalytic oxidation of toluene. The CABB/Cu_2O and CABB/Cu-Cu_2O heterojunctions operate via a Z-scheme charge transfer pathway, which significantly boosts photocatalytic performance. Under optimal conditions, benzaldehyde production reached 1576 μmol g^{-1} h^{-1} and 2034 μmol g^{-1} h^{-1} for CABB/Cu_2O (4:1) and CABB/Cu-Cu_2O (4:1), respectively, compared to 1212 μmol g^{-1} h^{-1} for pristine CABB. Moreover, while pure CABB showed 53% benzaldehyde selectivity, the composites achieved ≥99% and 75%, respectively. These results highlight the potential of lead-free perovskite heterojunctions for advancing photocatalytic C-H bond activation and selective oxidation.

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O1-GCM-03

Bimetallic NiCu Catalysts Supported on Rice Husk-Derived Silica for Efficient Hydrogen Production via Methane Steam Reforming

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Rice husk-derived silica (RH-silica) was investigated as a renewable support for Ni, Cu, and Ni–Cu catalysts in methane steam reforming for hydrogen production. RH-silica, prepared by acid leaching and calcination, exhibited high purity and mesoporosity suitable for metal anchoring. The 10%Ni/SiO_2, 10%Cu/SiO_2, and 5%Ni–5%Cu/SiO_2 catalysts were synthesized via incipient wetness impregnation and characterized using XRF, FTIR, XRD, SEM/EDS, and BET analyses. The 10%Ni/SiO_2 catalyst showed the highest activity, with 81.4% CH_4 conversion and 70.7% H_2 yield, attributed to uniform Ni dispersion with high density of active sites, though moderate coke formation (2.15%) occurred[1]. The bimetallic 5%Ni–5%Cu/SiO_2 catalyst achieved comparable activity (80.3% CH_4 conversion, 69.1% H_2 yield) but with significantly reduced carbon deposition (1.39%), indicating the stabilizing synergy between Ni and Cu[2]. In contrast, 10%Cu/SiO_2 catalyst showed limited performance due to particle agglomeration. These results demonstrate that RH-silica is an effective, low-cost support and that Ni–Cu systems offer a balance of activity and stability, suggesting their potential for sustainable hydrogen production and agricultural waste valorization.

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O1-GCM-04

Electrically Controlled Transdermal Release of Insulin from PEDOT:PSS/SF Hydrogel for Diabetes Mellitus Basal Treatment

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Silk fibroin (SF) was utilized here as the material to fabricate the physically crosslinked hydrogels. Poly(3,4-ethylenedioxythiophene): polystyrene sulfonate (PEDOT:PSS) was synthesized and characterized as the drug carrier, with insulin as the model drug. PEDOT:PSS, with the high electrical conductivity of 1666 ± 49 Scm^{-1}, interacted with the insulin molecules via the electrostatic interaction by replacing the dopant PSS molecules. Insulin loaded PEDOT:PSS embedded in the SF hydrogel resulted in the increases of the SF hydrogel degree of swelling, pore sizes, and mesh sizes. In the vitro release and release-permeation experiments, the amounts of insulin release and release-permeation were investigated by a modified Franz diffusion cell, under the effects of SF concentrations, electric fields, and pHs. The amounts of insulin release and release-permeation from the pristine SF hydrogels and the PEDOT:PSS/SF hydrogels followed the power laws with the scaling exponents close to 0.5, indicating the Fickian diffusion or the concentration gradient. Under electric fields, with or without PEDOT:PSS used as the drug carrier, the insulin amount and diffusion coefficient were shown to increase with increasing electric field, due to the electro-repulsive forces between the cathode and the insulin molecules and SF chains, the electroosmosis, and the SF matrix swelling. The SF hydrogel and PEDOT:PSS as the drug carrier were demonstrated here as the new components in the transdermal delivery system for the iontophoretically controlled insulin basal release applicable to diabetes patients.

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O1-GCM-05

Chemical Conversion of PET Wastes with Alcohol by Transesterification by $FeCl_3$–amine Catalyst

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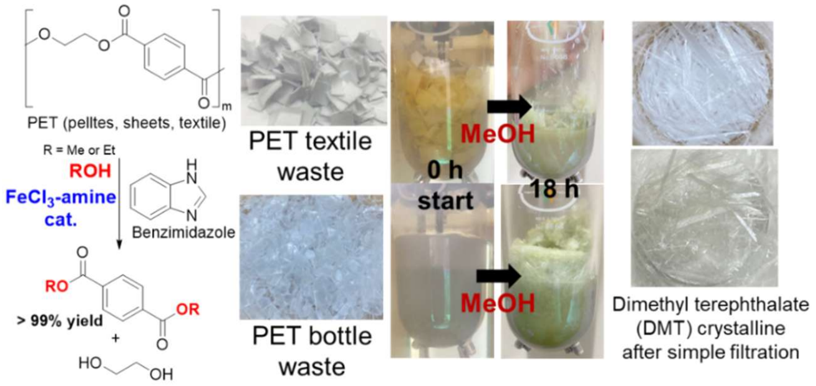
Poly(ethylene terephthalate) (PET) is a commodity thermoplastic used as drink bottles, textiles etc. Chemical recycling is a key strategy for addressing plastic waste. Conventional methods, transesterification with ethylene glycol or methanol generally conducted under harsh (high temperature, pressure) conditions in the presence of excess inorganic/organic bases or acids, and additives. We recently reported on acid-, base-free depolymerization (transesterification) with alcohols catalyzed by Cp'$TiCl_3$ [Cp' = C_5H_5 (Cp), C_5Me_5],[1] CaO,[2] or by $FeCl_3$.[3] The reactions exclusively afforded corresponding diesters and diols (>99 % conversion, selectivity). We herein demonstrated quantitative chemical conversion (>99 %) of PET wastes (bottles, pellets, and textile samples) through transesterification with alcohol using a $FeCl_3$–amine catalyst system to afford corresponding terephthalic acid diesters.[4] The addition of small amounts of amine, particularly benzimidazole (1.0–3.0 equiv), enhanced the catalyst efficiency without diminishing its exclusive selectivity. Moreover, the scale-up reactions (20.0–30.0 g of PET wastes) with methanol afforded dimethyl terephthalate (DMT) as white crystalline materials, without formation of any other by-products (Scheme shown below).[4]



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O1-GCM-06

Valorizing Agricultural Residues Into Biodegradable Mulch Films for Circular Farming System

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Agricultural intensification has generated mounting amounts of residue waste, while the widespread use of traditional polyethylene mulch films aggravates soil degradation, greenhouse gas emissions, and plastic pollution[1,2]. Harnessing agricultural residues to produce biodegradable mulch films supports a circular farming paradigm. In this study, cellulose was extracted from rice husk and banana pseudostem via alkaline treatment and bleaching; films were fabricated by solution casting with glycerol as plasticizer. Composite bioplastic mulch films were produced at blend ratios of 75:25, 50:50, and 25:75 (rice husk : banana pseudostem). Mechanical testing demonstrated clear differences in tensile strength and elongation at break across the blend ratios, reflecting the influence of composition on structural integrity and flexibility. Under soil burial conditions, short-term observations revealed microbial colonization, surface cracking, and weight loss. The films continued to degrade steadily over time, aligning with reported biodegradation behavior of cellulose-based films[3]. Among the tested formulations, higher rice husk content was associated with stronger tensile properties and slower degradation, while higher banana pseudostem content enhanced flexibility and accelerated biodegradability. These findings highlight that tuning blend ratios enables balancing strength and biodegradability. By valorizing agricultural residues into biodegradable films, this research contributes to reducing agricultural plastic waste, improving soil health, and advancing circular farming practices [1,4].

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O1-GCM-07

Green Synthesis of Tannin-Derived Nanomaterials from *Carica papaya* Leaves for Electrochemical Applications in Bio-Batteries

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The depletion of fossil fuels and the harmful effects of emissions have accelerated the search for renewable energy sources and sustainable materials for battery production[1]. *Carica papaya* leaves, which are rich in tannins, potassium, and cellulose, present a promising eco-friendly material for green synthesis[2]. This study investigates the electrochemical behavior of tannins from papaya leaves and their application in bio-batteries as a sustainable energy source for small devices. Papaya leaves were collected, sun-dried to reduce moisture, and ground into a fine powder before undergoing carbonization to enhance electrochemical properties. The powder was then infused into an alkaline medium for tannin extraction[3], and the extract was employed as the electrolyte in a bio-battery prototype. Voltage output was measured with a multimeter over 30 minutes across three independent trials. The bio-batteries generated initial voltages between 0.8 V and 1.1 V, followed by a gradual decline due to electrochemical depletion, stabilizing between 0.3 V and 0.6 V. Average voltage decreased from 0.77 V to 0.6 V across trials. Despite this decline, the reproducibility confirmed the electrochemical activity of papaya leaf tannins, supporting their viability as a sustainable bio-electrolyte for low-power applications[4]. These findings demonstrate that papaya leaves can be utilized as a bio-battery material. By harnessing their electrochemical properties, this approach reduces environmental impact, minimizes electronic waste, and fosters eco-friendly technologies, while further research is needed to enhance efficiency and scalability for broader applications.

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O3-GCM-08

Up-cycling of Waste PET Based on Ionic Liquid Catalysts

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Polyethylene terephthalate (PET), after single-use applications, becomes waste that is difficult to degrade naturally and is generated in large quantities, posing serious pollution and threats to the environment and human health. Our research group has developed dozens of ionic liquids and deep eutectic solvent (DES) catalysts [1], identifying highly efficient DES-based catalytic systems and elucidating the depolymerization mechanisms of waste PET. We have made breakthroughs in several key scientific and technological challenges, including the large-scale production of PET depolymerization catalysts, separation and purification of the depolymerized monomer BHET [2], repolymerization of BHET, operation of a pilot-scale (kiloton-level) depolymerization facility, and construction of a continuous PET recycling process [3]. These efforts have successfully led to the industrial application of our research outcomes. This presentation will highlight the group's long-term progress and achievements in the high-value utilization of plastic waste, particularly waste PET, and provide a platform for international exchange to foster future cooperation and technology transfer.

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O3-GCM-09

Catalytic Cracking of Crude Oil into Light Olefins/Aromatics

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Driven by the "carbon peak and carbon neutrality" targets, the petroleum industry is facing the challenge of transformation and upgrading. Production of chemicals (*e.g.*, light olefins and aromatics) from crude oil, instead of fuel oil, is the developing tendency in petroleum industry. Compared to steam cracking, catalytic cracking of petroleum components into chemicals exhibits the advantages of relatively mild conditions, adjustable product distribution, adaptable to a variety of raw materials, etc. Development of efficient catalyst is one of the keys for the conversion of crude oil into chemicals.

In this study, the acidity of zeolite was regulated by plasma activation, isomorphous substitution, etc. The regulation law of zeolite acidity was clarified. Besides, zeolites containing micro- and mesopores were fabricated by mixing zeolite with different pores, by introducing ionic liquid with long alkyl chains as the template, and by synthesizing nanosheet zeolites. The hierarchical zeolite exhibited excellent shape selectivity for the target product and good diffusion property for large reactant molecules. To further enhance the product selectivity and suppress proceeding of side reactions, basic sites, with no activity for hydrogen transfer and good anti-coking capability, were introduced into zeolite to fabricate catalysts containing both acid and base sites. The method for catalyst molding was also developed, and the obtained catalyst exhibited good mechanical property. The catalytic performance of the synthesized catalysts in cracking of crude oil was evaluated on a 100-ton pilot plant. Using paraffinic crude oil as the raw material, the C2-C4 olefins yield could reach 50.2%, and yield of BTX (benzene, toluene, xylene) was 12.9%.

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O2-GRE-01

Single-Step Synthesis of Propylene Oxide from Propane in Dielectric Barrier Discharge Reactor: Impacts of Propane Separate Feed

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The single-step epoxidation of propane (C_3H_8) to synthesize propylene oxide (PO), which has never been done before, was explored in a dielectric barrier discharge (DBD) system with two glass plates and a discrete feed of C_3H_8. In experiments of a mixed gas feed (C_3H_8:O_2 = 1:1) with He as a third gas, the highest PO selectivity of 46% was observed at 7 kV, 550 Hz, and a total feed gas flow rate of 75 cm^3/min (equivalent to a retention time (RT) of 12.1 s). Under the optimal circumstances of a C_3H_8 feed position fraction of 0.75 and a total reactant flow rate of 75 cm^3/min, relating to O_2 RT of 12.1 s, the maximum PO selectivity for 46.0% was achieved with the very lowest selectivities for other products and the nonappearance of both CO_2 and CO. The DBD with two frosted gas sheets provided uniform low electric discharge with low temperatures, and the separate feed of C_3H_8 also played a crucial role in minimizing undesired products such as cracking, dehydrogenation, coupling, and oxidative reactions of C_3H_8, leading to the highest PO selectivity.

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O3-GRE-02

Ionic Liquid-Enhanced Lignin Degradation

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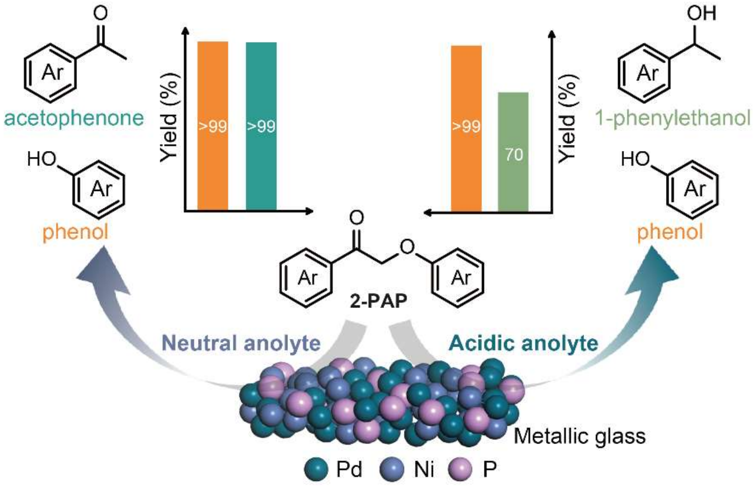
As the most abundant aromatic polymer in nature, lignin represents a promising resource for addressing the energy crisis and environmental challenges through high-value conversion. It is therefore essential to develop efficient and green methods for lignin degradation. Electrocatalytic technology has attracted growing interest due to its controllable reaction conditions and environmental benefits. The design of catalysts plays a central role in achieving effective electrocatalytic depolymerization of lignin[1]. In this study, we designed and synthesized a series of multimetallic catalysts with both crystalline and amorphous structures. Coupled with an ionic liquid electrolyte, the PdNiBi/PdNiP-EmimBF$_4$ electrocatalytic system achieved complete substrate conversion and high product yields (>90%). By fine-tuning the electrolyte pH, we were able to selectively shift the product distribution from acetophenone (>99% selectivity) to 1-phenylethanol (>99% selectivity), while successfully suppressing overhydrogenation. The PdNiP amorphous catalyst exhibited remarkable stability and activity, maintaining full recyclability for over 100 consecutive cycles in the ionic liquid electrolyte, which itself could also be recovered and reused without signs of decomposition. In the electroreduction of birch lignin, a monomer yield of 9 wt% was obtained. Our findings highlight a clear relationship between catalyst structure and product selectivity: crystalline catalysts primarily facilitate C–O bond cleavage[2], whereas amorphous catalysts not only cleave C–O bonds but also promote further hydrogenation and valorization of the products without loss of aromaticity[3]. This work offers new insights into the design of efficient catalysts for lignin depolymerization and lays a solid foundation for its high-value utilization.



Scheme 1. PdNiP-EmimBF$_4$ electrocatalytic system for lignin degradation

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O2-GSP-01

Feasibility Study of Pilot Scale Synthesis of Iso-amyl Acetate Using Reactive Distillation Technique

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The valorization of fusel oil—a low-value by-product of bioethanol production—presents a promising approach toward sustainable chemical manufacturing. This study explores the production of isoamyl acetate, a high-value ester widely utilized in the food, fragrance, and solvent industries, by integrating experimental screening, pilot-scale processing, and rigorous simulation methodologies. Among the tested heterogeneous acid catalysts, Amberlyst-15E exhibited the highest catalytic activity and demonstrated favorable economic performance. Parametric studies identified the optimal operating conditions to be a reaction temperature of 70–80 °C, 10 wt% catalyst loading, and a 1:2 molar ratio of isoamyl alcohol to acetic acid.

These optimized parameters were successfully implemented in a pilot-scale reactive distillation (RD) process, achieving conversion rates exceeding 90% and product purities of approximately 95%. Compared to conventional batch esterification followed by distillation, the integrated RD process reduced overall energy consumption by nearly 30%. Techno-economic evaluation revealed isoamyl acetate production at a rate of ~44.3 kg/h, with ~33.5 kg/h of unreacted isoamyl alcohol recovered, minimal wastewater generation (~6.1 kg/h), and effective acetic acid recycling. The findings validate the technical feasibility, economic viability, and environmental benefits of valorizing fusel oil via process intensification, contributing to the advancement of circular bioeconomy principles.

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O2-NEM-01

Advancing Organic and Perovskite Photovoltaic through Material Innovation

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The performance ceiling of organic and perovskite photovoltaic devices is intrinsically linked to the properties of their constituent materials[1]. This work elucidates how deliberate molecular engineering of organic materials serves as the fundamental driving force behind recent progress in these fields. We will demonstrate this through case studies, including the synthesis of novel additives and hole/electronic-transport materials that enhance the efficiency and stability of perovskite solar cells (PSCs), and the development of multifunctional interfacial ligands that suppress ion migration and non-radiative recombination[2,3]. Concurrently, innovations in narrow-bandgap non-fullerene acceptors (NFAs) have revolutionized the efficiency of organic photovoltaics (OPVs) [4]. These material-centric advancements directly translate to superior device metrics, including stability, efficiency, and reproducibility. Our work confirms that continuous material innovation is the essential prerequisite for transforming the theoretical potential of organic and perovskite semiconductors into practical, high-performance technologies.

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O2-NEM-02

Development of Multilayer TiO_2–PEGS/SiO_2–PEGL Coatings for Solar Cell Antireflection Applications

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The global transition to renewable energy highlights solar power as a leading solution to meet growing energy needs. However, the performance of photovoltaic (PV) panels is often reduced by surface soiling, particularly from bird droppings, which block light transmission and decrease energy conversion efficiency [1]. To address this challenge, we developed an anti-reflective, self-cleaning multilayer coating using a dip-coating sol–gel technique with low-temperature curing at 100 °C, ensuring compatibility with PV glass substrates. The multilayer structure integrates TiO_2 modified with polyethylene glycol 400 (PEGS) in the base double layers and SiO_2 modified with polyethylene glycol 4000 (PEGL) in the top double layers, combining photocatalytic, optical, and surface functionalities. Spectrophotometric analysis revealed that the TiO_2–PEGS/SiO_2–PEGL configuration achieved the average highest transmittance (89.7%) within the 500–1000 nm wavelength range, which is critical for silicon solar cells. Contact angle measurements confirmed super-hydrophilicity with values below 10°, enabling rapid water spreading, efficient removal of bird droppings, and additional anti-fogging functionality [2,3]. This combination not only facilitates rapid water spreading and effective removal of bird droppings but also provides strong anti-fogging functionality. By integrating photocatalytic activity, transparency, and durable surface wettability, the proposed multilayer coating effectively improves light harvesting, reduces maintenance, and offers a scalable pathway to sustained PV performance.

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O2-CNS-01

Sustainable Self-Calibrating Electrochemical Biosensor for Multiplex Detection of Kidney Injury Biomarkers

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We present a sustainable electrochemical biosensing platform with built-in calibration for multiplex detection of early kidney injury biomarkers. The device employs a dual working electrode design, each patterned with two heads. The first electrode (WE1) serves as a blank reference for self-calibration [1], while the second electrode (WE2) contains aptamer- and antibody-modified zones for simultaneous detection of Cystatin C and TIMP-2. Environmentally friendly redox reporters, ferrocene and thionine, are pre-deposited beneath each zone, enabling orthogonal, label-free readouts via square wave voltammetry. The calibration signal from WE1 is directly integrated into the sensing protocol of WE2, correcting for environmental and operational fluctuations and improving data reliability. A capillary-driven microfluidic [2] layer supports passive sample loading and washing without external pumps, reducing energy demand, reagent use, and waste generation. This compact dual-electrode strategy integrates multiplex detection, built-in calibration, and sustainable fluid handling into a single platform. By reducing resources while ensuring reliable performance, the biosensor exemplifies green analytical chemistry and aligns with carbon neutrality goals [3]. It offers a promising tool for environmentally responsible, point-of-care diagnostics and preventive healthcare.

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O2-CNS-02

A Novel DNA-Based Lateral Flow Assay for Rapid and Early Detection of *Treponema pallidum*

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Syphilis, caused by the bacterium *Treponema pallidum* (*T. pallidum*), remains a major global public health issue with rising incidence in many regions [1]. Timely diagnosis, particularly during the early or acute phase of infection, is crucial for effective treatment. This helps prevent severe long-term complications like neurosyphilis and cardiovascular syphilis while also reducing disease transmission for more effective control. However, most rapid diagnostic tests rely on host antibody detection [2], which often leads to delayed or missed diagnoses because antibodies are typically absent in the initial stages of infection. To address this limitation, the first nucleic acid-based lateral flow assay (LFA) for the direct and early detection of *T. pallidum* DNA has been developed. The assay employed a sandwich hybridization format, utilizing a capture probe and a signaling probe that specifically recognize a conserved region of the *T. pallidum* DNA. Additionally, the streptavidin-biotin system was strategically applied to ensure high-affinity and high-efficiency capture of the biotinylated probe, resulting in a more robust and sensitive detection platform [3]. The developed platform demonstrated high specificity, showing no cross-reactivity with closely related non-target organisms. Its strong potential for detecting syphilis in the acute phase makes it a valuable point-of-care tool for screening high-risk populations. This novel DNA-based LFA not only provides a rapid and effective diagnostic tool but also promotes sustainability by minimizing the need for energy-intensive laboratory equipment. It represents a substantial advancement in syphilis diagnostics and offers a promising approach to more sustainable public health strategies for effectively controlling the disease.

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O2-CNS-03

Ammonia Recovery from Wastewater via Electrochemical Process: A Parametric Study on Membrane Pretreatment and Electrochemical Optimization

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Efficient ammonia recovery from wastewater is essential for both environmental protection and resource recovery. This study investigates the combined effects of membrane pretreatment, applied voltage, and catholyte conductivity on the performance of electrochemical process using Nafion 117 cation-exchange membranes. A laboratory-scale H-cell system was used to evaluate ammonia recovery efficiency under various operational conditions. Membrane pretreatment procedures included sequential oxidative cleaning and acidic treatment, with and without subsequent immersion in aqueous ammonia. The results revealed that ammonium preconditioning significantly enhanced Ammonia Nitrogen (NH_3–N) recovery in the catholyte. The applied voltage was varied between 4 and 7 V, with maximum energy-normalized recovery observed at 6 V. Increasing voltage beyond this point led to diminishing returns due to electrochemical side effects and gas evolution. Additionally, the effect of sodium sulfate (Na_2SO_4) concentration in the catholyte was evaluated in the range of 0 to 0.35 M. It was found that NH_3–N recovery was insensitive to conductivity increases beyond 0.125 M. These findings provide practical insights into optimizing electrochemical system for ammonia recovery by balancing membrane conditioning, voltage application, and electrolyte composition.

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Poster Presentation Abstracts

P-GCM-01

Electrocatalytic Upcycling of Waste PBAT into High-Value Products PBS

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Poly(butylene adipate-co-terephthalate) (PBAT), a biodegradable plastic known for its excellent ductility, heat resistance, and impact strength, is widely used in agricultural and packaging applications[1]. However, the escalating production of PBAT has resulted in significant environmental pollution and resource wastage[2]. In this study, we developed a high-performance nickel-based catalyst and utilized an electrochemical method to efficiently convert waste PBAT into high-value succinic acid (SA). The 1,4-butanediol (1,4-BDO) derived from its hydrolysis products was then thermally polymerized into the more valuable plastic polybutylene succinate (PBS). This work pioneers a hybrid thermoelectric strategy for upcycling waste PBAT into PBS, presenting a novel approach for the valorization of discarded plastics.

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P-GCM-02

New Technology for Synthesis of Carbonate from CO_2 and Low-carbon Alcohols

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The conversion of CO_2 into high-value chemicals is not only a pivotal national strategy but also an international research priority. Carbonate is an essential electrolyte solvent and a key material for new energy storage batteries. It is of particular significance to develop a new technology for the synthesis of carbonate from CO_2 and low-carbon alcohols[1,2]. However, this reaction faces challenges such as thermodynamic limitations, low conversion efficiency, and severe reaction conditions. To address these issues, this study introduces a novel catalytic strategy that creates new active sites to facilitate efficient activation of CO_2 and alcohol substrates. By incorporating a proton abstractor, the reaction pathway was innovated, resulting in reduced activation energy and suppression of reverse reactions. Furthermore, ionic liquids were employed to modulate catalyst surface groups, enhance substrate adsorption, and introduce basic sites for alcohol hydroxyl activation, collectively improving catalytic performance. Additionally, tailored crystal structures and oxygen vacancy concentrations in the catalyst promoted CO_2 activation. It was found that catalysts predominantly exposing the (1 1 0) facet exhibited superior performance toward carbonate formation. Under mild conditions (100 °C, 0.5 MPa, 1 h), the proposed catalytic system achieved over 90% conversion of ethylene glycol with >99% selectivity toward ethylene carbonate[3,4]. This work also completes the conceptual process design, establishing a foundation for future industrial application of this promising technology.

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P-GCM-03

Functions of Surface Brønsted and Lewis Acidic Sites in the Catalytic Transfer Hydrogenation of Methyl Levulinate with 2-Propanol

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γ-Valerolactone (GVL) is a potential fuel and green solvent. In contrast to the case of hydrogenating methyl levulinate (ML) to GVL on metal catalysts with molecular hydrogen, many acid-base catalysts can catalyze the hydrogenation reaction with 2-propanol (2-PO) through catalytic transfer hydrogenation (CTH) process. As analogs to homogeneous catalysts, heterogeneous Lewis acids catalyze the reaction via the similar six-membered-ring transition state, in which both carbonyl group and alcohol are bonded to the Lewis acidic sites (LAS).[1] However, the functions of Brønsted acidic sites (BAS) on the reaction has long remained an issue of debate.[2] In order to identify the roles of BAS, lutidine (a specific poison for BAS) and pyridine (a non-specific poison for LAS and BAS) were added, respectively, to the reaction mixture for investigating possible effects of their poisoning of the acidic sites on γ-Al_2O_3 (Lewis acidic) and SiO_2-Al_2O_3 (both Brønsted and Lewis acidic). The GVL formation rates (FR) over γ-Al_2O_3 and SiO_2-Al_2O_3 are not affected by lutidine but by pyridine during the runs, which indicate that the presence of BAS has no effect on CTH reaction, and LAS are the catalytic sites for the CTH reaction. Isopropyl levulinate (IPL) is formed through interesterification (TE) reaction of ML and 2-PO over SiO_2-Al_2O_3. The addition of lutidine produced a remarkable decrease on the FR of IPL. The adsorption of lutidine on surface BAS was stronger than pyridine, relative insensitivity of the FR of IPL to pyridine is observed. These results clearly confirm that BAS have nothing to do with the CTH reactions but are responsible for catalyzing the TE reaction.

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P-GCM-04

Development of Particulate Air Filtration Media with Antimicrobial Property

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Air pollution caused by fine particulate matter (PM2.5) in Thailand is projected to worsen in the coming years, raising serious concerns about its long-term impact on public respiratory health. Effective air filtration technologies are, therefore, increasingly vital for reducing exposure to hazardous particles. In response to this challenge, the researchers, in collaboration with the industrial partner CRM International Co., Ltd., recognized the need to develop advanced filtration media specifically designed to capture fine dust particles while offering additional functional benefits.

The present study focuses on the development of a PM2.5/HEPA 13 filter membrane with enhanced antibacterial property. The fabrication process incorporates polyvinyl alcohol (PVA) electrospun nanofibers with conventional non-woven filter media, followed by antibacterial functionalization. PVA was selected as the base polymer due to its non-toxic and biodegradable properties, which make it suitable for environmentally sustainable applications.

Performance evaluation of the fabricated filter demonstrated a particulate filtration efficiency (PFE) exceeding 95% for PM2.5 particles. In addition to its high filtration efficiency, the developed membrane also demonstrated antibacterial functionality. These findings highlight the potential of PVA-based electrospun nanofiber filters for next-generation air purification systems capable of mitigating both particulate pollution and microbial contamination.

P-GCM-05

Modification of Biochar and Its Application in Acetin Synthesis from Glycerol

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Biochar is a carbon-rich solid material produced through the pyrolysis of organic biomass in oxygen-limited conditions and functions as a promising catalyst support for the acetylation of glycerol with acetic acid. This study focuses on three types of biochar: bamboo, cassava, and coconut shell. Sulfonic acid-functionalized biochar was prepared to introduce acidic functionalities onto its surface, which is expected to exhibit enhanced catalytic performance in acetylation reactions. The functionalized catalysts were comprehensively characterized using various analytical techniques, including N_2 adsorption-desorption isotherms, X-ray powder diffraction (XRD), scanning electron microscopy (SEM), and elemental analysis (CHN/S). The SO_3-functionalized cassava biochar exhibited a surface area of 28.2 m^2/g and an acidity of 2.41 mmol/g. Under optimal reaction conditions—catalyst loading of 0.5 g (5 wt% of glycerol), a molar ratio of 1:9 (glycerol:acetic acid), a reaction temperature of 115°C, and reaction times of 2, 4, 6, and 8 hours—the catalytic performance was systematically evaluated. After 8 hours, the SO_3-functionalized cassava biochar demonstrated exceptional catalytic performance in the acetylation of glycerol with acetic acid, achieving complete glycerol conversion (100%) and triacetin selectivity of 39.3%. This performance was comparable to that of commercial activated carbon, with a surface area of 1370 m^2/g and an acidity of 1.35 mmol/g, which achieved complete glycerol conversion (100%) but with a lower triacetin selectivity of 35.9%.

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P-GCM-06

Effect of Manganese Oxide Morphologies on Alumina-Supported Catalysts on Water-assisted Ketonization of FAME for Biowax Production

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Palm oil's use in biodiesel is increasingly challenged by the automotive industry's shift from petrol-based engines to electric vehicles. This transition potentially diminishes the economic value of biodiesel, making strategies for converting it into higher-value products such as biowax is needed [1]. Ketonization of biodiesel represents a promising pathway that offers straightforward conversion of fatty acid methyl esters (FAME) into fatty ketones, which can serve as precursors for biowax production. Among metal oxide catalysts, MnOx has demonstrated better performance for methyl palmitate ketonization [2]. However, optimization through the addition of □-Al2O3 is required to enable the hydrolysis-ketonization reaction [3] [4]. In this study, the ketonization of methyl palmitate, fatty acid mixtures, and pure biodiesel (B100) were evaluated using MnOx catalysts with different morphologies (nanorod, nanotube, nanowire, nanoflower) supported on □-Al2O3 and compared with commercial MnOx. All catalysts were prepared via hydrothermal and dip-coating techniques and characterized using X-ray diffraction (XRD), field emission scanning electron microscopy (FESEM), surface area analysis (BET), temperature-programmed reduction (H_2-TPR), high-resolution transmission electron microscopy (HRTEM), and X-ray photoelectron spectroscopy (XPS). Catalytic activity tests were performed in a continuous-flow fixed-bed reactor at 380 °C and 1 atm for 8 hours on stream. The results demonstrated that various morphologies exhibit different catalytic performances for ketonization across all substrates.

The findings also indicated that not only does surface area play a significant role in determining catalytic performance, but oxygen vacancies and the degree of saturation of substrates are equally important factors.

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P-GCM-07

Fe-Modified Pineapple Leaf Biochar for Efficient H_2S Removal: Adsorption Performance and Mechanistic Insights

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Thailand generates large amounts of agricultural residues, particularly pineapple leaves (PAL), which are often underutilized. In this study, pineapple leaf–derived biochar (PALC) was developed as an efficient hydrogen sulfide (H_2S) adsorbent via $FeCl_3$ pretreatment and pyrolysis under oxygen-free conditions at 400–800 °C, with PAL-to-Fe mass ratios of 0.5–3. The adsorption performance was governed by pore structure and iron species, both influenced by pyrolysis temperature and Fe loading. The optimal material, 2Fe/PALC600, dominated by Fe_3O_4, achieved the highest adsorption capacity of 380.1 ± 3.4 mg H_2S g^{-1} under humid conditions. While humidity enhanced H_2S removal, the presence of 40 vol% CO_2 significantly suppressed performance due to competitive surface physisorption. XPS analysis revealed transformations of Fe species on the biochar surface before and after H_2S exposure, and density functional theory (DFT) calculations provided further insights into the adsorption mechanism. Moreover, 2Fe/PALC600 exhibited excellent reusability, retaining over 91% of its initial capacity after five adsorption–desorption cycles. These findings highlight the strong potential of Fe-modified PAL-derived biochar as a sustainable and cost-effective material for gas purification, while also valorizing agricultural waste.

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P-GCM-08

Banana Pseudostem Cellulose-Based Mulch Films for Sustainable Plant Growth

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The growing environmental impact of petroleum-based mulch films, including soil contamination and plastic accumulation, underscores the need for sustainable agricultural alternatives[4]. Banana pseudostem, an abundant agricultural byproduct rich in cellulose, offers a renewable source for producing biodegradable mulch films that can promote plant growth while reducing waste[1,2]. In this study, cellulose was extracted from 100% banana pseudostem using alkaline treatment and bleaching, and films were fabricated through solution casting with glycerol as plasticizer[1,3]. These biodegradable films were evaluated for their influence on plant growth parameters, including plant height, number of leaves, and root development, under controlled soil conditions. Over the cultivation period, plants grown with banana pseudostem cellulose mulch films demonstrated improved growth performance compared to the unmulched control group. Soil analysis indicated slight increases in nitrogen and potassium levels, suggesting nutrient enrichment as the film decomposed. The mulch films also showed visible signs of biodegradation, such as surface cracking and microbial colonization, confirming their potential for complete breakdown under natural conditions[3,4]. Overall, the use of banana pseudostem-derived mulch films supports sustainable crop cultivation by integrating waste valorization, soil enrichment, and circular farming principles[2]. This study highlights banana pseudostem cellulose as a viable and eco-friendly material for biodegradable agricultural applications, advancing the shift toward greener farming practices.

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P-GCM-09

Development of Biodegradable Seed Sheets from Rice Husk and Banana Pseudostem

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The disposal of non-biodegradable plastic seedling trays and pots poses a major environmental concern in modern agriculture. To address this, biodegradable seed-planting sheets were developed using a 50:50 cellulose blend of rice husk and banana pseudostem, two abundant agricultural byproducts rich in lignocellulosic fibers[1,2]. Cellulose was extracted through alkaline treatment and bleaching, then combined with glycerol as a natural plasticizer before being cast into thin, flexible sheets suitable for seed planting. These sheets were evaluated for their influence on seed germination rate, early plant height, number of leaves, and root development compared to conventional soil-based germination. Seeds grown within the cellulose sheets exhibited higher and more uniform germination, likely due to improved water retention, oxygen permeability, and gradual release of organic nutrients as the material degraded[3]. The blended composition also supported microbial colonization, accelerating biodegradation while enriching the surrounding soil microenvironment[4]. The study demonstrates that integrating rice husk and banana pseudostem cellulose in equal proportions yields a biodegradable, nutrient-supportive, and eco-efficient planting medium, offering a sustainable alternative to single-use plastic seedling containers and promoting waste-to-resource utilization in agriculture.

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P-GCM-10

Biodegradable Rice Husk Cellulose Sheets for Enhanced Plant Growth

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Rice husk, a widely available agricultural residue rich in lignocellulosic content, represents a valuable yet underutilized resource for producing biodegradable materials[1,2]. In this study, cellulose extracted from 100% rice husk was used to fabricate mulch films through alkaline delignification, bleaching, and casting with glycerol as plasticizer[1]. The prepared films were applied as soil covers in plant growth trials to assess their influence on growth parameters such as plant height, number of leaves, and root proliferation. Results indicated that plants grown with rice husk cellulose mulch films showed notable improvements in growth performance compared to unmulched controls. These improvements were linked to better moisture conservation, moderated soil temperature, and gradual organic matter release as the films decomposed[3]. Visual and microscopic observations revealed progressive biodegradation, with microbial colonization evident after several weeks of soil exposure[4]. Additionally, slight increases in soil organic carbon and nutrient content were observed following film degradation, indicating potential soil enrichment. The findings suggest that rice husk cellulose mulch films not only promote sustainable crop production but also offer an eco-friendly pathway for agricultural waste valorization and soil health improvement.

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P-GCM-11

Dual-Layer Proton-Conducting Membrane for Controlled Hydration in PEMFC

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Proton exchange membranes (PEMs), such as Nafion, are still one of the reasons for the high cost of PEMFCs. Among the alternatives, cellulose waste from the nitrochemical industry was utilized as a renewable precursor to synthesize sulfonated cellulose (SC), which served as a proton-conducting component [1]. The SC was integrated with polytetrafluoroethylene (PTFE) to fabricate SC-PTFE composite membranes via electrospinning. Acid hydrolysis of cellulose using 48% H_2SO_4 at 50 °C for 1.5 h produced microcrystalline cellulose (MCC) with optimal particle size and a 49% yield. Subsequent oxidation and sulfonation yielded SC containing 511 μmol g^{-1} of $-SO_3^{2-}$ groups, confirming successful chemical modification [2]. The SC-PTFE membrane exhibited enhanced hydrophilicity. To control hydration behavior, one side of the membrane was coated with siloxane (D4), generating a hydrophobic layer and forming a dual-layer SC-PTFE/D4 structure. The resulting membrane demonstrated 69% water uptake, low swelling, and excellent dimensional stability. Thermogravimetric analysis (TGA) revealed decomposition temperatures between 375-580 °C, suitable for operation in PEMFCs within 160-220 °C [3]. The dual-layer membrane displayed improved proton conductivity, reduced methanol crossover, and greater thermal and mechanical stability compared with commercial Nafion membranes.

These results highlight the potential of SC-PTFE/D4 membranes as efficient, sustainable electrolytes for PEMFCs and demonstrate a viable pathway for converting industrial cellulose waste into high-performance materials supporting green energy conversion and transport-sector decarbonization.

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P-GCM-12

Bio-Based CMC/PVA Nanofiber Wound Dressings Enhanced with Liquorice Extract for Improved Antibacterial and Healing Performance

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Carboxymethyl cellulose (CMC), an anionic and water-soluble polysaccharide, has been widely explored for bio-based wound dressings due to its biocompatibility, biodegradability, and antibacterial activity [1]. However, its poor aqueous stability, leading to excessive swelling and weak mechanical strength limits its electrospinning and biomedical applications. To overcome these drawbacks, poly(vinyl alcohol) (PVA) was incorporated to enhance the spinnability and structural stability of CMC nanofibers. CMC was synthesized from microcrystalline cellulose (MCC) derived from Nata de coco food waste, providing a sustainable bacterial cellulose source. This approach promotes value-added utilization of food waste and aligns with sustainable biomedical material development. Electrospun CMC/PVA nanofibers with different weight ratios (30:70, 20:80, 10:90 wt/wt) were evaluated for antibacterial activity against *Staphylococcus aureus* and *Escherichia coli*. The 20:80 CMC:PVA membrane showed the highest inhibition zone (~1 mm) against *S. aureus*. Licorice extract (LE), possessing antioxidant and anti-inflammatory properties [2], was added at 1–3 wt% to enhance biofunctionality. The resulting LE-CMC/PVA nanofibers exhibited improved antibacterial and healing properties, demonstrating strong potential as sustainable, multifunctional wound dressings [3].

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P-GCM-13

Synthesis and Characterization of Biobased Sulfonated Cellulose (SC)-Acetate Membranes for Wastewater Treatment

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Industrial wastewater frequently contains complex mixtures of toxic dyes, heavy metals, and persistent organic pollutants that threaten both human health and ecosystems. Organic contaminants typically originate from food processing, textile, and petrochemical industries, whereas inorganic ions such as cadmium, lead, and chromium are discharged from biomedical, semiconductor, and mining sectors. Addressing the coexistence of these pollutants requires sustainable and efficient treatment technologies. To address these issue, cellulose acetate (CA) membranes were synthesized from microcrystalline cellulose (MCC) derived from industrial cellulose waste, promoting resource recovery and circularity. Then, citric acid 10 wt% (based on dry weight of CA) was incorporated as a green crosslinking agent to enhance the structural stability and antifouling resistance of the membrane [1-2], while 10, 20 and 30 wt% of poly(ethylene glycol) (PEG) was added to improve porosity and develop interconnected pore structures [3]. To further enhance heavy metal ion adsorption, MCC was chemically modified into sulfonated cellulose (SC) through oxidation and sulfonation reactions, introducing multiple negatively charged functional groups [4]. The resulting sulfonated CA/PEG composite membranes were fabricated via the phase inversion method and systematically characterized for their structural, mechanical, and permeability properties. These biobased membranes demonstrate significant potential as eco-friendly, cost-effective, and scalable materials for removing heavy metals and organic pollutants, contributing to sustainable wastewater management and environmental protection.

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P-GCM-14

Effective Catalyst Design and Process Innovation for CO_2 Selective Hydrogenation

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With the increasingly negative impact on the global climate change and ocean acidification caused by heavy emission of CO_2, sustainable and effective treatment technologies are strongly required for highly efficient CO_2 utilization. However, the conversion of CO_2 to methanol suffers from both thermodynamic and kinetic limitations due to the low activity and thermodynamic stability of CO_2, so highly effective catalyst and efficient transformative process are desired. Here, we propose electroassisted CO_2 hydrogenation to methanol with higher production on CuZnAl catalyst beyond conventional thermal process. An external electric field is utilized to drive the activation of CO_2 and H_2, formation of active Cu sites, generation of specific Cu-ZnO (Cu_2O) interfaces, preferential exposure of active facet, and controllable balance of Cu^0/Cu^+ species. These unique characteristics under electric field should consequentially trigger the excellent redox properties of Cu species, CO_2/CO adsorption/desorption capacities, and thermal tolerance, facilitating the formation of crucial intermediates and catalytic selectivity and stability for methanol production. The specific changes in physicochemical properties, as well as the catalytic process, induced by the electric field are evidenced by multiple (quasi) in situ characterizations in combination with kinetic assessment and theoretical calculations.

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P-GRE-01

Optimization and Application of Combined Impeller Reactor in Ionic Liquid-Mediated Aldol Condensation

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Stirring is critical for process industry efficiency, but traditional chemical scale-up wastes resources. Computational Fluid Dynamics (CFD) aids flow analysis, while ionic liquids as green solvent catalyzes formaldehyde-propionaldehyde aldol condensation to methacrolein (MAL). However, ionic liquids' high viscosity causes late-stage heterogeneous systems and uneven mass transfer, with limited mass/heat transfer research hindering scale-up. This study aimed to resolve scale-up issues and optimize stirring via new reactor design and CFD.

Targeting high viscosity of ionic liquids, a new reactor with combined impellers (propeller + cross) was designed. CFD simulated macro flow fields to optimize impeller structure, speed, and position. The new reactor was then built, with parallel experiments against the original to verify enhancement.

CFD showed the new reactor shifted from radial to axial flow (uniform turbulence, rational velocity). Optimal conditions: 300 rpm, impeller 44 cm from tank bottom (0.25 m/s velocity, 0.15 kW power, 1.63 velocity/power ratio). Experiments achieved 99% propionaldehyde conversion, 87% MAL yield (matching lab-scale) - 10.1% higher than the original reactor, reducing scale-up effects. This study guides ionic liquid-catalyzed aldol condensation engineering and promotes CFD in stirred reactor optimization.

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P-GSP-01

Multicomponent Modeling of Adsorption Isotherm: A Case Study of Cadmium(II) and Nickel(II) Ions Adsorbed onto Rice Husk Ash

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The study of multicomponent adsorption has increased steadily in recent years with particular attention given to isotherm modeling. Mathematical models are not only used to fit experimental data but also to describe the underlying nature of adsorption processes. In this work, several isotherm models were evaluated, including the non-modified competitive Langmuir (NML), modified competitive Langmuir (ML), Extended Langmuir (EL), Jeppu Amrutha Manipal Multicomponent (JAMM), and the reduced form of JAMM (rJAMM). These models were fitted to experimental data for the adsorption of Cd(II) and Ni(II) ions onto rice husk ash. The results indicated that the reduced form of JAMM model provided the best overall fit.

P-NEM-01

Tuning Interfacial Properties in Sodium-Ion Batteries with Imidazole-Based Ionic Liquid Additives

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Electrolytes pose a critical bottleneck in the development of high-energy-density sodium-ion batteries (SIBs). Conventional carbonate-based electrolytes have a major drawback of poor oxidative stability (≥4.3 V). This shortcoming results in an unstable electrode/electrolyte interface and high impedance, as reported [1]. To tackle these problems, introducing functional additives is an effective strategy for optimizing interfacial properties[2]. Ionic liquids (ILs), featuring excellent conductivity, a wide electrochemical window, and structural tunability, are promising candidates for high-voltage electrolyte additives[3].

Herein, we present the design and synthesis of a functionalized ionic liquid additive, 1-vinyl-3-methylimidazolium difluoro(oxalate)borate (VMIM−DFOB). Compared with commercial carbonate electrolytes for SIB operating in the 2.0-4.3 V range, the ionic liquid additive could effectively enhance the electrochemical performance. It has been demonstrated that the $VMIM^+$ cation facilitates the formation of a polymeric protective layer on the electrode surface. Simultaneously, the $DFOB^-$ anion undergoes preferential reduction to form a dense and stable solid electrolyte interphase on the anode. The findings indicate that the additive is capable of alleviating parasitic side reactions and continuous electrolyte decomposition, thereby safeguarding the electrode. Furthermore, long-term cycling tests demonstrate that after 500 cycles, the cells managed to retain an outstanding 87.48% of their capacity, accompanied by a steady coulombic efficiency of 99.35%.

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P-NEM-02

Posture Analysis for Surveillance using Camera Sensor on Electric Adjustable and Flipping Beds

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Flipping bed is a significant innovation in facilitating the care of bedridden patients [1, 2, 3]. They help reduce the workload of caregivers in both hospital and home settings through mechanisms that allow patients' bodies to change posture automatically. This process enables redistribution of body weight and prevents the development of pressure ulcers, which are highly dangerous for patients who cannot move on their own. However, excessive tilting may introduce risks, such as patients falling from the bed or turning face down, both of which can endanger patient safety [4, 5]. Therefore, caregivers are still required to continuously monitor patients' sleeping postures. To address this challenge, this study proposes the development of a monitoring system that integrates image processing techniques [6, 7, 8] to enhance patient safety and reduce caregiver workload. The system focuses on estimating the body slope-angle of patients on the flipping bed through camera-based observation. By quantifying and analyzing the slope angle, it is possible to predict the risk level of excessive rotation, preventing hazardous scenarios such as face-down positioning, which is particularly dangerous for patients supported by ventilators. The research aims to establish a prototype framework that demonstrates the feasibility of using vision-based monitoring for real-time patient care. It is expected that the outcomes of this study will provide a foundation for future advancements in intelligent caregiving systems, offering both improved patient safety and reduced dependence on constant human supervision.

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P-NEM-03

Enhancing the Electrochemical Performance of Silicon–Carbon Composite Anodes Using Tween 80 and Sorghum for Sodium-Ion Batteries

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Lithium-ion batteries (LIBs) have achieved remarkable progress in modern society, driven by the increasing demand for portable electronic devices and electric vehicles. However, their long-term future remains uncertain due to the scarcity of lithium and other critical raw materials such as nickel and cobalt, motivating the search for alternative, sustainable, and cost-effective energy storage systems. Sodium-ion batteries (NIBs) have emerged as a promising candidate, yet in both LIBs and NIBs, the anode plays a decisive role in determining capacity and stability. Silicon (Si), with its exceptionally high theoretical capacity of ~4200 mAh g^{-1}, has been considered as a strong alternative to graphite. Nevertheless, Si suffers from poor conductivity and severe volume expansion (>200%) during lithiation/delithiation, leading to pulverization and rapid capacity fading. To address these challenges, Si–carbon (Si/C) composites have been widely explored, where carbon provides both conductivity and structural buffering. In this study, hard carbon derived from sorghum was employed as a sustainable carbon matrix to replace conventional graphite. The carbon material not only enhances electrical conductivity but also mitigates Si expansion while offering a low-cost and environmentally friendly approach. Furthermore, Tween 80, a non-ionic surfactant, was introduced to improve particle dispersion through steric stabilization, preventing agglomeration and ensuring a uniform electrode structure. The combination of Si, sorghum-derived carbon, and Tween 80 modification provides a synergistic pathway to enhance electrochemical performance, highlighting a promising strategy for next-generation Sodium-ion batteries (NIB) anodes.

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P-CNS-01

Life Cycle Assessment on Conventional and Oxy-fuel Natural Gas Combined Cycle Power Plant Integrated with Carbon Capture Technology for Low Carbon Society

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Natural gas remains the second-largest contributor to global electricity generation in 2024, and global energy-related CO_2 emissions increased by approximately 15% between 2010 and 2023 [1]. Among the carbon capture technologies, liquid-based absorption technology is well-developed and commercially available [2]. This study assessed the environmental impacts of a conventional Natural Gas Combined Cycle Power Plant (NGCC) integrated with absorption technology and oxy-fuel combustion by absorption technology. The conventional NGCC used excess air, and the oxy-fuel combustion used excess pure oxygen instead of air. The oxy-fuel combustion included a cryogenic air separation unit (ASU) that produced oxygen with a purity of >95%. The monoethanolamine (MEA) is selected for liquid absorption due to its strong kinetics and is suitable for large-scale absorption processes. The modelling designs were employed by Aspen Plus version 14.0. The functional unit was 1 MWh of electricity generated, cradle-to-gate approach, ReCiPe 2016 Endpoint (H) V1.04 method was applied for life cycle impact assessment (LCA). The study aimed to compare the environmental impacts of conventional NGCC and oxy-fuel combustion by absorption carbon capture technology through the LCA. The results showed that conventional NGCC integrated with absorption could reduce the environmental impact in the categories of human health, ecosystem, and resources. The impacts of oxy-fuel combustion with absorption carbon capture technology were associated with high electricity demand of ASU for oxygen production.

Keywords: Carbon capture, Life Cycle Assessment, Oxy-fuel combustion

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P-CNS-02

Porphyrin-conjugated Microporous Polymer Nanospheres Functionalized MXene as an Alternative Counter Electrodes for Dye-sensitized Solar Cells

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Dye-sensitized solar cells (DSSCs) offer a promising solution to address the growing global demand for energy and environmental concerns due to their clean, cost-effective, durable, and easily fabricable nature. However, developing stable and efficient platinum-free counter electrodes (CE) remains a key challenge for DSSCs. MXene, known for its excellent catalytic properties and conductivity, has emerged as a promising material for CE in DSSCs[1]. This study explores the creation of a novel counter electrode using a binary composite of microporous carbon nanospheres (MPCNS)[2] and MXene. Our findings demonstrate that this MPCNS@MXene composite outperforms both the individual MXene and MPCNS materials. Through various physical and electrochemical tests, we confirm the successful synthesis of MXene-decorated MPCNS, which shows strong catalytic activity. The enhanced performance is attributed to the synergistic effects of MXene and MPCNS. Superior conductivity and hollow channels in the structure of MXene provided an ideal scaffold for electrolyte adsorption and electron transfer, which facilitates electrolyte adsorption and electron transfer, alongside the high surface area offered by NPCNS. These results suggest that the MPCNS@MXene binary composite holds significant potential as an efficient platinum-free CE for future high-performance DSSCs.

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P-CNS-03

Fabrication of UiO-66/Bacterial Cellulose Membranes for CO_2/CH_4 Separation

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Rising atmospheric CO_2 levels necessitate the development of advanced materials for the selective separation of gases from emissions. In this study, bacterial cellulose (BC), a mechanically robust and biobased material, was used as a porous substrate for the *in situ* growth of amino-functionalized UiO-66 (UiO-66-NH_2), a zirconium-based metal-organic framework (MOF) with tunable porosity. The effect of mixed-ligand ratios on MOF nucleation and integration within the BC network was systematically investigated, resulting in well-dispersed MOF crystals with an enhanced surface area. To further improve gas separation under humid conditions, the composite membranes were coated with a thin layer of polydimethylsiloxane (PDMS), producing superhydrophobic membranes. Gas permeation tests revealed that the PDMS/UiO-66-NH_2@BC membranes exhibited excellent CO_2/CH_4 selectivity, resulting from the synergistic effects of amine functionalization, optimized MOF integration, and the PDMS barrier. These present a novel strategy for constructing composite membranes for efficient CO_2 separation applications.

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P-CNS-04

Multimodal Chromatography and Spectroscopy Analysis with Machine Learning for Crude Palm Oil Fingerprinting

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The increasing global demand for crude palm oil (CPO) emphasizes the need for traceability and authenticity to confirm its geographical origin, ensuring product quality and supporting sustainable practices. Advanced analytical techniques, such as chromatography and spectroscopy, play a crucial role in this process. Gas chromatography-flame Ionization detection (GC-FID), high-performance liquid chromatography (HPLC), headspace gas chromatography–mass (HS-GCMS), Fourier transform infrared (FTIR), near-infrared (NIR), nuclear magnetic resonance (NMR), and ultraviolet–visible (UV-Vis) were employed to analyze CPO samples obtained from four countries: Indonesia (ID), Malaysia (MY), the Philippines (PH), and Thailand (TH). In the present study, CPO samples originating from four countries were subjected to analysis, with 25 data points acquired from each country, yielding a total of 100 data points per sample for every analytical instrument employed. The high-dimensional spectral data were processed using multivariate analysis techniques to assess which instrument offers the highest accuracy in predicting the origin of CPO. This approach provides a foundation for understanding how spectral data are arranged and manipulated using Machine Learning (ML) methods, facilitating the development of effective data processing techniques and models for CPO authentication. Consistency in variable formatting across data matrices is crucial for accurate model development, then two-phase clustering-classification strategy is employed: first, clustering identifies subgroups within labeled classes, followed by supervised classification using insights from clustering. It improves the precision and reliability of CPO fingerprinting, providing a potentials approach for authenticity testing in the other vegetable oils.

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P-CNS-05

Fabrication of ZIF-8@BC/SA Composite Beads for Carbon Dioxide Adsorption

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Zeolitic imidazolate framework-8 (ZIF-8), a subclass of metal-organic frameworks (MOFs), exhibits high porosity and is well-suited for carbon dioxide (CO_2) adsorption [1]. However, its fine powder morphology limits practical applications in industrial systems [2]. In this work, bio-based composite beads were developed by incorporating ZIF-8 into bacterial cellulose (BC), derived from Nata de coco waste, and sodium alginate (SA), which acts as a gel-forming agent. Both BC and SA are biodegradable and biocompatible, providing an environmentally friendly support matrix [3,4]. The optimized composite beads (ZIF-8@BC/SA) achieved a high specific surface area of 1,026 m^2/g, significantly greater than that of pristine BC (48 m^2/g). Furthermore, the CO_2 adsorption capacity of ZIF-8@BC/SA beads reached 1.28 mmol/g at 273.15 K and 1 bar, compared with 0.24 mmol/g for pristine BC. The fabrication process represents a green synthesis route, avoiding organic solvents and operating under ambient conditions with low energy consumption. Owing to their facile preparation and scalability, the developed composite beads show strong potential for future applications as sustainable CO_2 adsorbents in pilot-scale systems.

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Proceeding

O2-CNS-03

Ammonia Recovery from Wastewater via Electrochemical Process: A Parametric Study on Membrane Pretreatment and Electrochemical Optimization

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Abstract

Efficient ammonia recovery from wastewater is essential for both environmental protection and resource recovery. This study investigates the combined effects of membrane pretreatment, applied voltage, and catholyte conductivity on the performance of electrochemical process using Nafion 117 cation-exchange membranes. A laboratory-scale H-cell system was used to evaluate ammonia recovery efficiency under various operational conditions. Membrane pretreatment procedures included sequential oxidative cleaning and acidic treatment, with and without subsequent immersion in aqueous ammonia. The results revealed that ammonium preconditioning significantly enhanced Ammonia Nitrogen (NH_3–N) recovery in the catholyte. The applied voltage was varied between 4 and 7 V, with maximum energy-normalized recovery observed at 6 V. Increasing voltage beyond this point led to diminishing returns due to electrochemical side effects and gas evolution. Additionally, the effect of sodium sulfate (Na_2SO_4) concentration in the catholyte was evaluated in the range of 0 to 0.35 M. It was found that NH_3–N recovery was insensitive to conductivity increases beyond 0.125 M. These findings provide practical insights into optimizing electrochemical system for ammonia recovery by balancing membrane conditioning, voltage application, and electrolyte composition.

Keywords: Ammonia recovery; Ammonia Nitrogen; Wastewater; Electrochemical process; Membrane

1. Introduction

Nitrogen pollutants can be found in municipal wastewaters, wastewater from manufacturing processes, and agricultural drainage [1-2]. Nitrogen pollotants in wastewater is always in the form of NH_4^+ [3]. They are harmful to human health and environment, leading to problems like excessive nutrient enrichment in water bodies (eutrophication), harmful algal blooms, and oxygen depletion

[3-4]. Consequently, strict regulations have been implemented to limit nitrogen discharge in wastewater. Beyond its environmental problem, ammonia holds economic and energy value as a precursor for fertilizers, chemicals, and as an emerging zero-carbon fuel and hydrogen carrier [4-6].

Several techniques were utilized for nitrogen removal/recovery from wastewater: nitrification, denitrification, membrane bioreactors, adsorption, membrane filtration, ion exchange, struvite precipitation, ammonia stripping, electrochemical oxidation, photocatalytic oxidation, bioelectrochemical systems, and membrane hybrid systems [3-15]. Conventional biological processes such as nitrification and denitrification reduce oxygen demand and sludge production but achieve nitrogen removal rather than recovery [4]. Physicochemical recovery methods, including air/steam stripping, vacuum thermal stripping, ion exchange, and struvite precipitation, can selectively recover ammonia but require high pH, chemical additives, or have limited efficiency for dilute waste streams [2].

Electrochemical processes have emerged as effective alternatives for ammonia recovery [7-15], overcoming the high chemical and energy demands of conventional stripping and precipitation [9]. By integrating cation exchange membranes (CEMs), ammonia can selectively migrate under an applied electric field, enriching ammonium nitrogen in the catholyte [13].

The performance of the electrochemical systems is significantly influenced by the physicochemical properties of ion-exchange membranes. Among these, the membrane's surface condition, ionic conductivity, and fouling resistance play critical roles in determining ion transport efficiency, energy consumption, and system longevity. To enhance membrane performance, various pretreatment techniques have been employed to improve ionic conductivity, remove surface contaminants, and tailor membrane selectivity [1-4]. Conventional pretreatment typically involves ion exchange to remove multivalent cations that contribute to membrane fouling, replacing them with non-scaling ions such as H^+, Na^+, or K^+ [16]. In a related approach, Lee et al. [9] immersed the cation-exchange membrane in an aqueous ammonia solution following cleaning and acidic treatment; however, specific discussion of this issue is not provided.

The applied voltage is a key operational parameter in electrochemical systems, directly influencing the driving force for ion migration across ion-exchange membranes. According to classical electrokinetic theory, increasing the applied voltage enhances the electric field strength, thereby promoting ion mobility and transport rate across membranes. Its magnitude affects ion flux, current density, energy consumption, and overall separation efficiency. Optimizing voltage is therefore critical for enhancing recovery performance and minimizing undesired electrochemical side effects. The fundamental relationship between electrolyte conductivity and electrochemical performance lies in the electrochemical principles governing ion migration. A higher solution conductivity reduces ohmic resistance within the electrolyte compartments, thereby enhancing current flow and reducing the energy required to drive ion transport [17].

The literature emphasizes the multifactorial nature of electrochemical optimization. It involves balancing membrane characteristics, operating conditions, and electrolyte chemistry to achieve high recovery with minimal energy input. However, relatively few studies have systematically evaluated the combined effects of membrane pretreatment, applied voltage, and electrolyte concentration on ammonia recovery in a single framework. The present work contributes to the growing body of knowledge on electrochemical ammonia recovery by offering a systematic investigation of three interrelated factors: membrane pretreatment, applied voltage, and catholyte conductivity within a single experimental framework using Nafion 117 membranes, to offer practical optimization strategies for electrochemical ammonia recovery systems.

2. Materials and Methods

The electrochemical system employed in this study was based on a laboratory-scale H-type cell configuration as illustrated schematically in Figure 1. The H-cell consisted of two vertically aligned compartments, designated as the anode and cathode chambers connected via a cation exchange membrane (CEM), specifically Nafion 117. Platinum-coated titanium mesh electrodes were used as the anode and cathode. Each electrode was placed in its respective chamber and connected to a DC power supply. The voltage across the electrodes was varied between 4 and 7 V to investigate its effect on ion migration and ammonia recovery performance.

The anolyte was the synthetic wastewater had the following composition: 12.8 mM KCl, 10.9 mM NaCl, 0.26 mM K_2SO_4, 18.7 mM NH_4Cl, and 46.2 mM $(NH_4)_2CO_3$. The catholyte solutions were sodium sulfate (Na_2SO_4) solution added as the supporting electrolyte at varying concentrations (0–0.35 M) to enhance solution conductivity.

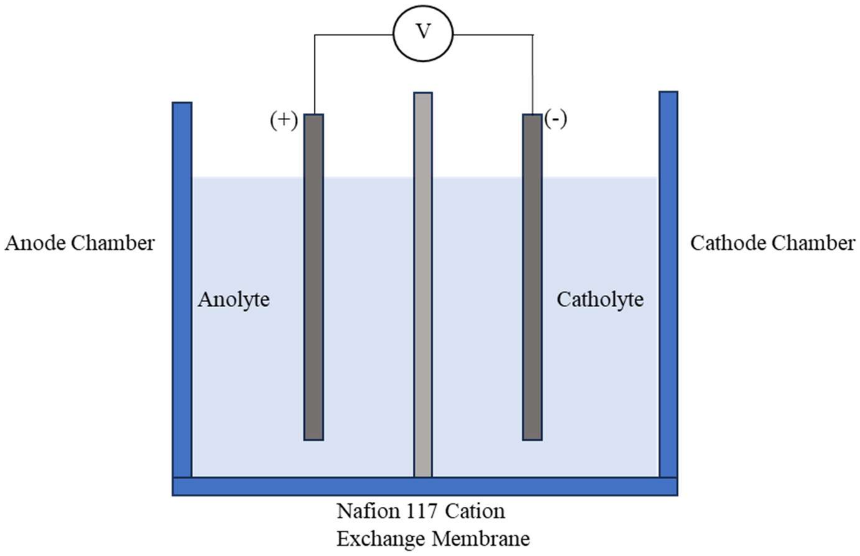

Figure 1. The experimental setup using H-cell.

The membrane pretreatment involved sequential boiling steps: first, in 3% hydrogen peroxide (H_2O_2) for 1 hour, followed by boiling in 1 M sulfuric acid (H_2SO_4) for another hour. Afterward, the membrane was immersed in 28% ammonia solution for 1 hour to exchange protons with ammonium ions. After each step, the membrane was thoroughly rinsed with deionized water to remove any residual chemicals.

The electrochemical process was carried out for 1 hour. During operation, voltage, current, temperature, and pH were continuously monitored. Samples were collected from the cathode compartment and analyzed for ammonia nitrogen (NH_3–N) concentration using the phenate method [18]. The pH levels in both the anolyte and catholyte compartments were also measured to track changes resulting from ion transport and water electrolysis.

3. Results and Discussion

3.1 Effect of Membrane Pretreatment

This study investigated the effect of two pretreatment methods on the performance of Nafion 117 membranes for ammonia recovery via electrochemical process. The first method involved hydrogen peroxide cleaning followed by sulfuric acid treatment, while the second method included an additional immersion step in an ammonia solution. Experimental results (Table 1) showed that the second method led to significantly higher ammonia recovery efficiency and caused more pronounced pH shifts in both the anode and cathode compartments.

These findings can be explained by the ion-exchange characteristics and conditioning behavior of Nafion 117 membranes. Nafion is a perfluorosulfonic acid (PFSA) cation-exchange membrane containing sulfonic acid groups (–SO_3H) as fixed charge sites [19]. After acid pretreatment, the membrane remains in the proton (H^+) form, which may lead to NH_4^+ trapping via ion exchange with membrane-bound H^+ ions. Sachse et al. [20] reported that the ion exchange between NH_4^+ and H^+ is reversible and governed by equilibrium, as shown in Equation (1). Using Nafion 115, they determined the equilibrium constant to be 2.0, indicating that NH_4^+ in the anode compartment tends to exchange with H^+ in the membrane and becomes retained within it. Although NH_4^+ desorption can occur under an applied electric field, the extent is limited when NH_4^+ is abundant in the solution. These findings align well with the results of this study.

$$c(NH_4^+, \mathrm{Sol}) + c\,(H^+, \mathrm{Mem}) \Leftrightarrow c(NH_4^+, \mathrm{Mem}) + c\,(H^+, \mathrm{Sol}) \qquad (1)$$

In contrast, immersing the membrane in an ammonia solution after acid treatment replaces membrane-bound protons with ammonium ions, as shown in Equation (2). This NH_4^+ form suppresses trapping of ammonium via ion exchange. As a result, NH_4^+ transport across the membrane is promoted, leading to a higher flux of ammonium ions under the applied electric field.

$$R{-}SO_3H + NH_4^+ \rightarrow R{-}SO3^{-}NH_4^+ + H^+ \qquad (2)$$

Table 1. Effect of membrane pretreatment on electrochemical performance.

Membrane Pretreatment Method	Current Density (mA/cm^2)	pH of Anolyte (initial pH = 9.02)	pH of Catholyte (initial pH = 6.10)	NH_3-N Concentration in Catholyte (mg/L)
Cleaned with hydrogen peroxide, then treated with sulfuric acid.	13.7	8.89	11.35	72.25
Cleaned with hydrogen peroxide, then treated with sulfuric acid and ammonia.	15.6	8.84	11.43	163.66

The observed pH shifts in the electrode compartments further supports this mechanism. In with a cation-exchange membrane, pH changes are directly influenced by the electrochemical reactions occurring at the electrodes:

At the anode, water is oxidized:

$$2H_2O \rightarrow O_2 + 4H^+ + 4e^- \quad (3)$$

This generates protons (H^+), making the anolyte more acidic, hence the slight drop in pH. Even though H^+ is produced at the anode, the buffering capacity of the solution may resist dramatic pH shifts. The remaining ammonia in the anolyte can neutralize some H^+, moderating the drop.

At the cathode, water is reduced:

$$4H_2O + 4e^- \rightarrow 2H_2 + 4OH^- \quad (4)$$

This generates hydroxide ions (OH^-), making the catholyte more basic, explaining the significant increase in pH. NH_4^+ migrates through the cation-exchange membrane into the cathode compartment. Distribution of NH_4^+ /NH_3 in the solution depends on pH [21]. In the basic environment of the catholyte (due to OH^- production), ammonium (NH_4^+) is converted to ammonia (NH_3) which is uncharged, and does not buffer the solution, allowing pH to rise further.

These results highlight the importance of membrane pretreatment and conditioning in optimizing electrochemical systems for ammonia recovery. Proper conditioning improves membrane selectivity, ion-exchange capacity, and transport number for target ions. The simple additional step of immersing Nafion 117 in ammonia solution after acid cleaning proved highly effective, suggesting a practical approach for enhancing ammonium recovery.

3.2 Effect of Applied Voltage

The relationship between applied voltage and ammonia recovery by electrochemical process was examined in terms of both the concentration of NH_3–N in the catholyte and the energy-normalized recovery efficiency, defined as the amount of recovered NH_3–N per unit of power consumed (mg/L-mW) is shown in Figure 2. The results, indicate a trend: increasing voltage enhances ammonia recovery, but only up to a certain point. As the applied voltage increased from 4 V to 6 V, the NH_3–N concentration in the catholyte rose significantly from 47.72 to 163.66 mg/L. This increase was accompanied by a rise in both current and power consumption. The recovery efficiency, defined as the amount of NH_3–N recovered per unit of electrical power, peaked at 0.98 mg/L-mW at 6 V, suggesting that this voltage offered the most efficient energy usage for ammonia transport.

However, when the voltage was further increased to 7 V, the NH_3–N concentration increased only slightly to 173.07 mg/L, while the recovery efficiency dropped markedly to 0.82 mg/L-mW. This decline in efficiency at higher voltage is likely due to side reactions and gas evolution. At elevated voltages, water electrolysis becomes more prominent, producing H_2 and O_2 gases. The resulting gas bubbles can obstruct membrane surfaces and electrode areas, increasing resistance and reducing the effective current available for NH_4^+ migration. Therefore, 6 V appears to be the optimal operating point under the given conditions, providing the highest recovery efficiency while minimizing the negative effects associated with overvoltage. Operating beyond this threshold leads to diminishing returns in performance, emphasizing the need for careful voltage optimization in practical electrochemical system design.

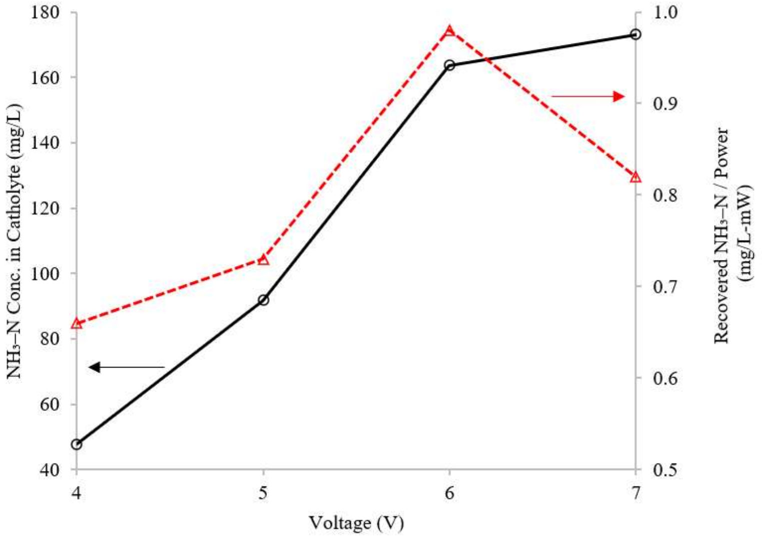

Figure 2. Effect of applied voltage on the concentration of NH_3–N in the catholyte and the amount of recovered NH_3–N per unit of power consumed.

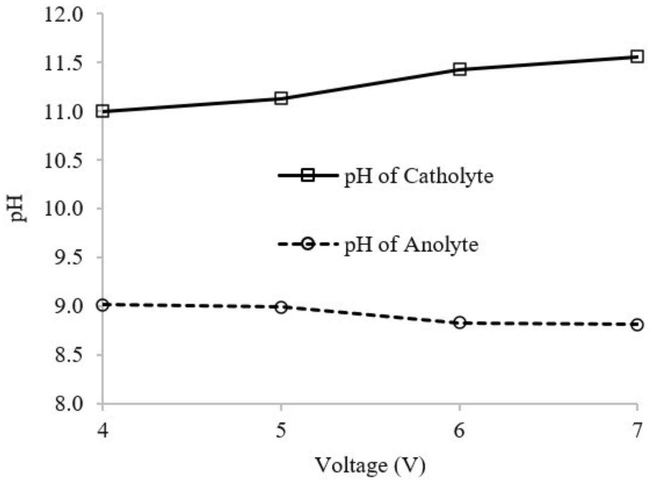

Figure 3. pH of anolyte and catholyte under different applied voltages.

The changes in pH values observed in the anode and cathode compartments at different applied voltages offer valuable insights into the electrochemical behavior of the electrochemical system. As illustrated in Figure 3, the pH of the anolyte showed a slight decrease as the voltage increased, while the pH of the catholyte rose steadily. These trends can be attributed to similar mechanisms discussed earlier in Section 3.1

3.3 Effect of Na_2SO_4 Concentration in the Catholyte

In general, wastewater contains various cations such as Na^+, K^+, Ca^{2+}, and NH_4^+. Among these, Na^+ is the most significant competing ion for NH_4^+. Yang and Qin [22] investigated ammonium transport in membrane electrochemical systems and found that adding Na^+ to the catholyte enhances NH_4^+ transport via the Donnan effect. In the present work, sodium sulfate (Na_2SO_4) was used as the supporting electrolyte in the catholyte at varying initial concentrations of 0, 0.125, 0.25, and 0.35. The experimental results (Figure 4) revealed that Na_2SO_4 primarily serves to enhance the conductivity of the solution, thereby facilitating electrical current flow and completing the electrochemical circuit between the anode and cathode, resulting in promoted NH_3-N recovery. However, when the electrolyte concentration exceeds a certain threshold, the incremental increase in conductivity becomes marginal due to the saturation effect, where ionic mobility and conductivity no longer rise proportionally with concentration.

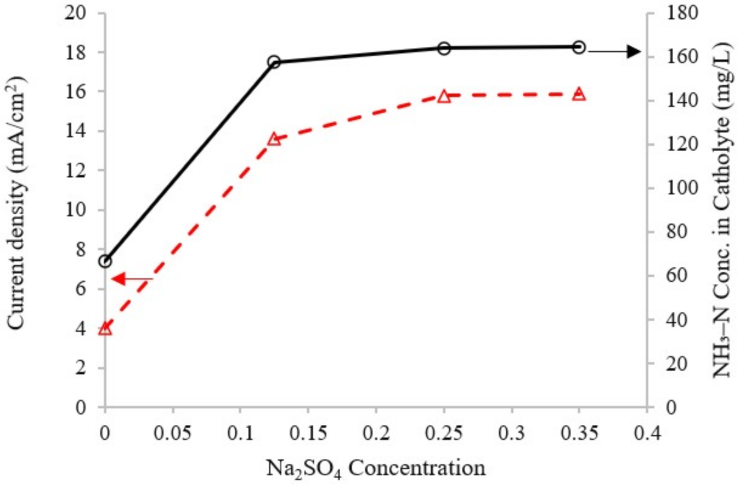

Figure 4. Current density and NH_3-N concentration in catholyte at different initial Na_2SO_4 concentration in catholyte.

The data suggest that increasing Na_2SO_4 concentration improves system performance up to a certain limit (around 0.125 M), beyond which additional salt does not significantly enhance ammonia recovery. This highlights the importance of optimizing electrolyte concentration to balance performance and resource efficiency.

4. Conclusions

This study investigated the effects of membrane pretreatment, applied voltage, and catholyte conductivity on the performance of electrochemical for ammonia recovery using Nafion 117 membranes. The key findings are summarized as follows:

1. Membrane pretreatment plays a critical role in enhancing ammonia recovery. The inclusion of an ammonium conditioning step, by immersing the membrane in ammonia solution after oxidative cleaning and acidic treatment significantly improved NH_4^+ transport.

2. Applied voltage had a strong influence on recovery efficiency. The NH_3–N concentration in the catholyte increased with voltage, but the energy-normalized recovery efficiency peaked at 6 V. Operating beyond this voltage resulted in diminishing returns due to enhanced water electrolysis and gas evolution, which increased resistance and reduced effective ion transport.

3. Catholyte conductivity, varied by sodium sulfate (Na_2SO_4) concentration, showed minimal impact on ammonia recovery beyond 0.125 M. This indicates that once sufficient conductivity is achieved to maintain current flow, further increases do not significantly enhance performance.

Acknowledgements

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P-GCM-05

Modification of biochar and its application in acetin synthesis from glycerol

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Abstract

Biochar is a carbon-rich solid material produced through the pyrolysis of organic biomass in oxygen-limited conditions and functions as a promising catalyst support for the acetylation of glycerol with acetic acid. This study focuses on three types of biochar: bamboo, cassava, and coconut shell. Sulfonic acid-functionalized biochar was prepared to introduce acidic functionalities onto its surface, which is expected to exhibit enhanced catalytic performance in acetylation reactions. The functionalized catalysts were comprehensively characterized using various analytical techniques, including N_2 adsorption-desorption isotherms, X-ray powder diffraction (XRD), scanning electron microscopy (SEM), and elemental analysis (CHN/S). The SO_3-functionalized cassava biochar exhibited a surface area of 28.2 m^2/g and an acidity of 2.41 mmol/g. Under optimal reaction conditions—catalyst loading of 0.5 g (5 wt% of glycerol), a molar ratio of 1:9 (glycerol:acetic acid), a reaction temperature of 115°C, and reaction times of 2, 4, 6, and 8 hours—the catalytic performance was systematically evaluated. After 8 hours, the SO_3-functionalized cassava biochar demonstrated exceptional catalytic performance in the acetylation of glycerol with acetic acid, achieving complete glycerol conversion (100%) and triacetin selectivity of 41.5%. This performance was comparable to that of commercial activated carbon, with a surface area of 1370 m^2/g and an acidity of 1.35 mmol/g, which achieved complete glycerol conversion (100%) but with a lower triacetin selectivity of 35.9%.

Keywords: Triacetin, Biochar, Glycerol

1. Introduction

The global biodiesel industry has experienced significant growth in recent decades, driven by environmental concerns and the pursuit of renewable energy sources. This expansion has resulted in a substantial glycerol surplus as a by-product, with approximately 10% of glycerol produced for every unit of biodiesel (Tan et al., 2013). The oversupply has drastically reduced glycerol's market value, prompting extensive research into value-added applications for this abundant by-product. The acetylation of glycerol with acetic acid has emerged as a promising approach, producing mono-, di-, and triacetin—compounds with diverse applications in fuel additives, polymers, cosmetics, and pharmaceuticals (Dosuna-Rodríguez et al., 2011). Triacetin can be used as a fuel additive, a viscosity improving agent, a cold-flow improve agent, and it also improves engine performance. Biochar, a carbon-rich solid residue obtained through thermochemical conversion of biomass under oxygen-limited conditions, has emerged as a promising heterogeneous catalyst or catalyst support due to its unique physicochemical properties, including high carbon content, tunable porosity, surface functional groups, and inherent thermal stability (Tan et al., 2015). Modified biochar catalysts, particularly those functionalized with acidic sites through sulfonation, metal impregnation, or chemical activation, have demonstrated significant potential in catalyzing the esterification reaction between glycerol and acetic acid under mild reaction conditions (Konwar et al., 2014)

The objective of this research is to study the physicochemical properties of the modified biochar by sulfonation: bamboo, coconut shell and cassava. In addition, the reaction temperature and molar ratio of glycerol and acetic acid will be fixed and the reaction time will be optimized to achieve high glycerol conversion as well as high selectivity towards triacetin. Furthermore, the reusability of the catalyst will be examined as well.

2. Materials and Methods

A. Catalyst Preparation

The sulfonation on biochar (bamboo, coconut shell and cassava) was carried out. First, 7 g of biochar was dried in the oven at 100 °C for 4 hours. After that, biochar was functionalized with sulfonic acid groups by sulfonation method, in which 200 mL of concentrated H_2SO_4 (>98%) at 100 °C under N_2. After heating for 10 h and then cooling to room temperature, 1000 mL of distilled water was added to the mixture to form a black precipitate, which was washed repeatedly with hot distilled water (80 °C) until impurities were no longer detected in the wash water. The sulfonated solid product was subsequently filtered, and dried at 100 °C overnight.

B. Characterization

Specific surface area, total pore volume and average pore size of the catalysts were investigated by the N_2 physisorption using a QS-evo MP (Quantachrome, USA). Prior to the measurement, the sample was outgassed at 200 °C for 14 h under a high vacuum condition to eliminate volatile absorbents on the surface. The specific surface area was calculated by Brunauer-Emmett-Teller (BET) method using adsorption and desorption data points. Nitrogen (N_2) gas was adsorbed on the catalyst surface at -196 °C. The pore size distribution was analyzed by Barrett-Joyner-Halenda (BJH) method using data from the desorption branch. The pore volume was accumulated at P/P_0 ratio less than 0.1

The crystallographic structure of the catalysts was analyzed by X-ray Diffraction (XRD) using a Rigaku SmartLab X-ray diffractometer equipped with CuKα radiation (($\lambda = 1.5406$ Å) operating at 30 mA and 50 kV. The wide-angle scattering patterns (2θ range from 10° to 70°) were collected with a step size of 0.01° and a scan rate of 2°/min.

The acidity of the prepared catalysts was determined by acid-base titration using NaCl solution as an ion-exchange agent. A 50 mg sample in powder form was ion-exchanged with 20 mL of 2 M NaCl solution at ambient temperature for at least 24 h, followed by filtration and washing with 3 mL of de-ionized water. The filtrates were then titrated with a 0.01 M NaOH solution (Chen et al., 2011).

The elemental analyzer was employed to measure the chemical compositions of carbon (C), hydrogen (H), and sulfur (S) using a TruSpec CHN/S instrument equipped at 900 °C and 1350 °C for the CHN analyzer and S analyzer, respectively. In addition, element analyzer was calibrated by EDTA and coal before analysis.

C. Catalytic activity

The glycerol conversion and acetin selectivity were analyzed by using gas chromatography (GC) equipped with a flame ionization detector (FID) (Agilent 7890B). The glycerol conversion and acetin selectivity were calculated using the following equations:

$$\text{Glycerol conversion}\left(X_{\text{gly}},\%\right) = \frac{\text{initial mole of glycerol - reamained mole of glycerol}}{\text{initial mole of glycerol}} \times 100$$

$$\text{Selectivity}\left(S_i,\%\right) = \frac{\text{mole of i product}}{\text{total moles of products}} \times 100$$

Where i denoted as monoacetin, diacetin or triacetin products

3. Results and Discussion

A. Physicochemical properties of biochar and SO_3- functionalized biochar

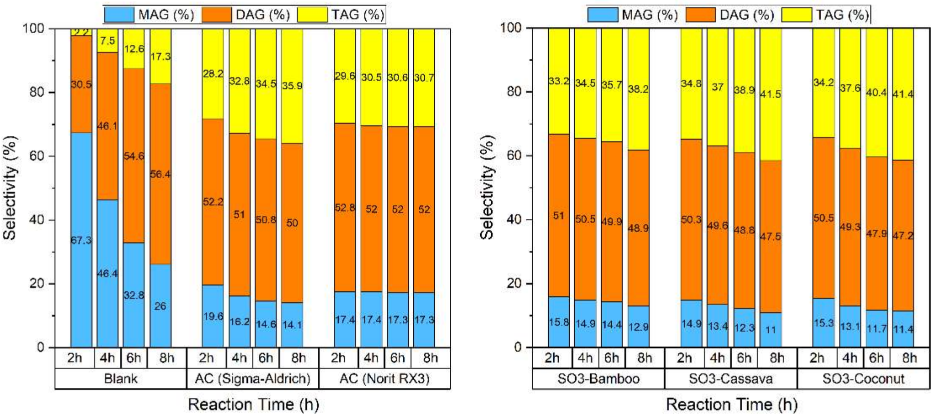
The physicochemical properties of biochar and SO_3-functionalized biochar were investigated. As shown in Table 1, the biochar exhibited moderate surface areas of 46.0 -151.0 m^2/g and pore diameters of 3.06-3.41 nm. The SO_3-functionalized biochar catalysts demonstrated lower surface areas (15.7-29.8 m^2/g) compared to those of the biochar supports, which can be attributed to the grafting of sulfonic acid groups onto the biochar surface. The sulfur content increased upon SO_3-functionalization, with SO_3-functionalized cassava biochar exhibiting the highest sulfur content (4.93%). Consequently, the acidity of the biochar catalyst increased following SO_3-functionalization.

Table 1. Physicochemical properties of biochar, SO_3- functionalized biochar, activated carbon and SO_3- functionalized activated carbon.

Catalyst	Surface area (m^2/g)	Pore diameter (nm)	Element Composition				Acidity (mmol/g)
			C	H	N	S	
Bamboo	46.0	3.06	71.29	2.49	0.77	0.11	0.04
SO_3-Bamboo	15.7	3.06	64.42	2.74	0.59	3.88	1.17
Cassava	78.5	3.06	61.77	3.84	1.67	0.20	0.03
SO_3-Cassava	28.2	3.05	52.64	3.96	1.30	4.93	2.41
Coconut shell	151.0	3.41	74.24	2.04	0.02	0.07	0.05
SO_3-Coconut shell	29.8	3.06	65.39	1.79	0.02	4.36	2.58
Activated carbon	1093.6	3.81	74.92	0.94	0.27	-	0.04
SO_3-Activated carbon	411.3	3.81	57.12	1.83	0.01	-	1.12

B. Effect of Sulfonic Loading on Catalytic Performance

The effect of sulfonic acid loading on the catalytic performance was investigated, as shown in Figure 2.Under the fixed reaction condition (0.5 g catalyst loading, 1:9 glycerol-to-acetic acid (Gly:ACOH) molar ratio, 115°C, 8 h), all catalyst achieved 100% glycerol conversion. In terms of product selectivity, the commercial activated carbon (Sigma-Aldrich) exhibited selectivities of 14.1% for monoacetin, 50.0% for diacetin, and a lower triacetin selectivity at 35.9%. For the SO_3-functionalized biochar catalysts (bamboo, cassava and coconut cell)), selectivity towards triacetin increased with the sulfonic acid loading. The highest triacetin selectivity (41.5%) was achieved by the SO_3-cassava biochar catalyst.



(a) (b)

Figure 2. Catalytic performances of the catalysts at reaction conditions of 0.5 g catalyst loading (5wt% of glycerol), molar ratio of 1:9 (Gly:AcOH), reaction temperature of 115 °C, and reaction time of 8 h. (a) SO_3- functionalized comercial activated carbon; (b) SO_3- functionalized biochar

4. Conclusions

The acid-functionalized cassava biochar catalysts showed high catalytic activity achieving 100% glycerol conversion and high triacetin selectivity. The presence of high amount of sulfonic acid groups was identify as the key parameter driving for the high triacetin selectivity of 41.5%. This superior performance surpassed that of the commercial activated carbon, which achieved complete glycerol conversion (100%) but yield a lower triacetin selectivity of 35.9% despite its much higher surface area.

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Multicomponent Modeling of Adsorption Isotherm: A Case Study of Cadmium(II) and Nickel(II) Ions Adsorbed onto Rice Husk Ash

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Abstract

The study of multicomponent adsorption has increased steadily in recent years with particular attention given to isotherm modeling. Mathematical models are not only used to fit experimental data but also to describe the underlying nature of adsorption processes. In this work, several isotherm models were evaluated, including the non-modified competitive Langmuir (NML), modified competitive Langmuir (ML), Extended Langmuir (EL), Jeppu Amrutha Manipal Multicomponent (JAMM), and the reduced form of JAMM (rJAMM). These models were fitted to experimental data for the adsorption of Cd(II) and Ni(II) ions onto rice husk ash. The results indicated that the reduced form of JAMM model provided the best overall fit.

Keywords: Adsorption, Isotherm, Multicomponent system, Cadmium(II), Nickel(II)

1. Introduction

Adsorption is one of the most important separation processes in wastewater treatment and has been extensively studied. Continuous efforts have been made to develop novel adsorbents with improved efficiency. Among the fundamental characteristics of adsorbents, the adsorption isotherm plays a critical role as it describes the equilibrium relationship between the adsorbent and the adsorbate.

To represent isotherm data, numerous mathematical models have been proposed. Early studies primarily focused on single-component adsorption, the Langmuir and Freundlich models being the most widely used. However, real wastewater systems typically contain multiple components, making multicomponent adsorption studies increasing relevant. Consequently, many isotherm models have been extended or modified from the original Langmuir and Freundlich formulations to account for competitive adsorption.

To compare the strengths and limitations of these models, experimental data for the adsorption of Cd(II) and Ni(II) ions onto rice husk ash were selected[1]. The models investigated in this work include the non-modified competitive Langmuir, modified competitive Langmuir, Extended Langmuir, JAMM, and the reduced form of JAMM. To evaluate model performance, several statistical error functions were applied, including the coefficient of determination (R^2), sum of squared errors (SSE), sum of absolute errors (SAE), hybrid fractional error function (HYBRID), Marquardt's percent standard deviation (MPSD), average relative error (ARE), and chi-square test (χ^2). Following the recommendation of Serafin and Dziejarski[2], the chi-square test was chosen as the primary evaluation criterion. In addition, predicted data were visually compared with experimental results to provide further insight into model accuracy.

2. Methods

Experimental data for the competitive adsorption of Cd(II) and Ni(II) ions onto rice husk ash were taken from Srivastava et al.[1]. In brief, 1 g of adsorbent was mixed with 100 mL of a metal ion solution of known concentration. The mixture was shaken at 150 rpm and the temperature was maintained at 30˚C. When adsorption equilibrium was reached, the samples were centrifuged at 5000 rpm for 5 minutes. The concentrations of metal ions in the supernatant were then analyzed using atomic absorption spectroscopy.

Although the primary objective of this work was to compare mathematical models for multicomponent adsorption, parameters from single-component adsorption experiments were also required for some models. Therefore, the Langmuir isotherm was first applied to single-component data before extending the analysis to multicomponent systems.

a. Langmuir model

The Langmuir model, one of the most commonly applied single-component isotherms, assumes monolayer adsorption onto a homogeneous surface with no interactions between adsorbed molecules. It is expressed as equation (1).

$$q_e = \frac{q_m K_L C_e}{1+K_L C_e} \qquad (1)$$

q_e is the equilibrium adsorption capacity; q_m is the maximum adsorption capacity; K_L is Langmuir constant; C_e is equilibrium concentration of metal ion.

b. Non-modified competitive Langmuir model

This model extends the Langmuir formulation to multicomponent systems, using single-component parameters to predict competitive adsorption capacities. Its form is given in equation (2).

$$q_{e,i} = \frac{q_{m,i} K_{L,i} C_{e,i}}{1+\sum_{j=1}^{N} K_{L,j} C_{e,j}} \tag{2}$$

j is the metal ion in the solution; N is total number of metal ions. $q_{m,i}$ and $K_{L,i}$ are determined from single component Langmuir isotherm. It can be said that this model use adsorption data of single component to predict adsorption capacity of each component in multicomponent adsorption.

c. Modified competitive Langmuir model

To account for interactions between adsorbed species, this model introduces an interaction factor (η_L). It is expressed as equation (3).

$$q_{e,i} = \frac{q_{m,i} K_{L,i} \left(C_{e,i}/\eta_{L,i}\right)}{1+\sum_{j=1}^{N} K_{L,j} \left(C_{e,j}/\eta_{L,j}\right)} \tag{3}$$

$q_{m,i}$ and $K_{L,i}$ are evaluated from single component Langmuir isotherm like non modified competitive Langmuir model.

d. Extended Langmuir model

This model has the same functional form as the non-modified version but derives its parameters directly from multicomponent adsorption data, as shown in equation (4).

$$q_{e,i} = \frac{q_{m,i} K_{L,i} C_{e,i}}{1+\sum_{j=1}^{N} K_{L,j} C_{e,j}} \tag{4}$$

e. JAMM model

Recently proposed by Acharya et al.[3], the JAMM model incorporates multiple parameters such as interaction coefficients, mole fractions, affinity factors, and heterogeneity indices, as shown in equation (5).

$$q_{e,i} = \frac{q_{m,i} \Phi_i x_i \left(K_{L,i} C_{e,i} a_i\right)^{n_i}}{1+\sum_{j=1}^{N} \left(K_{L,i} C_{e,i} a_i\right)^{n_i}} \tag{5}$$

Φ_i is interaction coefficient of component i which shows competition between metal ions. x_i is mole fraction of component i. a_i is affinity factor of component i which shows attractive force between metal ion and solid surface. n_i is heterogeneity index of component i which depicts heterogeneity of actual surface.

f. Reduced form of JAMM model

To simplify the JAMM formulation, the mole fraction term was excluded, yielding a reduced model expressed by equation (6).

$$q_{e,i} = \frac{q_{m,i} \Phi_i \left(K_{L,i} C_{e,i} a_i\right)^{n_i}}{1+\sum_{j=1}^{N} \left(K_{L,i} C_{e,i} a_i\right)^{n_i}} \tag{6}$$

3. Results and Discussion

Since some competitive adsorption models require parameters from single-component adsorption, the analysis began with the Langmuir model. Most studies determined Langmuir parameters through linearization of equation (1). Osmari et al.[4] compared six linear forms and identified one of the most suitable, expressed as equation (7). Parameters were calculated by both linear regression and nonlinear regression methods.

$$\frac{C_e}{q_e} = \frac{1}{q_m K_L} + \frac{1}{q_m} C_e \tag{7}$$

The Langmuir parameters obtained are summarized in Table 1, while the corresponding isotherms are shown in Figure 1. Nonlinear regression provided better results according to the chi-square test (χ^2), although deviations increased significantly at higher concentrations. Consequently, parameters from linear regression were chosen for further modeling.

Table 2. Langmuir parameters.

	Cd(II)			Ni(II)		
	q_m (mmol/g)	K_L (L/mmol)	χ^2	q_m (mmol/g)	K_L (L/mmol)	χ^2
Linear regression	0.027	20.984	2.673×10^{-3}	0.083	10.207	5.779×10^{-3}
Nonlinear regression	0.022	48.937	1.673×10^{-3}	0.072	14.759	4.741×10^{-3}

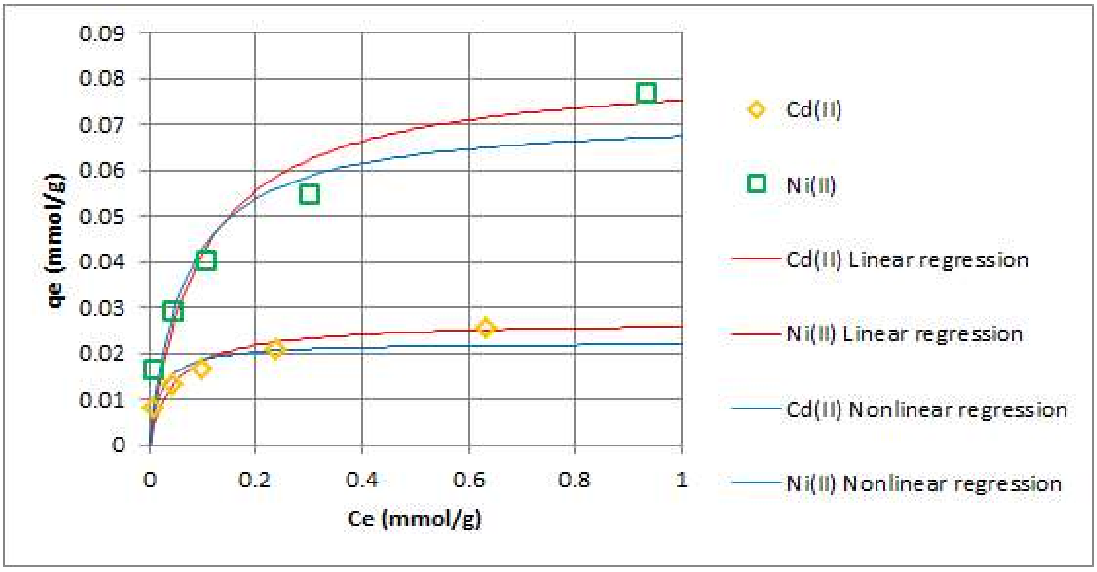

Figure 1. Langmuir isotherms.

Using the Langmuir parameters, non-modified competitive Langmuir isotherms were generated (Figure 2). Results showed that adsorption capacities decreased as the initial concentration of the competing ion increased. Larger deviations between predicted and experimental data appeared at higher concentrations, primarily because the model does not incorporate an interaction factor.

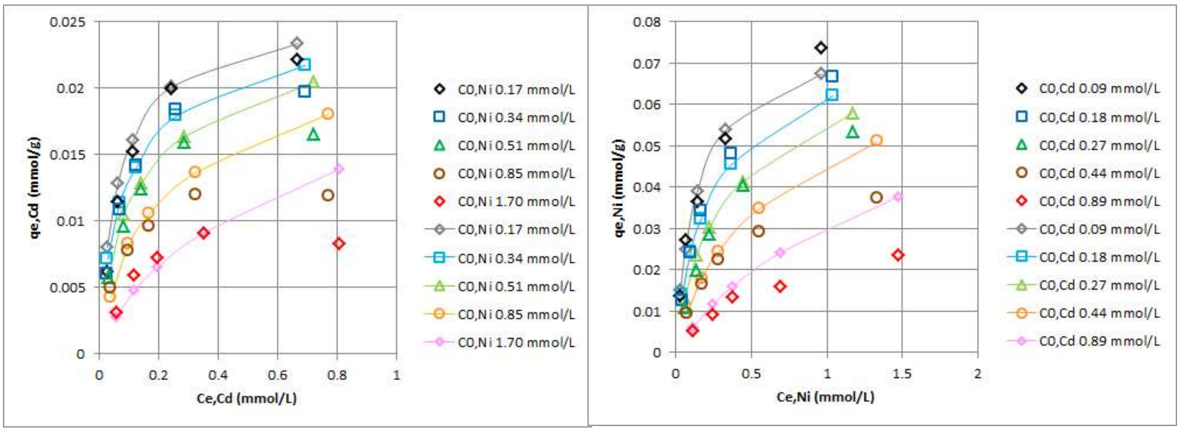

Figure 2. Non-modified competitive Langmuir isotherms (markers with connected lines) with experimental data (markers without connected lines) of Cd (left) and Ni (right).

The modified competitive Langmuir model was then tested, with interaction factors estimated using MS Excel Solver. The resulting isotherms are shown in Figure 3, with parameters summarized in Tables 2 and 3. Although the model slightly improved the fit for Ni(II), it performed worse for Cd(II), indicating that inclusion of a single interaction factor is insufficient to capture competitive adsorption behavior.

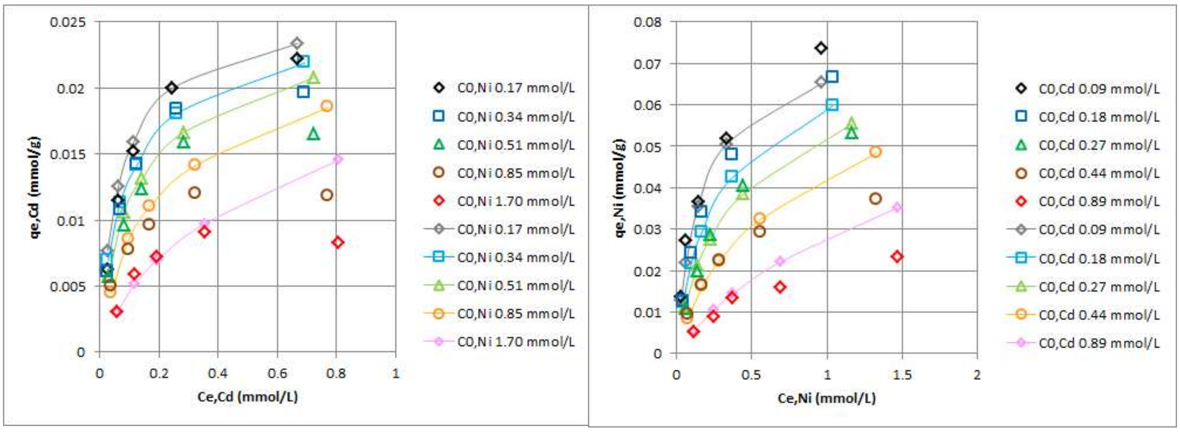

Figure 3. Modified competitive Langmuir isotherms (markers with connected lines) with experimental data (markers without connected lines) of Cd (left) and Ni (right).

Table 2. Isotherm parameters for competitive adsorption of Cd(II).

	$q_{m,i}$	$K_{L,i}$	$\eta_{L,i}$	Φ_i	a_i	n_i	χ^2
NML	0.027	20.984					0.010
ML	0.027	20.984	1.123				0.012
EL	0.026	24.453_{Cd}, 16.864_{Ni}					0.008
JAMM	0.027	20.984		1.025	2.536_{Cd}, 0.0002_{Ni}	3.015_{Cd}, 0.013_{Ni}	0.013
rJAMM	0.027	20.984		1.225	0.329_{Cd}, 0.352_{Ni}	0.679_{Cd}, 1.126_{Ni}	0.004

Table 3. Isotherm parameters for competitive adsorption of Ni(II).

	$q_{m,i}$	$K_{L,i}$	$\eta_{L,i}$	Φ_i	a_i	n_i	χ^2
NML	0.083	10.207					0.024
ML	0.083	10.207	1.255				0.017
EL	0.087	15.016_{Ni}, 48.008_{Cd}					0.010
JAMM	0.083	10.207		5.107	0.0007_{Ni}, 0.084_{Cd}	0.299_{Ni}, 1.139_{Cd}	0.008
rJAMM	0.083	10.207		1.405	0.356_{Ni}, 0.529_{Cd}	0.804_{Ni}, 1.170_{Cd}	0.005

The Extended Langmuir model, optimized using three parameters, provided a better overall representation of the experimental data (Figure 4). However, because its parameters are not related to single-component isotherms, the model does not fully capture the fundamental nature of competitive adsorption.

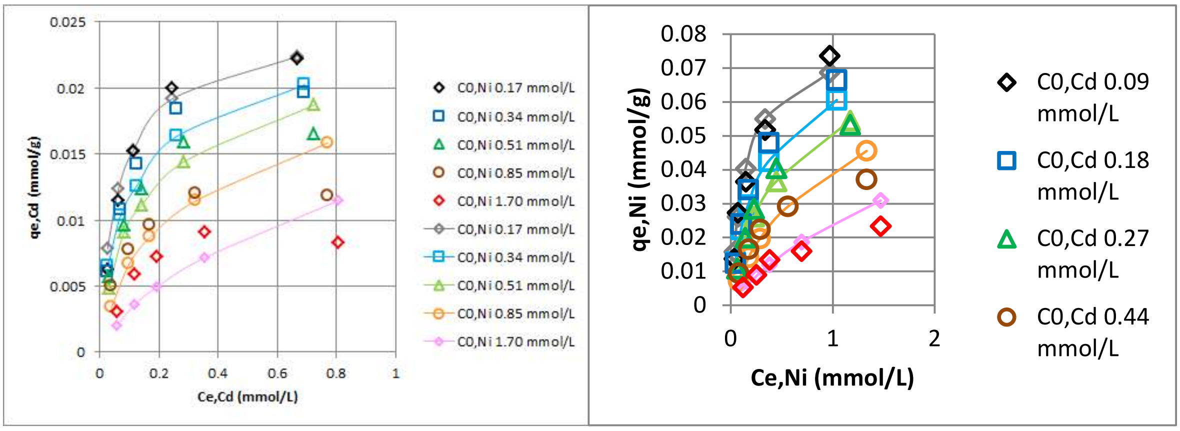

Figure 4. Extended Langmuir isotherms (markers with connected lines) with experimental data (markers without connected lines) of Cd (left) and Ni (right).

The JAMM model, with five parameters estimated by nonlinear regression, performed better for Ni(II) but poorly for Cd(II), as shown in Figure 5 and Tables 2 and 3. The large number of parameters may require more extensive experimental data for robust fitting.

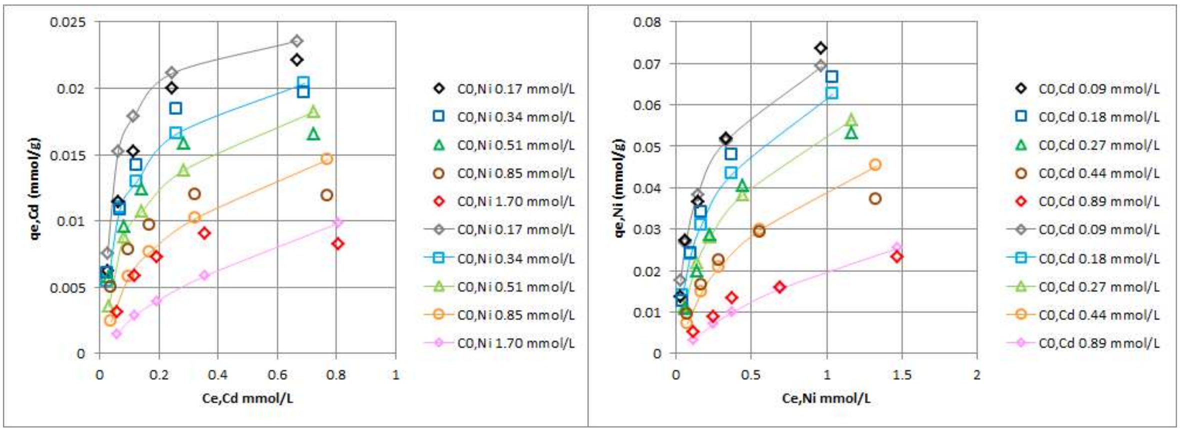

Figure 5. JAMM isotherms (markers with connected lines) with experimental data (markers without connected lines) of Cd (left) and Ni (right).

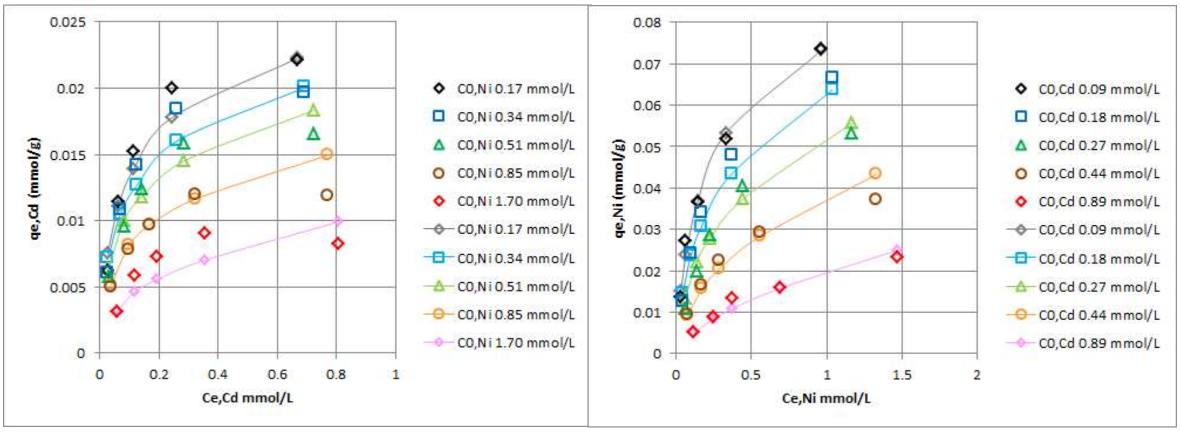

Figure 6. Reduced form of JAMM isotherms (markers with connected lines) with experimental data (markers without connected lines) of Cd (left) and Ni (right).

To reduce complexity, the reduced JAMM model was tested by excluding mole fraction terms. Results (Figure 6) demonstrated the best overall agreement with experimental data, supported by the lowest chi-square test values in Tables 2 and 3.

4. Conclusions

This study compared several multicomponent adsorption isotherm models using the case of Cd(II) and Ni(II) adsorption onto rice husk ash. Except for the extended Langmuir model, most models were based on parameters derived from single-component isotherms. Model performance, evaluated using chi-square tests and visual comparisons, generally improved as the number of parameters increased. Among the models studied, the reduced form of the JAMM model provided the best fit, effectively balancing accuracy and complexity.

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